Design Parameters

[All CoY details are given in Appendix 1]

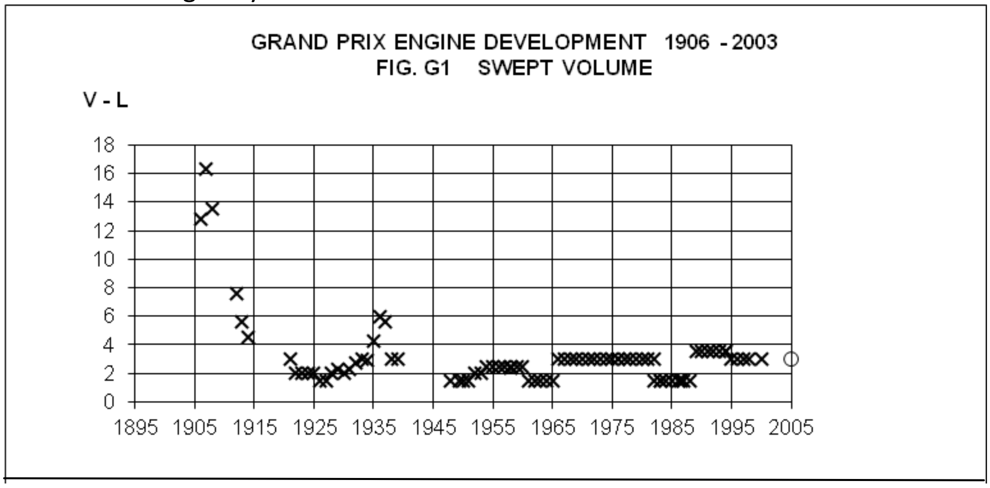
On the following pages Figs G1 to G15 show the variation with date of a number of Design Parameters in CoY engines, *plus* 3 non-CoY Grand Prix units built within the review period where firm data is available to supplement scarce CoY information (these are shown with open 'O' symbols) (see Note 22, which also provides some firm data for post-review non-CoY GP engines. The 2005 BMW P85 is plotted).

The following notes amplify the Figures.

G1. Swept Volume: **V – Litres**

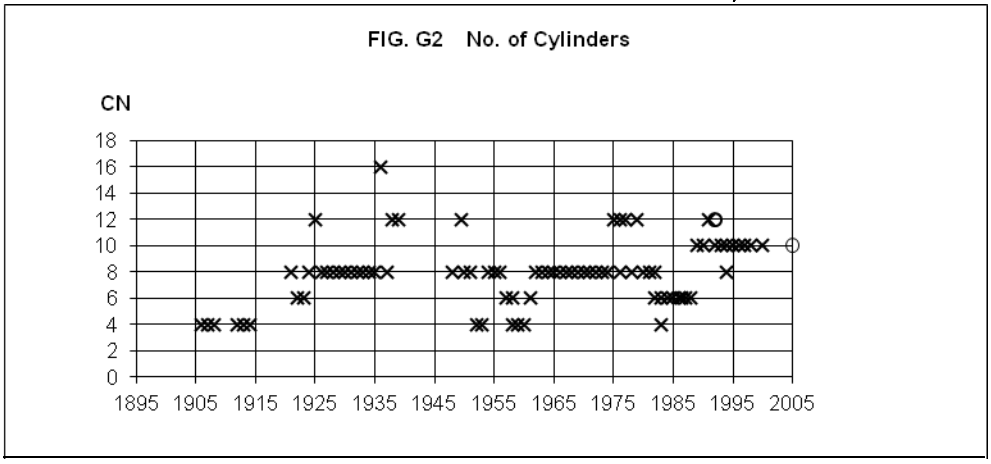
(See also Table 1 in "The Sporting Limits".)

This illustrates the early racing rule experiments, settling down after 1913 mostly to limited V, at various values, except for the 1934 – 1937 period when there was a maximum car weight with no V limit. Ingenuity and improved materials then led to large increases in V, doubling the 3 Litres which had been envisaged by the rule-makers.



G2. Number of Cylinders: **CN**

While the numbers range from 4 to 16 (once only), 8 was the most popular choice in the review period – In Line(IL) up to 1955 inclusive; 90^0 Vee subsequently. During the TurboCharged (**TC**) era (1983 – 1988) V6 was usual. From 1989 inclusive V8, V10 and V12 engines were built but the V10 emerged as the most effective compromise between power and range of useable torque. In 2000 (and post the review up to the end of 2005) 10 cylinders were the rule limit. Vee angles in V10 engines increased from 67^0 to 90^0 so as to lower the Centre of Gravity.

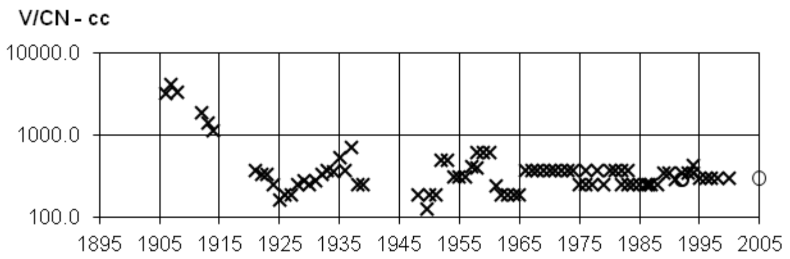


G3. Swept Volume per Cylinder**: V/CN – cc**

This parameter is shown logarithmically for clarity. The largest was 4,072 cc in 1905 (Renault AK, Eg. 1) and the smallest a nominal 125 cc in 1949 (Ferrari 125GPC/49, Eg. 27). Late period engines were a nominal 300 cc.

The largest Bore was 180 mm in 1907 (FIAT, Eg. 2) and the smallest was 51.3 mm in 1925 (Delage 2LCV, Eg. 11).

FIG. G3 Swept Volume per Cylinder



G4. 1/Stroke: **100/Smm**

G5. **B/S**

As discussed in the section on "General Design", regulated V leads to shorter strokes in the search for power and the 1/S parameter has more than quadrupled over the review period. B/S has had a similar rise for the same physical reason, except in the years to 1914 when designers were learning to run at higher piston speeds.

FIG. G4 1 / STROKE

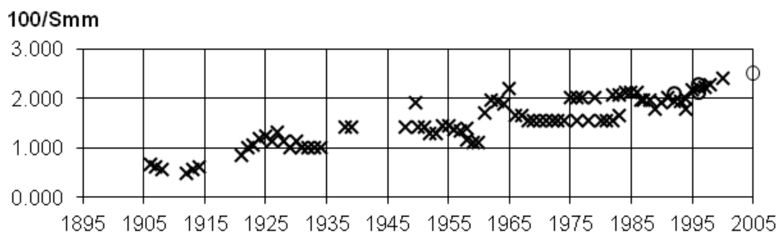
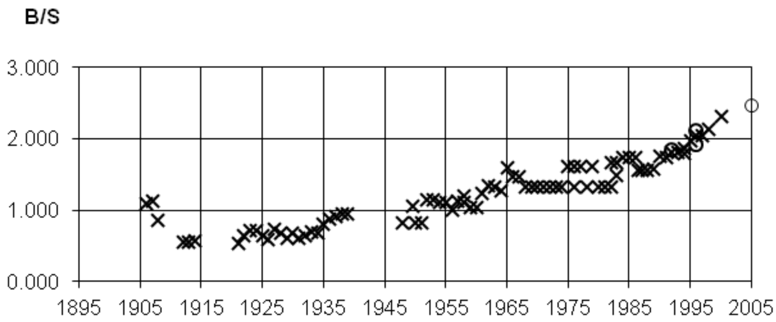


FIG. G5 BORE / STROKE



<u>G6. Compression ratio: **R**</u>

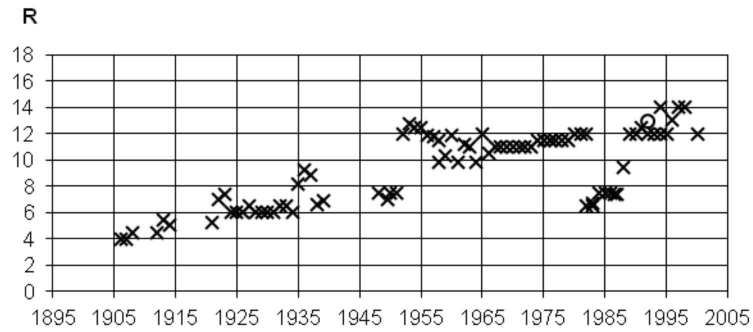
The more-than-tripling of R for NA engines was partly due to better fuel and partly to the generation of more turbulence in a compact combustion chamber.

However, during the 2 Pressure-Charged eras (1924 – 1951 and 1983 – 1988) a value of R between 6 and 7½ had to be accepted generally for fuel (knocking) and mechanical (maximum cylinder pressure) reasons.

The latest high B/S engines have had R somewhat limited by the difficulty of accommodating both valves partly-open at exhaust Top Dead Centre to enhance breathing (but see Note 22 recording the 2009 Toyota RVX-09H with R = 13.6 at B/S = 2.375).

More detail of progression in R is given in Note 23.

FIG. G6 COMPRESSION RATIO



<u>G7.Number of Inlet Valves per Cylinder: **VNI**</u>

<u>G8. Angle included between Inlet and Exhaust Valves: **VIA – Degrees**</u>

<u>G9. Inlet Valve head Area/Piston Area: **IVA/PA**</u>

<u>G10. Maximum Inlet Valve Lift/Head Diameter: **IVL/IVD**</u>

The 2 Inlet (and 2 Exhaust) Valves/Cylinder layout triumphed finally over 1/cyl. after 1967 when it was coupled by Keith Duckworth (of Cosworth Engineering) with smaller VIA and inlet ports angled and shaped to give "Barrel Turbulence" (aka "Tumble Swirl") of the induced charge in the cylinder. It was then only necessary to provide IVA at about ⅓rd of PA with IVL around ⅓rd of IVD.

Towards the end of this review period, however, there has been a move to higher IVA/PA and IVL/IVD ratios; Eg. 85, the Ferrari 049, had an official 0.354 and 0.384, respectively. This involved compound valve angles – 6^0 included longitudinally coupled with VIA = 25^0 for the 049.

FIG. G7 No. of INLET VALVES per Cylinder

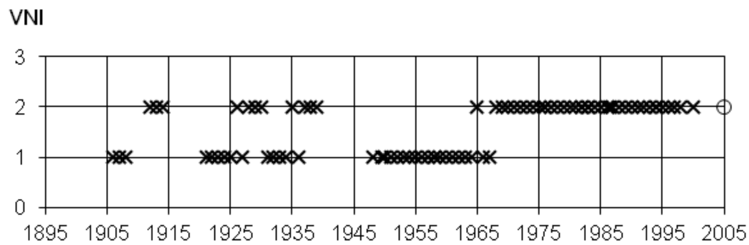
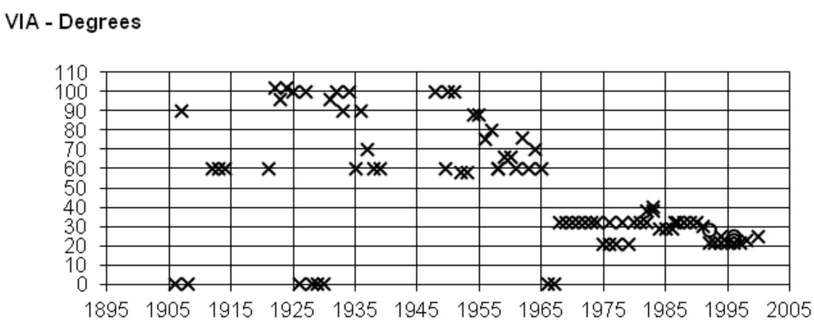
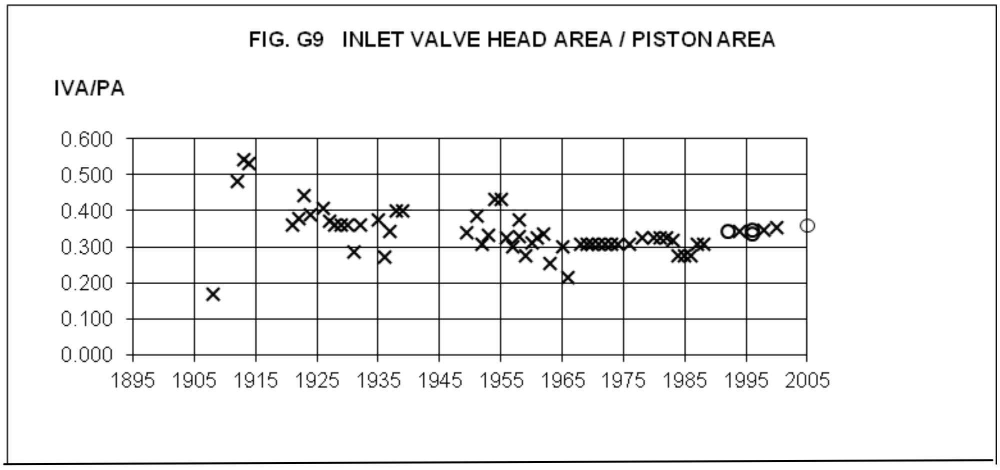
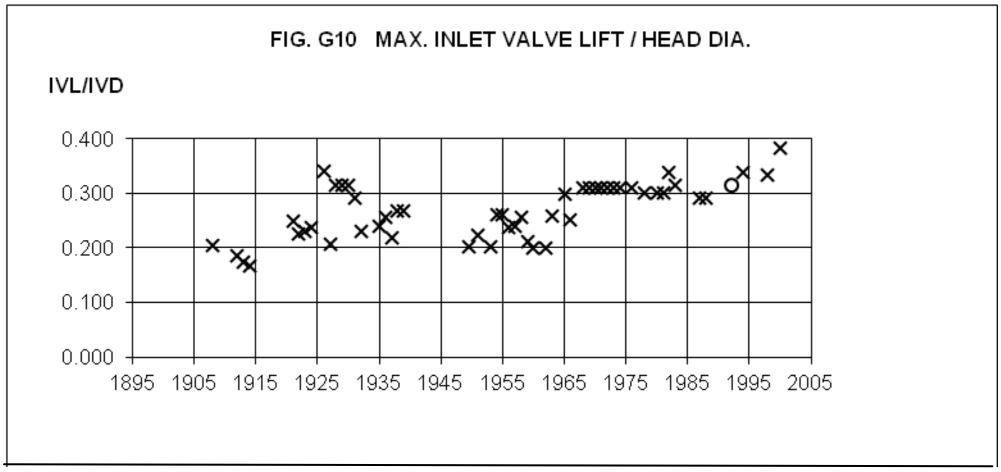


FIG. G8 ANGLE INCLUDED between VALVES

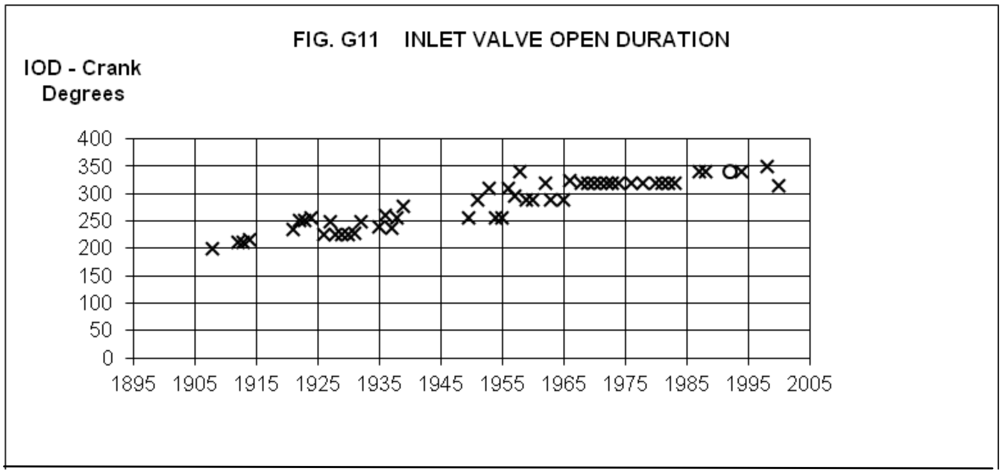






<u>G11. Inlet Valve Open Duration: **IOD – Crank Degrees**</u>

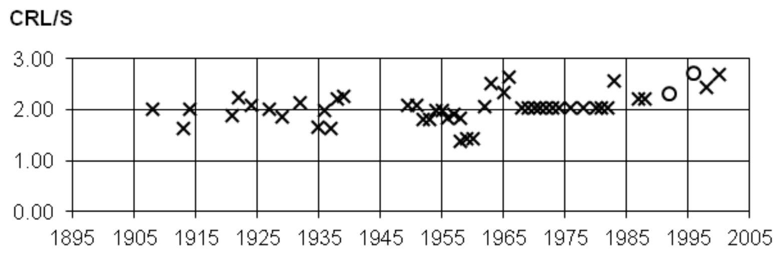
The desire to raise RPM to increase power has led to the steady increase of this IOD parameter by about 70%, although it has then stabilised at about 320^0. There is a caveat on the figures; ideally the figure should be taken between, say, 5% off/on the seat. Better still the parameter should relate to the integrated area under the chart of Lift versus Opening. This information is scarcely ever available to an external analyst so the review has had to make do with the simple IOD.



G12. Connecting-Rod Length (between bearing centres)/ Stroke: **CRL/S**

Until recently a value of CRL/S around 2 was typical, with excursions *down* to 1.44 and *up* to2.65 where engines were *enlarged* (Egs. 38, 39 Climax 1959 – 1960) or *adapted* (Egs. 45, 46 Repco 1966 – 1967) respectively. The later trend was to go well above 2 to reduce friction from piston side-thrust. Note 22 records the 2009 Toyota RVX -09H at 2.724 (official data).

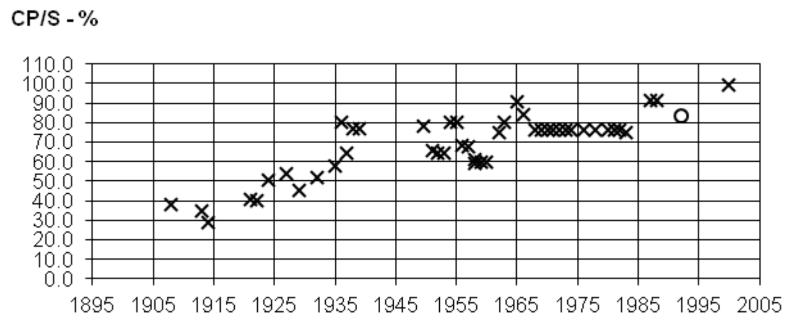
FIG. G12 Con.-Rod Length between Centres / STROKE



G13. Crank Pin diameter/Stroke: **CP/S - %**

As RPM have been raised and B/S increased, so that crank pins are proportionately longer (and Vee engines with side-by-side con.-rods have become the norm) it has been necessary to raise CP/S to keep torsional vibrations out of the running range.

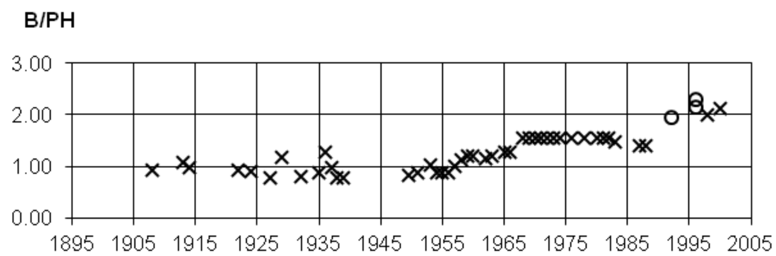
FIG. G13 Crank Pin Diameter / STROKE



G14. Bore/Piston (overall) Height: **B/PH**

The convention up to 1955 was to keep the above ratio around 1, but since then there has been an increase to limit piston mass and thereby limit stresses and friction as RPM rose. A B/PH ratio of 2 or more is now usual.

FIG. G14 BORE / Piston Height



G15. Charge Pressure at Inlet Valve: **IVP – Atmospheres Absolute (ATA)**

See also Table 1.

This chart shows the 2 Eras of Pressure-Charging (PC).

The earlier period (1924 – 1951) used Roots-type Mechanically-driven Superchargers (MSC) with rich-mixture alcohol fuel of high latent heat of evaporation to reduce compressed air temperature so as to increase Manifold Density Ratio (MDR) and also to avoid knocking.

The second period (1983 – 1988) used TurboCharging (TC) and rule-specified petrol fuel of low latent heat of evaporation so that air – air intercooling was required between the TurboCharger and the inlet valves for the same reasons of raising MDR and avoiding knocking.

FIG. G15 Charge Pressure at INLET VALVE