

## Note 78



### The four valves-per-cylinder revival, 1959 onwards

Post WW2, no GP CoY had more than two valves-per-cylinder (2 v/c) until 1965 (the Coventry Climax FWMV Mk 6) but a renewed interest in four valves-per-cylinder (4 v/c) for GP engines had begun in 1961. It was not a coincidence that this was the year that the 4 v/c Honda RC144 IL2 125cc and RC162 IL4 250cc motor-cycles won Championships in those capacity classes. These 1961 Hondas were the first 4 v/c engines to win classic motor-cycle races since Rudge-Whitworth in 1934. Honda had entered international racing in 1959 with a 4 v/c RC142 IL2 air-cooled 125cc, which was reliable but not fast enough. They produced an improved 125cc (RC143) the following year plus, effectively a doubled-up 250cc version (RC161), both of which showed promise which was confirmed in 1961 after more development. The 1961 250cc, designed by Yoshio Nakamura, had  $B/S = 44/41 = 1.07$  and  $VIA = 76^\circ$ , a figure required to get adequate air-cooling to the top of the cylinder head, in which squish plateaus were incorporated.  $BMPP = 11.5 \text{ Bar}$  at  $MPSP = 19.1 \text{ m/s}$  with  $MVSP = \text{about } 2.9 \text{ m/s}$ .  $R \times VIA = 10.5 \times 76^\circ = 798^\circ$  and  $MGVP = 48.7 \text{ m/s}$ . None of these factors was exceptional. Honda's success was due to the smaller stroke of the 125 twin and 250 four in competition with 125 singles and 250 twins, plus careful and scientific attention to combustion chamber shape and exhaust scavenging (with low-taper megaphones) to offset the adverse higher surface area/volume ratio of the smaller cylinders, along with efforts to minimise the loss of mechanical efficiency at high RPM (75). Honda continued from 1961 through 1967 to produce ever-higher HP/litre in all classes in the classic way of reducing stroke, mainly by miniaturising cylinders, except for their 500cc engine, rather than raising B/S. Their success in this is illustrated on an attached Figure 115/dst. Every engine up to 1967 was 4 v/c. (To complete a description of the Honda four-stroke GP motor-cycle series, the 1984 NR500 90V4 500cc engine has been added, which had 8 v/c in 'race-track' shaped ('oval') cylinders, the equivalent-circular B/S being  $75.36/28 = 2.69$ . This was an attempt, beginning in 1979, to wrest back racing supremacy from the two-strokes which had dominated all motor-cycle GP classes since 1975 but it failed despite achieving 268 HP/L. Its influence on GP cars was that non-circular cylinders were banned!).

Chronologically in the post-WW2 automobile 4 v/c story there were several abortive designs and one success:-

- In early 1952 Mercedes-Benz tested a 4 v/c single-cylinder unit, experienced valve-gear problems (curiously) and then adopted a 2 v/c desmodromic head instead for the M196 (468) - described in Eg 32;
- Stewart Tresilian designed an IL4 2L of high B/S ratio with 4 v/c for Connaught, who did not have the money to build it (587);
- In 1954, Tresilian then produced a similar IL4 2.5L design for BRM, the extreme  $B/S = 102.87 / 74.93 = 1.37$  being matched to the 4 v/c head (587). However, Peter Berthon altered this to 2 v/c with hollow-headed valves - and incurred much valve and valve-spring trouble;
- In consequence of their 2.5L 2 v/c problems BRM did try 4 v/c in a single-cylinder test unit 'some years earlier' than 1964, ie pre-1961 (when the formula swept-volume changed) but the result did not encourage them to proceed to a main engine (587, 830);
- There was a *successful* sports-racing Borgward RS IL4 1.5L engine with 4 v/c at  $VIA = 64^\circ$  in 1958 which, in a Cooper chassis, secured seven F2 wins in 1959. Details of this unit are given in [Note 79](#).

Ferrari was the first GP engine maker during the 1.5L formula to consider 4 v/c as a way of extracting higher power and, pre-season, announced that his 1962 car would have this feature

in a redesigned 120V6. The engine was built and shown to the Press in a car but it never appeared in competition. Coventry Climax designed a 4 v/c head for their 90V8 in 1963, as described in Eg 44, taking a long time to obtain more power than their 2 v/c but eventually racing it in 1965. BRM designed another 4 v/c head for their 90V8 at the same date; it never exceeded the 2 v/c power and was discarded (830). The Climax and BRM designs had relatively wide VIA: 60° for the former, 68° for the latter (836), with some squish for the Climax but none for the BRM, which had axial ('downdraught') inlet ports.

Honda entered GP car racing in 1964 with the RA271 60V12 1.5L ( $B/S = 58.1 / 47 = 1.24$ ), having their 'trademark' 4 v/c wide-angle head ( $VIA = 65^\circ$ ), the engine mounted transversely. This was improved to the RA272 in 1965 and this won the final race of the 1.5L formula.

Honda also provided in 1965 a F2 IL4 1.0L engine for a Brabham chassis, once again with 4 v/c wide-angle head, but this needed a short-stroke redesign for 1966, after which it was very successful, the Brabham-Honda winning the F2 Championship easily in that year. Part of the reason for this success, following two F2 Championships won by the SOHC Cosworth SCA, was that Keith Duckworth's efforts that year were devoted to a design for the new 1.6L F2 formula to come into effect in 1967. He spent 1965 first choosing a suitable cylinder head for the Ford Cortina 120E production block and then designing in detail his own narrow-angle ( $VIA = 40^\circ$ ) version of a 4 v/c engine, the FVA ('Four Valve type A'), which is described fully in the main text, Eg 47 et seq, and [Note 79](#).

While the Cosworth FVA became a very successful commercial racing engine, powering all the 1.6L F2 Champions bar one in 1967-1971 and forming the top-end basis of the phenomenally successful DFV GP engine (qv Eg 47), which first raced and won in June 1967, it has to be recorded that it was preceded in 1964 by the Shell-financed Weslake WRP22 IL2 375cc research unit with narrow-angle ( $VIA = 32^\circ$ ) 4 v/c head (587). This produced  $BMPP = 11.6$  Bar at  $MPSP = 20.7$  m/s on petrol. Enlarged to 500cc with  $VIA = 30^\circ$  it was developed to  $BMPP = 14.3$  Bar at  $MPSP = 20.0$  m/s (587), and this was the basis of the Gurney-Weslake or 'Eagle' 60V12 3L GP engine which first raced in September 1966. The Weslake WRP22, therefore, was the first of the second phase narrow-VIA engines which really produced the 'Four Valve Renaissance' (in the late Brian Lovell's words) where the first phase had begun in 1959 with the wide-VIA Honda (but see also [Note 80](#)).

**HONDA**  
**Racing Motor-Cycles 1962 - 1984**

Example	<u>SO18</u>						
DASO	14,228, 354	14,228, 354,357	14,228, 354	14,228, 354	14,228, 354,357	14,228, 354	14,228, 354,357
Year	1962	1962	1963	1965	1965	1965.5	1966
Model	RC145	RC163	RC146	RC148	RC165	RC149	RC180
100/S mm	2.439	2.439	3.125	3.333	2.874	3.984	2.083
PP/V HP/Litre	163.6	184.5	208.7	230.6	220.5	263.2	165.5

DASO	14,228, 354,357	14,228, 354,357	16,74,228, 354,357,358
Year	1967	1967	1984
Model	RC168	RC181	NR500
100/S mm	3.175	2.227	3.571
PP/V HP/Litre	248.5	191.3	268.2

