Note 94

Grand Prix 1.5L TC engines developed from F2 2L NA

Some interesting comparisons between Normally Aspirated (NA) and TurboCharged (TC) engines can be made from the 1977-1988 developments by Renault, BMW and Honda of their F2 2L NA engines into Grand Prix 1.5L TC units, in each case the basic changes being to shorten the Stroke and lower the Compression Ratio (apart from adding the TurboCharger, of course, feeding into a plenum chamber from which individual and tuned inlet tracts fed the cylinders as in the NA application).

Data are tabled below. In each case the F2 engine is the fully-developed specification and the TC is the initial version.

All engines, NA or TC, running on 102RON "real" petrol
F2 NA i.e. Manifold Density Ratio (MDR) = 1

Year	1977	1982	1983
Make	Renault	BMW	Honda
Type	CH1	M12/7	RA263
Data Sources	910	454	680,929,931
Configuration	90V6	IL4	80V6
Valves per Cylinder	4v/c	4v/c	4v/c
@ Included Angle (VIA)	21.5^0	40^0	40^0
Bore/Stroke (B/S)	86mm/57.3	89.2mm/80	90mm/52.3
	= 1.501	= 1.115	`= 1.721
Swept Volume (V) cc	1,997	1,999	1,996
Compression Ratio (R)	11	11	11?
Peak Power (PP) HP	310	301	350
@ NP RPM	11,000	9,250	12,000
PP/V HP/L	155.2	150.6	175.4
Brake Mean Effective Pressure @ NP (BMPP) Bar	12.63	14.56	13.08
@ Mean Piston Speed (MPSP) m/s	21.01	24.67	20.92
Mean Gas Velocity at Inlet @PP (MGVP) m/s	64.53	76.57	69.16
	4 steel or Ni-alloy valves per cylinder with steel Coil-spring Valve Return System (CVRS)		
Mean Valve Speed @ PP (MVSP) m/s	4.54	3.89	not available (na)
BNP m/s	15.77	13.75	18.00
BMPA/MDR* Adj. Bar	12.90	14.87	13.35

*For petrol engines, where:-
Air Standard Efficiency = ASE = $[1 - 1/(R)^{0.4}]$, then

$$\frac{BMPA}{MDR} = \frac{BMPP}{MDR} \times \left(\frac{ASE\ @\ R = 12}{ASE\ @\ specified\ R} \right) = 24 \times (EV \times EC \times EM)$$ Adjusted Bar;

where:- EV = Volumetric efficiency;
EC = Combustion efficiency;
EM = Mechanical Efficiency.

The reasoning behind this expression is given more fully in Analysis Part 2 Page 8

Grand Prix 1.5L TC

Year	1977	1982	1983	
Make	Renault	BMW	Honda	
Type	EF1	M12/13	RA163E	
Data Sources	571,909	741	573,933	
Configuration				
Valves per Cylinder	All as for the F2 engines			
@ Included Angle (VIA)				
Bore/Stroke (B/S)	86mm/42.8	89.2mm/60	90mm/39	
	= 2.009	= 1.487	= 2.308	
Swept Volume (V) cc	1,492	1,499	1,489	
Compression Ratio (R)	7	6.7	7?	
Manifold Density Ratio (MDR)	2.5	2.58	na	
Peak Power (PP) HP	510	575	600	
@ NP RPM	10,500	10,500	12,000	
PP/V HP/L	341.8	383.6	403.0	
Brake Mean Effective Pressure @ NP (BMPP) Bar	29.13	32.69	30.05	
@ Mean Piston Speed (MPSP) m/s	14.98	21.00	15.60	
(MPSP relative to value of F2 NA)	(-29%)	(-14.9%)	(-25.4%)	
Mean Gas Velocity at Inlet @PP (MGVP) m/s Note (1)	46.01	65.18	51.58	
	4 steel or Ni-alloy valves per cylinder with steel Coil-spring Valve Return System (CVRS)			
Mean Valve Speed @ PP (MVSP) m/s	na	na	na	
BNP m/s	15.05	15.61	18.00	
(BNP relative to value of F2 NA)	(-4.6%)	(+13.5%)	(0%)	Note (2)
BMPA/MDR Adj. Bar	13.57	14.98	na	
(BMPA/MDR relative to value of F2 NA)	(105.2%)	(100.7%)	na	Note (3)

Note (1): assuming same Inlet Valve Head Diameters (IVD) in the Renault and Honda TC engines as in the NA.

Note (2): Speed-Limiting factor

It will be seen that a limiting Mean Valve Speed in the TC engines, represented by the surrogate parameter 'BNP' (see Note 13 Part III), was controlling the value of NP in the cases of the highly over-square Renault and Honda TC engines to the same level as the NA engines. Therefore, TC powers were not as high as might have been expected.

Note (3): BMPA/MDR: TC versus NA

The similarity of this value for the BMW suggests that the TurboCharger was not very efficient, since the TC value should have been relatively higher, as is the Renault TC (see Note 96).

Constructional features of NA and TC engines

CH1 and EF1 had belt-driven camshafts.

Renault and Honda had wet Al-alloy Nikasil-coated liners in thinwall cast-iron blocks.

BMW had cast-iron unlinered blocks taken from high-mileage production 89mm bore engines from which all the residual casting strains had relaxed. Therefore, after boring to 89.2mm the bores stayed perfectly round and so minimised friction.