Ferret Ignition

The coil on the Ferret is a 12-volt unit mounted horizontally on the induction manifold. A ballast resistor connected in series makes this suitable for a 24-volt supply. The resistance is short-circuited at starting. The reason a 12 volt coil with a ballast resistor (3.8 ohms) rather than a 24 volt coil, is used on the Ferret is because a 24 volt coil has a primary inductance of about twice that of a comparable 12v coil.

When the contact breaker opens, the induced charge across the primary winding is about 300 volts. Because the primary winding produces much more heat (about 100x as much) than it the secondary, it is wound on the outside of the coil, bringing it into closer contact with the insulating/cooling oil and the outside case. The HT output is generally via the screw sealing the oil filler plug.

One reason the Ferret uses a 3-sided camshaft and two sets of points is to reduce physical and electrical wear. The disadvantage is that *both* sets of points must be in proper synchrony.

The other reason - the main one - for having two contact breakers arises from the need to screen the ignition system to prevent radio interference. The screening braid introduces capacitance, which **reduces the amount of available HT**. This problem manifests itself at high engine speeds and under heavy loads. At high revs/engine speed a 6-sided camshaft would lead to 'points bouncing' where the movable contact point loses some of its closing tension and the points then either bounce or float, preventing the normal induction charge to build up. Having a small points gap (0.010" – 0.012") which means an increased dwell time and a small gap at the spark plug (0.015" – 0.018") also means better performance from a naturally weaker HT spark, particularly as the loss of HT becomes greater with increasing engine speed. The Ferret ignition system is screened and filtered to reduce radio interference. The filter unit comprises two choke coils connected in series with the low tension circuit on the primary winding side.

The **distributor** performs three functions. Firstly it switches the LT supply to the ignition coil by opening and closing the contact breaker 'points'. Secondly it coordinates this LT supply with the rotation of the rotor arm that distributes the HT to the spark plugs in the correct order. Thirdly it optimises engine performance by advancing the ignition timing.

The distributor is situated centrally on the exhaust side of the engine, and is driven in a clockwise direction (looking down onto the engine) by an extension of the oil pump driving shaft. The contact breakers, with two sets of contact points, are actuated by a three-lobed cam. Under the baseplate in the distributor is an automatic advance mechanism. Very occasionally the distributor will require mild oiling, although in practice this rarely occurs.

The ignition switch and starter switch are situated on the switchboard. When the **ignition switch** is turned on, current from the battery is fed through the distribution box, generator panel, ignition switch, ballast resistors and the filter unit to the coil. Current is also fed through a circuit breaker to the generator warning light, oil pressure switch, oil pressure light, starter switch, temperature gauge, fuel gauge, and instrument panel lights. (Switchboard exploded diagram here).

When the **starter switch** is operated, the starter motor soleneoid and starter motor are energised. At the same time, the ballast resistance is shorted and the full 24 volts applied to the coil. When the starter switch is released - it springs back – the ballast resistance is inserted into the ignition circuit so that the voltage applied to the coil is now 12 volts.

A 24 volt electrical system is used for two reasons. First, to achieve high starting power, since for a given electrical power requirement, the doubling of the voltage (pressure) compared with 12 volt systems, reduces the current (amps, I) by half (P = V x I). Without the extra 12 volts, the current load on the battery and starter circuit becomes exceptionally high, especially on a cold morning in winter. Heavy power equipment runs better off 24 volts; there is less stress on lead-acid batteries during engine starts. Higher torque starters could be made to handle higher compression engines. Also, sufficient electrical power is required for the high torque needed to overcome inertia of heavy engines.

The second reason for a 24 volt system is to power the Clansman radios for long periods when the vehicle is static but with the engine idling. A third advantage of 24 volt supplies is that they are more compatible with AC appliances. For any given load, if the DC current is halved, losses are down by ¼. This also reduces any fire risk. The effect of any voltage drop is reduced because it is proportionally a smaller percentage of the initial 24 volts. Also, reducing the current means that smaller diameter wires can used.

A ballast resistor has two functions.

1. To give out full battery volts on a 12v coil. During start up the ballast resistor is short circuited & applies the full battery volts to the coil, although this may be a bit lower due to the drain of the starter motor. It also depends how good the battery is. Prolonged hanging on the starter button (more than 10 secs) can overheat the coil.
If you apply Ohm's Law to the circuit, all becomes clear. The essential fact is that the ballast resistor only reduces the 24v supply to the coil during the period when the points are closed and current is actually flowing through the circuit: +24v --> ballast resistor --> coil primary --> earth --> battery negative. With this current flowing, there is a (approximately) 12v drop across the resistor (which is dissipated as heat) leaving the other 12 to appear across the coil. When the points are open, no current flows, so no 12v drop across the ballast resistor, therefore the voltage measured at the coil + terminal rises to 24v. The resistor also ensures the coil magnetises faster (see this graph).

2. To boost the HT output. This can be in high performance vehicles but in MVs particularly in screened ignition systems operating on 24v. Adding resistance to the primary circuit offsets some of the effect of inductance of the coil. It has the effect of reducing the time constant of the circuit. The result is that at high revs the engine can perform better by a more rapid collapse of the magnetic field in the coil when the contact breaker opens. This is used in screened systems to try to compensate for the HT that is lost by trying to 'charge up' the capacitance in the screened cables.
Ballast resistances in civilian ignition systems are for improved cold starting & although this feature is incorporated in the RR system, the important issue for a screened HT system is the improved time constant to allow the magnetic field in the coil to collapse & deliver the maximum spark (see this graph).

Capacitors (condensers)

Without a capacitor, or with a defective one, there will be increased sparking at the contact breaker. This affects the performance of the engine, particularly under load, because of the lower HT output. It is important to differentiate between the two types that may be found around an ignition system. There will often be a capacitor in the feed to the coil (SW) this might be rated a bit above the normal vehicle voltage say 25v. Its purpose is to try to dampen down some of the interference from the contact breaker from entering the vehicle wiring system. It is of limited effect & in FFR vehicles a more sophisticated filter is often built into the ballast resistor enclosure.

The important capacitor is the one in or connected to the distributor this is rated at about 500v, as the back EMF in the primary winding when the contact breaker opens is around 300v. The small spark at the contact breaker is the effect of this voltage. Without it the points will wear more rapidly because the greater spark occurring when the coil is switched off will be less abrupt there will be a reduced HT output. The capacitor can have the effect of improving HT output by 30% compared with no capacitor (see this graph). The contact breaker needs to open very rapidly in order to ensure that, by the time the condenser has done its job, the points are open enough to ensure that the low tension current could not jump the points gap.

Capacitors rarely fail outright but the insulation will deteriorate with time even if unused. The only way to get a reliable assessment of capacitor performance is to test it at its rated voltage. Trying test with a multi-meter might only weed out a few absolutely awful capacitors, it will not distinguish poorly performing capacitors that are contributing to poor engine performance. Capacitors that get too hot will suffer a reduction in their internal resistance and so will gradually fail over time.

The generator and distribution box within the Ferret can be seen here
The internal construction of the generator panel and wiring diagram is here.

Full instructions for **setting the engine ignition timing** is given here, taken from the Rolls Royce Workshop Manual TSD702 (1961) Section 22: Ignition System, plus the two pages on valve timing from Section 13:Wheelcase & Power.