Note 71B

Cylinder liners in compression

It was not the mixture of materials (cast iron liner and Al-alloy block) which caused the original Climax V8 problem but the length of liner *in compression* between the top and bottom locations. Given a warm-up time to stabilise the power readings the material differential expansion would have reduced some of the clamping load on the sealing ring *once per running cycle* from start-up to full speed but, presumably, there was still sufficient to seal the cylinder during ordinary test bed runs at incremental RPMs, when no trouble was experienced. This cycle would have occurred only a few times in an engines' racing life, after which the ring would be replaced at overhaul.

It was the in-cylinder temperature difference from throttle-open-to-shut cycling at the rapid rate of road racing, acting on the full length of the liner while the block at coolant temperature remained at expanded length, which caused the clamping load fluctuation leading to ring failure.

BRM V16 problem

A similar problem of cylinder sealing occurred in the 1947-designed BRM V16 which also had liners held in compression over their full length within the block by the detachable head (see Fig. N71B(B). In this engine, when the repeated liner expansions-and-contractions during the throttle cycling on the circuit forced the Al-alloy block locations to give way in fatigue, the gap created at the top spigot joint in the head allowed the coolant to enter the tiny cylinder on shut-throttle and form an hydraulic lock (838). The resultant cast-iron liner breakage led to such disastrous secondary damage that it took a long time to determine the primary failure (56).

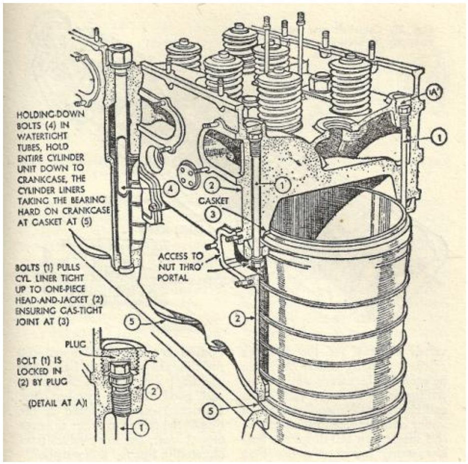
Not surprisingly, when BRM designed their IL4 2.5L NA engine for the 1954 Formula they went to liners screwed into the head, as had been done by Colombo in the 1938 MSC Alfa Romeo 158 and in the Lampredi-designed 1950 – 1953 V12 and IL4 NA Ferraris.

Rolls-Royce *Merlin* experience

The racing engine designers were in good company in falling into the trap of cylinder liners retained in compression. Rolls-Royce built the same thing into the *Merlin* in 1937 when the Mk II was hastily fitted with the ex-*Kestre*l layout (which leaked (900)) after the Mk I "ramp head" engine proved unreliable (see Fig. N71B(A). It was not until 1942 when the "two-piece-block" having a top-flange-located liner finally went into production (initially at Packard in the USA) that the cylinder leakage problem at high boost in fighter duty was overcome.

Ironically, the Mk I had a top-flange-liner-location!

Fig.N71B (A)
The Rolls-Royce *Merlin* Mk II
cylinder layout.
DASO 900



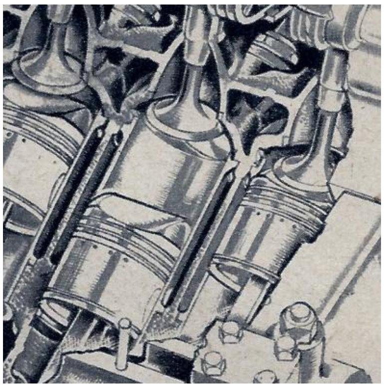


Fig. N71B (B)
The BRM Type 15
cylinder layout.
Motor 25 Nov 1953

It is curious that Erich Richter, who did the detailed BRM design and had worked at Rolls-Royce previously, did not use the liner solution adopted there,