DAF service

Ignition systems

A common problem and reason for breakdowns in the ignition system, so it would seem appropriate to highlight and identify the ins and outs so that should a fault arise, you may be able to get up and running again more quickly.

The ignition system comprises of the ignition switch, a coil, a distributor and the spark plugs. Only the distributor is complicated as it contains the contact set, the condenser and the rotor arm; all components that we have heard of but do we know what they really do?

Let's look at the whole system in the order each component plays its part and where necessary, we'll take time to discuss each item in the system.

The ignition switch

The ignition switch only energises the rest of the system when the ignition is turned on. There is the further position on the switch that is spring loaded and which operates the starter. Essentially, the switch is two switches in one – the first part operates the ignition and it can be likened to a simple on/off switch. We can turn the ignition because we want to start the car, and we can leave it turned on until we want to stop the car. The second part of the switch operates the starter. As long as we are in control and can turn it off as soon as the engine is running, no harm will be done and in fact, we can copy this mechanism by using two separate switches. Electrical current flows to the coil when the ignition is turned on.

The coil

The coil is best looked upon as the "spark maker" and it has two electrical systems in its design. There is primarily the 12-volt system, which feeds from the ignition switch via the coil to the distributor. This "low tension" function causes the coil to internally produce a "high tension" spark which leaves the coil via the thick lead from its centre and which is connected to the centre of the distributor cap. Let's leave the "high tension" side for a while and concentrate on the "low tension" arrangement. The 12-volt (or on early air-cooled DAFs, 6-volt) feed from the negative terminal of the coil is connected into the contact set inside the distributor:

The contact set

The contact set is merely a switching device and comprises two separate contacting surfaces, which as the contacts close and open, make and break the circuit. The opening and closing is controlled by the rotating centre spindle which is not round but round with lobes on which force open the spring-loaded contact set and then let them close together again.

One part of the contact set is earthed through the base of the distributor thus creating the complete circuit when the two contacting surfaces are closed to allow the current to flow from the battery via the ignition switch, via the coil to the distributor, to earth via the contact set.

Each time a lobe on the centre spindle passes the heel on the contact set the contacts open and close briefly thus making and breaking the circuit and each time this occurs, the coil emits a high-tension spark (at around 12,000 volts) via the thick centre lead.

As the lobed spindle of the distributor rotates rapidly when the engine is running, the contacts make the coil emit a series of these high-tension sparks.

How then do we arrange for the spark to leave the coil and arrive at the correct spark plug at the right time? The heavy lead from the coil is connected to the centre of the distributor cap and spark travels through the cap to the carbon brush which is situated inside the centre of the cap and which rests on the rotor arm.

The rotor arm

The rotor arm rotates with the lobed spindle and allows the spark to be distributed to one of the brass contacts around the rim of the cap. The high-tension spark is then fed along the plug lead to the spark plug. By the time the next spark from the coil reaches the rotor arm, its position will have moved to the next contact in the cap thus distributing the spark to another spark plug. Of course, the whole action only takes a mere fraction of a second.

The condenser

The other component of the ignition system not yet mentioned is the condenser, but really it only "smoothes" the flow of current at the contacts. The condenser usually works and if it fails, it tends to cause misfire when under load.

Dwell

Dwell is usually expressed in degrees and refers to the angle through which the distributor spindle rotates whilst the contacts remain closed. Typically it is 50 or 60 degrees and is adjusted by adjusting the contacts to the correct gap.

When you set the contacts using a feeler gauge, it is a pretty good guide but the accuracy of the system is thwarted if you are not sure how much grip there should be on the feeler gauge. I.e. should the feeler be a sloppy or tight fit between the contacts and then how sloppy or tight?

Even if years of experience guide you, you cannot know how much any wear in the distributor will affect the accuracy when the centre spindle is rotating. With the dwell method, you measure the angle dynamically and all wear and tear effects are taken into account, so it is a more accurate method.

Remember, too much dwell means too little gap at the points; too little means too great a gap.

Fault tracing in the ignition circuit

Generally, ignition faults show themselves as a complete or sudden failure.

Petrol associated faults, on the other hand, generally show themselves as missing and spitting intermittently before the engine dies.

For the engine to run at its optimum, it must be set up at an optimum setting. Manufacturers specify various specifications which if met should ensure that the engine gives of its best.

The details hinge upon:

a. The timing point expressed in degrees before, at, or after Top Dead Centre

b. The dwell angle expressed in degrees and which means the amount of rotation of the rotor arm during which the contacts remain closed

c. Engine speed expressed in revs per minute (RPM)

When we say the timing should be set to Top Dead Centre (TDC) we mean we want the High Tension (HT) spark to occur when No. 1 cylinder has its piston at TDC on the firing stroke. That is when the piston is at its highest point in the cylinder but that occurs twice in every cycle of the 4-stroke engine. (Try not to become confused; one cycle comprises the following: induction, compression, expansion, exhaust) In slow motion, the piston:

a. Moves downwards sucking the air/fuel mix into the cylinder via the inlet valve (Induction)

b. The valves both close and the piston moves upwards thus compressing the air/fuel mix (Compression). Note, if the engine is said to have 10:1 compression ratio, it means that 10 volumes of air/fuel are compressed into 1 volume when the piston moves from the bottom to the top of its stroke.

c. At the top of its stroke the valves remain closed, thus the air/fuel mix is trapped in a small volume (the combustion chamber) and the HT spark is made to occur. The explosive mixture and a spark together create an explosion in a small place, the force of which forces the piston back down the cylinder. The point of firing or the explosion is the expansion stroke (Expansion).

d. When the piston is at the bottom of its stroke, the exhaust valve opens and as the piston rises, the burnt gases are exhausted via the valve into the exhaust system (Exhaust)

This represents a full cycle, which is repeated continuously while the engine is running and each cylinder is arranged to be on a different stroke of the cycle. Even though it is only ONE CYCLE the piston has moved down and up twice, i.e. two revolutions of the crankshaft. So we can see that at 2000RPM, the above cycle is completed 1000 times per minute.

If an engine fires at a time other than TDC, then it fires other than when the air/fuel mix is at its most compressed. If it is way out, then power will be reduced and indeed it maybe that the explosion is so weak as to be negligible. E.g, if it is arranged to fire on the exhaust stroke, the exhaust valve is open, there is no compression so there swill be now power developed.

The manufacturer's figure is the one to work to. If a DAF 66 is meant to fire at 6 degrees before TDC, it means it should fire 6 degrees of revolution before it reaches TDC.

So, thinking back over what we have said, we must ensure our engine fires at exactly the right point of rotation the manufacturer recommends. Carefully with a spanner, we turn the engine until the fixed point and the marker on the crank pulley are aligned (on a 66 the marks are on the flywheel not the crank pulley but the principle is the same).

Align the rotating mark with the fixed point. The engine is then at the place where the spark should occur. All you have to do then is to arrange for a spark to occur at this instant. By rotating the distributor we can arrange for the spark when we want it. Remember that the HT spark occurs at the split second the contacts open. The contacts are controlled by the lobe on the distributor shaft and instead of the shaft rotating and opening the contacts we can rotate the distributor body relative on the lobed spindle to create the same effect.

All we then have to do is to fix the distributor in the position where the spark is made. When the contacts are touching, the low voltage from the ignition switch (6 or 12 volt) passes across the contacts to earth. When the contacts open there is no route to earth for the voltage, be it 6 or 12 volt.

By connecting a bulb to the distributor or coil negative terminal and earth, the bulb will not light when the contacts are closed because the current takes the least line of resistance to earth. I.e. directly via the points rather than via the higher resistance of the bulb. When the contacts open, the route via the bulb is the only route available to the current which will cause the bulb to light.

By having the ignition on (to provide the voltage) the bulb should be off, then by rotating the distributor to the point where the bulb lights indicates the point where the spark will be made.

That's all there is to it.

As a variation but achieving the same result, rather than a bulb a voltmeter can be used. A bulb shows no light and it lights up. A voltmeter shows 0 volts, then it will show the voltage of the battery. Either way is the point you need. So clamp the distributor at this point.

Speed of light!

It has been suggested that the static method is inaccurate because it demonstrates the spark at the distributor centre, not at the spark plug, but mathematically the difference is negligible. Consider that the distance the spark has to cover in these circumstances is the length of the centre carbon brush in the cap, the length of the rotor arm, the distance through the cap from the inner electrode to its outer end, and then along the plug lead and finally along the length of the spark plug – a total distance of, let's say, 18.6 inches.

We know a spark travels at 186,000 miles per second, i.e. 186,000x63, 360 inches per second. So we can calculate that to travel along the 18.6 inch route to the spark plug, the spark plug will take:

$$\frac{18.6}{186{,}000 \times 63360} \text{ seconds}$$

$$= 10{,}000 \times 63360 \times 10 \text{ seconds}$$

$$= 6{,}336{,}000{,}000 \text{ of a second}$$

You can see, therefore, that the difference in time between the spark leaving the coil and reaching spark plug in the combustion chamber is absolutely negligible.

Putting theory into practice

In order to set the timing, we need to ensure that the spark at the plug occurs when the crankshaft has rotated to the correct position. By removing the HT lead from the centre of the distributor cap and placing it adjacent to a good metal part of the engine with a small gap between the lead and metal component, we can turn on the ignition and turn the crankshaft nut with a spanner either on the crankshaft pulley or the dynamo pulley nut. When the spark is seen to jump then that is the precise moment to stop turning the crankshaft and see if the timing marks are in alignment. Try it on your car first as it is now and surprise yourself.

Some people say that this method is inaccurate because it's not possible to stop rotating the crankshaft quickly enough when the spark is seen. To an extent, I agree with this because the compression on the cylinder head tends to spring the crank a little further than you intend to turn it. Nevertheless, this way demonstrates the spark in the manner in which it is produced normally when the car is running.

Having regard to the calculations shown, for our purposes if we know when the spark is generated, we know too that this is the time when the spark occurs at the plug. To recap, we know the spark occurs just as the points are opening, so setting the timing is simply a matter of ensuring that the crankshaft is in the correct position and at the same time ensuring the points are just opening.

The crankshaft is easily positioned using a spanner on the crank or dynamo pulley to rotate it to the correct position. Remember that it is at TDC TWICE on every cycle of the engine, so care must be taken to ensure that the crankshaft is in the correct position and on the firing stroke. It will be when the timing marks are aligned AND the rotor arm points to the plug lead of the No.1 cylinder. We can then slacken the distributor clamp and rotate the distributor until the contacts are just opening. At this point the distributor can be re-clamped and the timing has been set "statically".

How do you know that the contacts are just open? Well, I agree. You can't readily see them and certainly you cannot with any accuracy. There are two methods available to you:

1. You can detect the HT spark by placing the centre HT lead from the distributor cap to near a clean metal part of the engine. Then with the ignition on, turn the distributor anticlockwise until a spark jumps to earth. This is the correct point. Or:

2. You can use the low-tension circuitry to indicate to you when the spark is produced. By connecting a bulb, buzzer or voltmeter between the distributor side terminal or the negative terminal of the coil and earth, you will find the 12 volt current preferentially runs to earth via the closed contact set, and not the bulb/voltmeter etc. As the distributor is turned, the contacts will open thus breaking this route to earth for the low-tension current, which then chooses to run to earth via the bulb or voltmeter. The current causes the bulb to light or the voltmeter to register the voltage of the battery. At the precise point when the bulb lights, you clamp the distributor in this position to set the timing "statically".

   If you use a voltmeter, in theory it will register 0 volts and then it should register 6 or 12 volts depending on the system in you DAF. In practice it reads 0 volts and if you gently rotate the distributor you reach the point where the contacts are only just still touching but without any spring pressure to hold them together. Here with a sensitive voltmeter you will record something like 0.25 volts immediately before the contacts open to show the 6 or 12 volts you were expecting. This is normal.

To fine tune your ignition system

Now we are all knowledgeable about the components and the part they play in helping our engines run at optimum efficiency, let us consider replacing the plugs and points and tuning our ignition to give its best.

My method would be as follows:

1. Remove the spark plugs
2. Remove the distributor cap and rotor arm
3. Replace the contacts and turn the crankshaft until the heel of the contact set sits upon the highest part of the lobed centre spindle of the distributor. Now adjust the contact set gap with feeler gauges, to give the manufacturer's recommended gap.
4. With the dwell meter connected, operate the starter and read the dwell angle. You can do this without replacing the distributor cap.
5. Adjust the contact to give the correct dwell reading.
6. Next replace the rotor arm and distributor cap.
7. Rotate the crankshaft until the timing marks are in the desired position (see manufacturer's specifications).
8. Slacken the distributor clamp and attach your bulb or voltmeter to the negative coil terminal and earth, or between the distributor LT terminal and earth and turn on the ignition. The reading should be 0 volts or the bulb should not be lit. If this is not so, turn the distributor a little clockwise to arrive at this position. Gently turn the distributor anti-clockwise until the bulb lights or the voltmeter reads the voltage of your car.
9. Re-clamp the distributor in this position and turn off the ignition.
10. Replace the spark plugs – accurately gapped and replace the plug leads.

Your ignition should now be perfectly set. Start the engine and with your rev counter adjust the tickover to the recommended setting.

Timing Lights

Basically there are two types:

The first has two leads which interrupt the route of the spark, and direct it via a bulb in the timing light on its route to the spark plug. They are simple, work reasonably well but their drawbacks are that you have to switch of the engine to connect the light between the spark plug and HT lead, then operate the engine and finally switch off to remove the light from the circuit. The light is also rather dim which cannot readily be seen in daylight.

The second type has an external power source for its light and a third lead to trigger the flashing light. These have much brighter white bulbs and can be seen in daylight.

They can be mains (240 volt) or car battery (12 volt) operated. The mains type obviously means you can only use it at home and not by the roadside. The battery versions, although more expensive, are much more useful. Similarly, the trigger mechanism relies on of the two systems. Either the spark path is interrupted, the spark being diverted via the light to trigger the flash, or a separate inductive pickup is used. The former necessitates the same procedure as Type 1 above. I.e. you have to disconnect the plug lead, reconnect it and then go through the same procedure after setting the timing.

More modern types with the inductive pickup can be clamped across any lead whilst the engine is running and are particularly useful when one cylinder is not firing, as you can clamp the pickup on each lead in turn to detect which lead does not work.

Static or dynamic?

Dynamic Timing means setting the engine without it running. Of course you can't detect the points opening and closing at speed so an alternative method has to be found to those suggested in setting the ignition statically. Enter the timing light!

The timing light detects the high-tension spark and flashes a light in unison with the spark. By arranging the timing light to operate in unison with the No.1 cylinder spark plug, the light can be aimed at the timing marks and the stroboscopic effect makes both the stationary and moving timing mark appear to be stationary. By carefully rotating the distributor we can see the marks move relative to each other, and when they are aligned the timing is set accurately and distributor can be re-clamped.

Dynamic timing takes account of wear in the distributor and should be more accurate than static timing. However, the distributor is more sophisticated than we have accepted so far. It merely provides the switching mechanism which produces the spark but is influenced by the speed of rotation of the centre spindle and the vacuum of the manifold.

The base plate of the distributor is able to move and is spring loaded into the static position. As the revs rise, the spring-loaded bob weights move and cause (through centrifugal force) the base plate to move relative to the centre spindle thus changing the timing of the engine by a small amount. **This is Centrifugal Advance**.

It is determined by the manufacturer and need not be considered adjustable by us.

Secondly, the base plate is influenced by the vacuum caused in the manifold when the engine is under load. The vacuum, which sucks along a small pipe which is attached to a bell arrangement in the side of the distributor. In here is a diaphragm which moves depending on the amount of vacuum produced. In turn this alters the position of the base plate relative to the centre spindle, again altering the timing as the engine runs. **This is Vacuum Advance**.

Again, it is determined by the manufacturer and is not to be considered adjustable by us.

One difficulty of setting the ignition with a timing light (the dynamic way) is that the centrifugal and vacuum advance may come into effect and although we think we have set the timing correctly, we may be quite a way out, especially on air-cooled models. Of course, the vacuum advance can be discounted by disconnecting the vacuum pipe but the centrifugal advance cannot be disconnected.

It is for this reason that manufacturers specify that the dynamic timing should be set at a given engine speed.

So now you are going to require a rev counter too, and as you alter the timing, the engine speed varies so you have got to balance the timing setting with the rev counter reading and ensure that all meets the specifications laid down by the manufacturer.

Finally and very personally, I never set the timing dynamically on an air-cooled DAF, but would use either method on a water-cooled DAF. The reason is that air-cooled DAFs, especially later ones, have extremely light centrifugal springs and even at very low engine speeds, the centrifugal advance upsets the accuracy of the dynamic method.

Distributor removal

Never attempt to dismantle a distributor whilst it is still inserted into the engine block. You will only succeed in dropping bits into the most inaccessible places. Always undo the clamp bolt and remove the distributor first.

Water-cooled engines

Undo the 11mm clamping nut and lift off the retaining fork. The distributor will then life vertically from the block.

Inside the Ducellier distributor you will notice on the base plate a notched “D” shaped piece. The notches and the teeth, which align with the notches, are factory set to control the individual advance of the distributor.

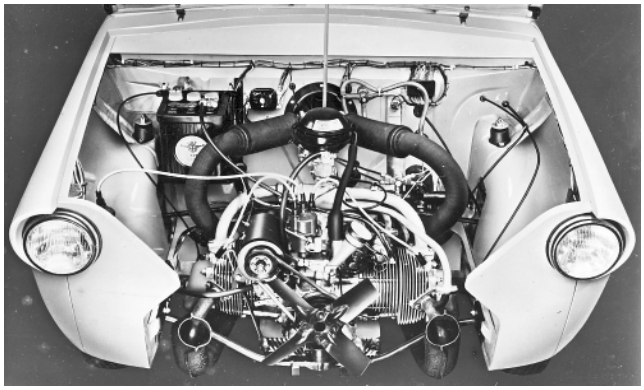
Re-setting the advance requires a very expensive special tool, which only the very largest Renault dealer may have.

Other than that, it’s back to Ducellier. Note where your tooth and segment arrangement is and do not disturb the setting, otherwise your distributor characteristics will be damaged beyond recognition. Why not note the set position of your distributor, write it down and leave it stuck on the inside of your toolbox for that “just in case” moment?

Air-cooled engines

Because of the heat from the engine, oil and grease will sometimes accumulate on the bob weights in the base of the distributor, which will become very gummy. This may cause the weights to stick a little, necessitating the dismantling of the distributor to effect a remedy.

It’s all very straightforward and as long as you lay everything out in order, rebuilding really is a reversal of the dismantling process.



How to install a distributor into the engine block

If the distributor has been removed, and the engine turned so that the timing point has been lost, do not despair. The following simple procedure will enable you to put it all back together and have it running at the first turn of the key.

Turn the crankshaft until both the timing marks are aligned, and with the No. 1 cylinder on the firing stroke. Remember that the crank rotates twice for each cycle of the engine (induction, compression, expansion, exhaust). You need the engine at the top of its compression stroke for the No.1 cylinder and not its exhaust stroke.

Easy checks are to take out the spark plug and put your finger over the No.1 plug hole and while turning the crankshaft with a spanner, you should feel the compression build up. In this condition with the marks aligned, you have the crankshaft in the correct position. The No.1 piston is at the TDC of the firing stroke.

Therefore at the top of its stroke, the exhaust valve must close and inlet must open. You can easily observe the valve stems “rocking”, i.e. one just closing, the other just opening indicating that No.1 piston must be on the compression stroke. Think about this one because it is not easy the first time it’s explained, but once you’ve grasped it, it will save you many, many hours of frustration when rebuilding engines.

Already, the air-cooled members are worrying about their No. 4 cylinder. Don’t. I know you’ve only got two cylinders, so for 4, read 2.

When the engine is correctly aligned, it is a simple matter to drop the distributor back in its place ensuring that the rotor arm is pointing to the No. 1 spark plug on the distributor cap. All you need to do then is to fine-tune the ignition as previously described. Remember to replace the rotor arm, distributor cap, connect up the coil and it will go first time.

Sit with a red face all those who have carefully put the rotor arm in their pocket and then wondered why the car won’t start!

Steve Bidwell