Static ignition timing for engines with breaker points / distributor ignition

Let's start with a basic description of the operation of the ignition system:

The IGNITION COIL has a 'low tension' and a 'high tension' circuit. On the nose of the ignition coil there is a small terminal marked negative and a small terminal marked positive. These terminals are at the ends of a wire that is wound many many times around the inside of the coil body- this is the 'primary winding' also called the 'low tension winding' of the coil. Another set of windings, the 'high tension' or 'secondary' windings are *inside* the primary windings. These secondary windings are connected to the larger terminal on the nose of the coil body- the one where the big spark-plug wire goes.

When the LOW TENSION windings are energised at (nominal) 12volts, a magnetic field is created by the current passing through the primary windings. When the current to the PRIMARY windings is suddenly switched off ('broken'), this magnetic field collapses across the SECONDARY windings, creating a massive electrical spike in the secondary windings, which makes its way down the spark plug wires to burn your expensive petrol.

Inside the distributor there lives a set of 'breaker points' whose job it is to 'make' and 'break' the continuity of the low-tension ignition circuit, acting as a mechanically operated switch. Positive battery voltage, via the ignition switch, is supplied to the positive terminal of the ignition coil; the negative terminal of the coil is connected to ground VIA THE BREAKER POINTS. As the distributor rotates, the contact points are opened and closed by a cam on the distributor shaft. When the points are closed, the LOW TENSION circuit of the coil Is switched on and the magnetic field starts to build up. When the points are opened (by the rotating distributor shaft), the primary circuit is 'broken' and the secondary or HIGH TENSION circuit sends out it's high-voltage spark. The distributor is constructed so that the 'rotor button' will be aligned with one of the high-tension terminals of the distributor cap when this occurs.

DWELL ANGLE refers to the duration (expressed in degrees of distributor shaft rotation) that the ignition points are closed. This is influenced by the 'points gap' which refers to how far apart the contact points are at their widest opening, i.e. at the top of the cam lobe. There is a balance between how long the points stay closed (or 'dwell'), allowing a good fat magnetic field to build up, and how far they open, ensuring a complete break of the primary circuit. This is specified by the engine designer. Dwell angle can be measured with an inexpensive meter. Points gap is usually set by feeler gauge. For practical purposes, the amateur mechanic can set the points gap with the engine off and let the dwell angle worry about itself. (NB it is useless trying to set the gap of pitted or worn ignition points; the feeler gauge will be riding up on lumps and hollows and will not reflect the true electrical gap)

Now that we know how the spark is made, the next bit is to get this spark into the combustion chambers at the right moment (in relation to the movement of the piston). Ignition timing is expressed in DEGREES BEFORE TOP DEAD CENTRE or degrees BTDC. 'Top Dead Centre' refers to the position of the piston at the very top of its stroke within the cylinder. The DEGREES in question here are degrees of CRANKSHAFT revolution. Spark will always need to occur BEFORE the piston reaches the top of the compression stroke, as it takes time for the pressure of the

burning fuel to build up enough to push the piston powerfully down on the POWER STROKE. (note; the faster the engine is running, the earlier the spark will need to occur, as the burning of the fuel does not speed up; hence the centrifugally-operated advancing mechanism in the distributor).

A spark timed to occur earlier in crankshaft rotation is referred to as ADVANCED; a spark occurring later is referred to as RETARDED. An excessively advanced ignition will result in the pressure wave of burning fuel-air mixture building up before the piston reaches TDC, the pressure wave tries to stop the piston coming up, resulting in engine KNOCK or 'pinging / pinking'. An excessively retarded spark will result in the pressure wave following the piston down a feeble power stroke. In the goldilocks zone, the expanding pressure wave reaches its peak as the piston commences its downward travel and propels the piston smoothly down the cylinder.

To set the ignition timing, the body of the distributor is rotated, thus altering the comparative position of the ignition points (mounted to the distributor body) and the lobes of the distributor shaft cam, which remains in a fixed relationship to the engine crankshaft. Rotating the distributor body *in the opposite direction to distributor shaft rotation* will bring the points into contact with the cam *earlier,* thus advancing the spark timing. Rotating the distributor body *in the same direction as distributor shaft rotation* will move the points *away* from the approaching cam lobe, *retarding* the ignition timing.

Phew, that took longer than expected- but I always think it's worth knowing how something works before we mess with it. Now let's get to what it said on the tin- STATIC IGNITION TIMING which simply refers to setting the ignition timing whilst the engine is not running.

This can be done in two ways; either with the use of a lamp to indicate the moment that the points open, or without a lamp, by observing the small spark that occurs between the points as they break contact. I'll describe the process in relation to both methods.

We remove the distributor cap from the distributor- this both enables us to observe the points, looking for that little spark, as well as ensuring that the engine does not start as we rotate it by hand, tearing off valuable parts of our body.

Locate the ignition timing marks- usually on the front pulley of the engine- and the reference pointer that interacts with these marks.

A NOTE ABOUT TIMING MARKS: some engines have only one mark; this will be at TDC. Some engines have TWO marks; generally speaking, the one that reaches the pointer first (i.e. leading mark) will indicate the static, or idle, timing point- usually about 6 to 8 degrees BTDC. The TRAILING mark will be the TDC mark. Some engines will have multiple marks, usually helpfully labelled in degrees BTDC. There will not be any marks after TDC. No-one is interested.

We need to know which way both the CRANKSHAFT and the DISTRIBUTOR SHAFT rotate when the engine runs. If unsure of this, an easy way to find out is to remove the distributor cap and hang it safely out of the way, then have someone briefly crank the starter whilst you watch which way both things turn. Don't stick your fingers in anything. Tell your assistant to get the heck away from that starter for the rest of the job.

You'll need a way of rotating the crankshaft manually; a spanner on the crankshaft pulley bolt usually works, or some engines can be turned by hand, holding onto the pulleys- don't get your fingers cut off by the fan belt.

NOTE: do not turn the engine backwards at any time; some engines can be damaged by doing this. I don't know if your engine is one of those.

If you're using a test lamp, now is the time to connect it TO THE NEGATIVE TERMINAL OF THE IGNITION COIL and to an EARTH point somewhere on the engine or car body. The test lamp is thus connected in PARALLEL with the ignition points. If the points are CLOSED, the lamp will not illuminate, as the current is taking the path-of-least-resistance via the points. If the points are OPEN, the lamp will illuminate.

Turn the ignition ON. (the engine won't start with the distributor cap removed). Slowly rotate the crankshaft (manually, not with the starter) in its normal direction of rotation, until the timing marks on the pulley begin to approach the reference mark or pointer. Observe the distributor contact points closely- there will be a small spark at the points at the moment that they break contact. If you're using a test lamp, this is when it wlll light up. Observe where the timing marks are in relation to the pointer at the moment that the points break contact; THIS IS WHERE YOUR IGNITION TIMING IS CURRENTLY AT.

As a rule of thumb, a static ignition timing set at 8 degrees BTDC will enable just about any engine to start and run.

If you need to change the timing, proceed as follows:

Rotate the crankshaft (the correct way) until the ignition timing marks are lined up where you want the spark to occur, (e.g. 8 degrees BTDC). Loosen the distributor clamp bolt enough so that you can rotate the distributor by hand but with a little friction so that it stays where you put it. Rotate the distributor body a little way *in the direction of distributor shaft rotation* until you are sure the points are CLOSED (test lamp will not be lit if you're using one). Now rotate the distributor body SLOWLY back the other way until the points open, i.e. test lamp lights up, tiny spark at the points. Tighten down the distributor clamp bolt or nut, making sure the distributor doesn't move.

THAT'S IT you're done. Turn off the ignition switch. Put the distributor cap back on. Admire your work.

One more note: don't go and have lunch in the middle of this job and leave the ignition switched on. If the ignition is left switched on for long periods whilst the points are in the closed position, the primary windings of the ignition coil are energised and will overheat, ruining the ignition coil.

I hope this was helpful, this knowledge has been taking up space in my brain since 1979.