Note 16

Sparking-plug Problems and their solution

Up until 1939 sparking-plugs were often blamed unjustly by team managers for racing retirements but actually the basic problem of keeping the high-tension central electrode insulated while getting rid of the heat absorbed by the surrounding insulation had been solved before WW1 by using mica for the latter instead of the brittle porcelain of the original de Dion-Bouton type used from the start of the 20th C (520). The 1914 Grand Prix Mercedes used mica-insulated plugs after the original type selected (which may have been porcelain) proved unsatisfactory at high RPM (468). The fact that 3 plugs were fitted per cylinder in that engine indicated partly, no doubt, Daimler's "Belt and- Braces" philosophy – they actually provided bosses for 4 per cylinder! – but also the state of plug design at that date. By coincidence this M93654 Mercedes is the 1st Grand Prix unit for which a contemporary power curve is known but it may not have been a coincidence with the plug change that it was tested over the natural power peak (468). This was not usually the case with contemporary non-GP automobile and aero engines.

The feature of 3 plugs per cylinder recurred in Harry Ricardo's 1922 3 L TT design for Vauxhall (242) but only 1 was used (4).This may mark the date at which confidence in plugs was well established. Aero piston engines, of course, used 2 plugs per cylinder from an early date and continue to do so to this day, as a matter of safety.

Temperature variation problem

A particular plug problem remained for racing engines. A plug with a large diameter heat-path to coolant from the nose of the insulator which, at full power, ran comfortably below the temperature (about 850C (942)) which could cause pre-ignition of the mixture would not, at warm-up speeds, burn off the short-circuiting deposits from oil reaching the combustion chamber through piston clearances above the operating figure (294). The range of heat dispersion to be covered was, of course, magnified in proportion to any pressure-charging.

This problem was avoided by warming-up on "hot" (or "soft") plugs with smaller diameter heat paths (724) and then changing to "cold" (or "hard") plugs for the race. On occasion overheated plugs in an over-revved engine could still cause a pit-stop for a change or a slow-down to let them cool, see Sub-Note A.

Optimum plug temperature was 550C (942).

Sintered aluminium oxide insulation introduction

Just before WW2, to meet the needs of supercharged military aero engines running on highly leaded fuel, where the combustion products attacked mica, a stronger ceramic insulator was developed. This was sintered aluminium oxide, trade- named "Corundite" by KLG, the original makers. This material had 2x the strength and 5x the thermal conductivity of the best porcelain and the new plugs using this insulation had 4x the heat range of mica plugs (76,611). It became standard post-WW2 for motor-racing. The warm-up/plug-change routine was then not always necessary (52) but was still used sometimes, e.g. by Mercedes-Benz (conservative again) in their 1954-1955 M196 (613). [In 1951 the Bosch 14mm plug range had a "softest" plug (W240) with a 5.5mm diameter at the insulator nose; the "hardest" plug (W440) had a 9.5mm nose (ref. *Autocourse* 1951/2, article by Bosch)].

By 1968 the individual plug heat range had certainly reached a level at which only one type needed to be used in a naturally-aspirated (NA) GP engine (634).

Two plugs per cylinder

Two plugs per cylinder appeared in the 2nd naturally-aspirated (2NA) era, post 1951, as Bore/Stroke ratio increased with 2 valves per cylinder where the ideal central location for one plug was not available. This duplication was to aid combustion rather than reliability.

Four valves per cylinder and reversion to single plugs

The return of 4 valves per cylinder in 1966 freed the efficient central location and a single plug has been used there ever since.

Plug size

The size of plug has come down in 3 steps, hence reducing the heat absorbed which has to be dispersed, reducing the restriction on overhead valve diameter and improving its placement towards the cylinder centre in 2 valve/cylinder engines and, finally, reducing its weight.

Originally an 18mm outside diameter (OD) of screw thread size was chosen by de Dion-Bouton and this became the European standard (428). A reduction to 14mm OD was possible in the mid-30s (294) and became general in post-WW2 designs. A 10mm OD plug appeared in the early '50s and is still used as standard. Honda, with their miniaturised 5-cylinder 125cc racing motor-cycle in 1965-1966 actually fitted an 8mm OD plug in a 35.5mm bore with 4 valves per cylinder (76).

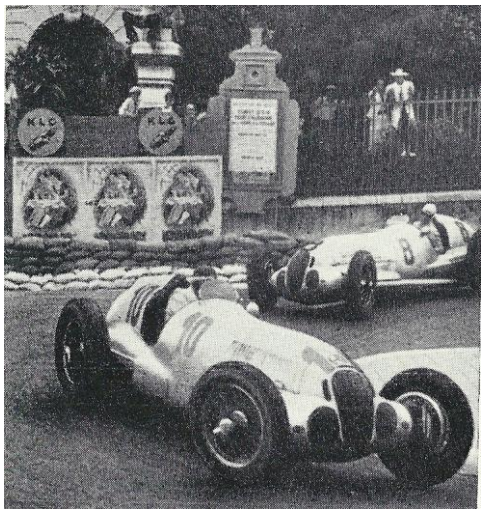
Note 16. Sub-Note A

Sparking plug overheating in supercharged racing engines

During the famous 1937 Monaco Grand Prix duel between Mercedes-Benz W125 team-mates Carracciola and von Brauchitsch – the latter completely ignoring the manager's pit signals to stop hounding or let pass his leader! – Carracciola certainly had to have his plugs changed and (280) times it as *after* raising the 1935 circuit lap record by 11% at 74% distance. A more detailed history (887) puts the plug change much earlier when he had lapped at "only" 9½% faster than the record.

The picture shows the two "team-mates" during their Monaco scrap, von Brauchitsch leading Caracciola.

At any rate the spectators were saved from a boring procession, even if Neubauer was having apoplexy!



Another example

During the 1939 Eifelrennen Lang in a Mercedes-Benz W154/M163 fitted with the 1st 2-stage supercharger (468), in order to pass Nuvolari's Auto Union, over-revved in 4th gear above the 7,500 RPM red-line to 9,200 (according to Neubauer (886)). This overheated his plugs which caused misfiring (pre-ignition from incandescent insulators) but by easing off to cool them he was able to continue and win the race (612).