**2nd Naturally-Aspirated Era (2NA) 1952 – 1982: 31 Years.**
**Part 1, 1952 – 1957; Egs. 30 to 35**

**30. 1952 Ferrari 500; 1,985 cc; 180 HP @ 7,200 RPM** (see Fig.30A)

**31. 1953 Ferrari 500; 1,985 cc; 187 HP @ 7,500 RPM** (see Figs. 31A, 31B)

[A SHORT GLOSSARY of abbreviations is linked here. A full glossary is given as a Key to Appendix 1.]

Although the racing rules of 1.5L PC: 4.5L NA were to have applied to major races until the end of 1953, the fact that only Ferrari had cars fit to enter under those rules in 1952 led race organisers to switch their events in 1952 – 1953 to Formula 2 and the International Sporting Commission then accepted it for the Drivers' Championship. This Formula had been used for minor races since 1948 and was 0.5L PC : 2L NA. Its 1 : 4 ratio of PC to NA had ensured that all serious entrants chose the NA limit. Actually, there was at least *one* small-budget Italian car with a supercharged 500 cc engine, the Giaur in 1950. Also, as an historical footnote, Rudolph Uhlenhaut of Mercedes-Benz kept his hand in during 1946 by designing a transverse IL4 supercharged 500 cc but unsurprisingly this was never built (52).

Ferrari had dominated the secondary formula from the start with the type 166 2L engine derived directly from the original type 125 1.5L, in the same block casting and SOHC per bank, being 60V12 B/S = 60 mm/58.8 = 1.02. This engine with improvements was fitted in an improving series of chassis. The 1950 version, with De Dion back axle, won nearly every F2 event entered but, along with earlier swing axle versions, on occasion found IL4 Simca-Gordini and HWM cars giving it a hard time and sometimes leading it on twisty circuits. This was all-the-more stimulating to Ferrari in that the Gordini (in a petit, light chassis) was only 1.5L with PROHV; and the 2L HWM was a nominal 2-seater! The higher power but peakier torque curve of the V12 Ferrari was not always the best solution.

As a consequence Aurelio Lampredi proposed to Enzo Ferrari at the close of the 1950 season the design of a 2L 4-cylinder engine and the resultant type 500 with B/S = 90 mm/78 = 1.15 was on bench test early in 1951. Lampredi continued the screwed-into-head wet liner feature with 2 valves-per-cylinder with HVRS of his big engines ($58^0$ VIA instead of $60^0$) and retaining 2 sparking plugs-per-cylinder (but semi-centrally-mounted with DOHC instead of recessed at the sides in the SOHC 4.5L). However, having raised the B/S ratio from the 1.08 ratio of the 4.5L he took special trouble over the valve operating system. The DOHC (which was his first such gear) operated the valves through inverted-cup tappets which had rollers under the cams and their own coil return springs. As developed MVSP was 3 m/s, which was no advance over the 1951 Alfa Romeo 159 DOHC despite the more elaborate valve gear. No other CoY engine in this review found it necessary to go to the same complexity in its tappets.

Most importantly, for the first time a Grand Prix NA engine had individual and tuned inlet tracts, each drawing through its own carburetter choke, to raise BMEP at a chosen RPM by boosting Volumetric Efficiency (EV). It appears that Lampredi produced his design of this feature independently of earlier work (see Note 27). His engine, as it first appeared in 2L form in late September 1951 without tuned exhausts, had BMPP = 10 Bar @ MPSP = 19 m/s with a Compression Ratio (R) suitable for 80/20 Petrol/Alcohol fuel so as to run a 500 km race non-stop (i.e. 24L/100 km)(8).. This BMPP, actually no better than the 24-plug V12 4.5L although with much less alcohol in the mixture, was rather disappointing. Fitting 1+4, 2+3 tuned exhausts with a single tail pipe improved BMPP to over 11 Bar, although tuned stub pipes were used for most of the 1952 season. There was a reversion to the tail-pipe layout for 1953.

The Ferrari type 500 was CoY in both seasons, fighting off a revised IL6 Maserati challenge whose later engines had been improved by Colombo. The final type 500 version obtained BMPP = 11.2 Bar on R = 12.8 at MPSP = 19.5 m/s. ECOM for the 1953 specification was 46.3%.

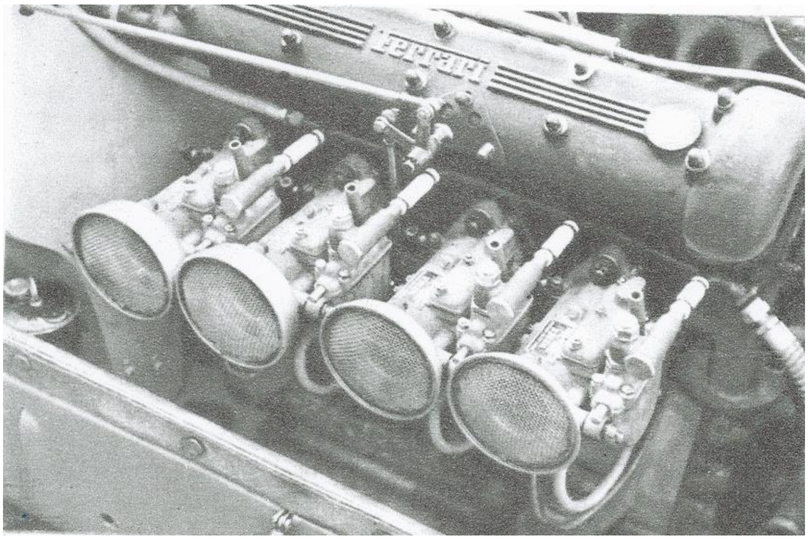
One problem was still the same as in the type 375 – the "orange peel" shape of the combustion chamber at TDC (R x VIA = 12.8 x $58^0$ = $742^0$) and also MGVP = 58 m/s was low for individual, tuned inlet tracts, i.e. at IVA/PA = 0.33 the engine was "over-valved" (see Note 34). There was no squish in the head. Lampredi would not have been aware that Leo Kuzmicki of Norton had just introduced this very beneficially in his 1951 development of their 350 cc motorcycle (683), which was probably the 1st use of squish in an opposed-OHV head.

Regarding the unexceptional BMPP, Ferrari had a philosophy about super-tuned engines (386) which was "*They are horses which are with you in the morning but have vanished by the afternoon!*". He accepted a 10% drop from a power which had been demonstrated in a bench test in exchange for complete reliability (see Note 48

It is known that the type 500 engine was near the piston-ring flutter boundary (see Note 13 Part II) but, run within its set limits, the engine did have ample reliability with superior performance.

Of 15 major races in the 2 years 1952 – 1953, 14 victories were obtained (and the race lost was due to a final corner accident while leading.

Fig.30A
1952 Ferrari Type 500
IL4 90/78 = 1.154 1,985 cc
Sections of this engine are given on Figs. 31A and 31B
This illustrates the 4 single Weber carburettors
as raced in 1952 and up to mid-1953.
DASO 1078




Figs. 31A and 31B are given on P.3

Fig. 31A
1953 Ferrari Type 500
IL4 90/78 = 1.154 1,985 cc
Note the elaborate valve-gear with rollers in the tappets
and their own double coil springs to return them, while the valves
had hairpin springs (HVRS).
The cylinders were screwed into the head.
For the 1st time on a CoY engine each cylinder had its own individual, tuned inlet tract including the carburetter choke. Originally (post the prototype) this was by 4 carburetters (see Fig. 30A) but in mid-1953 this was changed to 2 double-choke units.

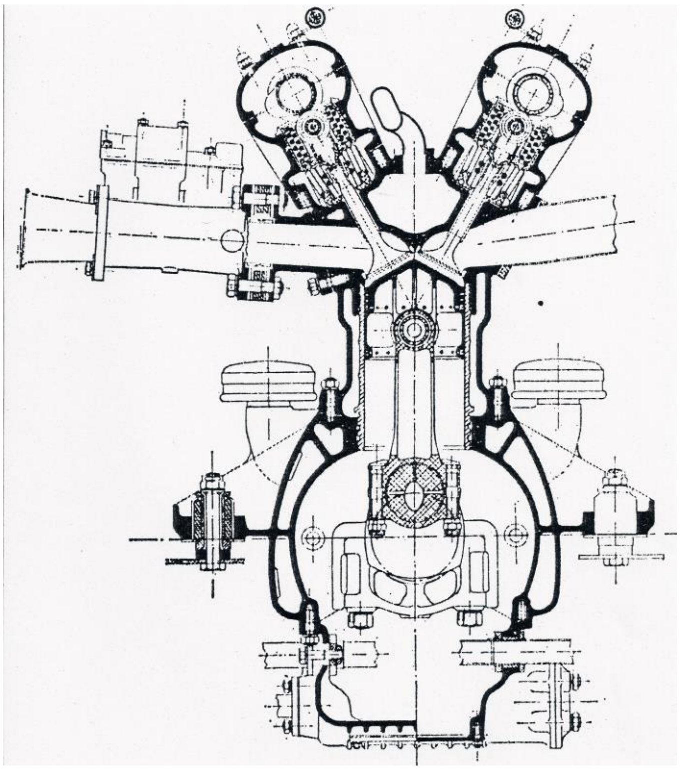


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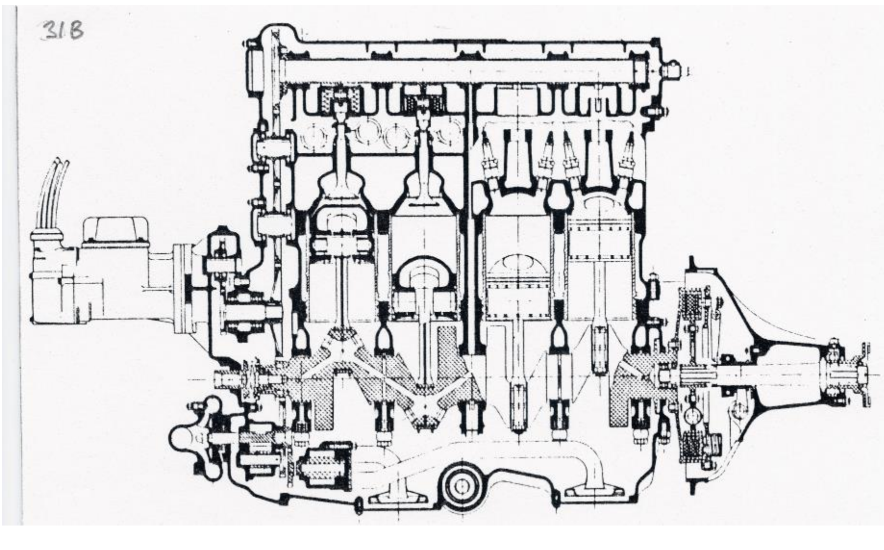
Fig. 31B
Note 2 sparking-plugs per cylinder
The 2 magnetos on the original type 500 were driven off the back of the camshafts and protruded into the scuttle. They got too hot there and were re-mounted as shown at the front in mid-1952.
Both Figs. DASO 80 p. 42.



**32. 1954 Mercedes-Benz M196; 2,497 cc; 253 BHP @ 8,250 RPM** (see Fig. 32A)

**33. 1955 Mercedes-Benz M196; 2,497 cc; 286 BHP @ 8,500 RPM** (see Fig.33A)

The 1954 Formula

The consideration by the FIA of the design rules to come into force at the start of 1954 had begun in early 1951. Thoughts turned to a 2.5L NA limit. Enzo Ferrari, in his shrewd way, sought to influence the final choice by producing a 2.5L NA (Type 625) version of his new Formula 2 2L (Type 500) engine then under construction (with B/S = 94mm/90 = 1.04 compared to the smaller unit's 90/78 = 1.15). This larger engine actually appeared first, at the non-Championship F1 race at Bari in early September 1951 and it finished 3rd behind an Alfa Romeo 159 and a Ferrari 375 (Note 49).Whether or not this convinced the FIA at their October 1951 Congress the 2.5L NA size *was* chosen for 1954 (and this rule lasted until 1960 inclusive as it turned out, after various extensions) with an alternative 0.75L PC option. This PC : NA ratio of 1 : 3.33 *would* have represented equality in late 1951 races (see Note 50).

With the improvement in BMPP of NA designs brought about by the adoption of individual, tuned inlet and exhaust systems the NA route was chosen universally. It was much cheaper than the PC option. Mercedes-Benz *did* study the 0.75 PC possibility, as might be expected of this "Conservative-Pioneering" company (787) (see Note 51).

The M196

However, the outturn of the Daimler-Benz/Mercedes return to Grand Prix racing in 1954, after 15 years absence, was the M196 IL8 2.5L NA engine for which research with a 1-cylinder unit began in early 1952. TheW196 car was CoY in 1954, despite a mid-season start and a mixed campaign (4 wins and 2 definite defeats from 6 classic races entered). It was also CoY in 1955 with more certainty (5 wins/6 races, one race lost by full-team mechanical failure). Over the 2 years the result was 9/12 = 75% of the possible.

Design details

The IL8 configuration, with B/S = 76/68.8 = 1.1 (the highest of any IL8), was chosen by the design team headed by Hans Scherenberg after evaluating IL6, V8 and V12, the latter considered too costly and too heavy (787). It was believed from pre-WW2 experience that the IL8 would be lighter than the V8. Rudolf Uhlenhaut, the development chief, who had wanted a V8, only revealed 32 years later that the original IL8 was found on first test to have severe crank torsional vibrations, despite a primary and secondary power take-off from the centre. This feature was a 1st in CoY which it had been calculated would avoid such problems. Nevertheless, dampers had to be added at each end of the crank and this eliminated much of the theoretical weight saving (786). Ref.(787) of 1955, describing the original design process, did not disclose that these dampers were a necessary modification!. The final weight was 205 Kg.

The "Conservative" elements of the M196's technology were:-

- Fabricated steel upper-works – used since 1912!;
- All roller-bearing bottom-end – used 1st in 1924 – but now with a Hirth-type built-up crank, improved since originally tried experimentally over 1936 – 1939, so that bearing races were no longer split. The double-row rollers, spanning the crank joints, were replaced after each race. (Camshafts were also carried in roller bearings. Unusual, harking back to the pre-WW2 Auto Union, were needle-roller little-end bearings).

The "Pioneering" took the form of:-

- Cam-closed, spring-less ("Desmodromic") valves, with DOHC operating 2 valves-per-cylinder at VIA = $88^0$ (where 4 v/c at 50 – $60^0$ had been used since 1914);
- Fuel injection directly into the cylinder (from a Bosch piston-pump – see Note 52);
- Engine inclined at $53^0$ from the vertical towards the exhaust, to reduce frontal area and lower the centre of gravity so that reduced lateral weight transfer would improve cornering speed.

Other design features which were normal for the time were:-

- Na-cooled exhaust valves;

- 2 sparking plugs per cylinder.

The Desmodromic valve-gear was adopted (apparently without knowledge originally of the many previous attempts at such a system (486)) to permit a very high MVSP (= 5.2 m/s in 1955) while obtaining complete immunity from valves striking the high-compression pistons if an upward gear-change was missed or a premature down-change made (also *possibly* reducing valve-gear friction). A serendipitous discovery during development was that hairpin springs included to take-up expansion clearances, which were failing, were superfluous – the valves sealed themselves satisfactorily under compression pressure. This had no deleterious effect on valve/seat condition as the valves were mostly re-useable on checking post-race (985). The "bullet-proof" valve gear *did* disgrace itself once, at Monaco in 1955, when all 3 engines failed after a small screw in a newly-modified system broke in fatigue (468) – particularly annoying as Mercedes had built 2 short-wheelbase cars specially for the twisty circuit and each was leading at the time of failure!

The direct injection, for which Bosch solved the difficult problem of providing accurately the small fuel quantities (about 0.05 cc for each312 cc cylinder) at up to 4,500 inlet strokes per minute, meant that MGVP could be chosen for low inlet pressure drop since there was no need for final fuel vaporisation at the valve (see see Note 34) at only 45 m/s (1955 spec.), IVA/PA being 0.43. The injector spray was partially onto the exhaust valve, cooling it and partially compensating for no inlet tract charge cooling. Over 100% Volumetric Efficiency (EV) was claimed (787) (probably at maximum torque at 76% peak power speed (1955)).The by-now-standard use was made of individual, tuned inlet and exhaust systems; the 1955 intake length from entry plenum chamber to valve being 5.3 x Stroke (see Fig. 33A) so that resonance (see Note 27) was at 16.7 m/s (86% of peak i.e. a compromise between Peak Power and Peak Torque. The exhaust pipe lengths averaged about 80 cm, equivalent to a resonant RPM roughly 70% of peak (see Note 83) but for the open-wheel cars hastily prepared for the 1954 German GP on the twisty Nurburgring these pipes were lengthened on average to about 130 cm. This length was never used again, even for the 1955 Monaco race on a slower circuit, so presumably it brought no significant benefit.

Combustion Efficiency

There were 2 features of the design which spoilt Combustion Efficiency (EC):-

- The inlet ports were between the valves ("downdraught" in relation to the cylinder axis) and so unwittingly lost any possible advantage of "Tumble Swirl" (see Note 26);
- The very high-crowned piston needed to obtain R = 12.5 with the wide VIA chosen to fit 2 large valves (see Fig. 32A) meant that the combustion chamber had probably the worst (Surface Area/Volume) ratio of any GP CoY engine (R x VIA = 12.5 x $88^0$ = $1{,}100^0$) (see Notes 53 and 54).

1955 performance

The best performance in 1955 – significantly after a re-shaping of the piston crown to concentrate the charge better (468) (plus injection changes) was a BMPP of 12.1 Bar on 25% methanol fuel (see Appendix 2) at MPSP = 19.5 m/s. ECOM was 44.6%*.The 1955 performance was 10% higher pressure at 3% higher speed than the initial 1954 output.

RPM Limits

The high-crowned, fully-skirted piston added mass which limited the MPSP. Although Fangio (Champion in 1954** and 1955) used 9,000 RPM regularly and successfully ((787) i.e. 20.6 m/s and 12% higher stresses than at Peak Power speed of 8,500 RPM) it is noteworthy that the one technical failure repeated in the M196 in 2 seasons was piston failure:- once in the 1st race and again in the last race (one engine in 3 or 4 entered in these cases (468)). Mercedes-Benz advised drivers that various engine speeds could be held as follows (468):-

| | RPM | Time permitted |
|---|---|---|
| | 8.000 | 5 minutes |
| Peak Power | 8,500 | 40 seconds |
| Nominal 'Red Line' | 8,700 | 20 seconds |
| | 9,000 | 3 seconds |

In 1955 no engine was taken over 9,250 in the last 4 races.

*After adjusting to Petrol from Alcohol using **1/1.12 –** see Key to Appendix 1 at Line 43.

**Including 2 Maserati victories before joining Mercedes.

In the clean sweep at the 1955 British Grand Prix (1st to 4th places – revenge for the 1954 BGP where they secured only 4th and 7th places!) Moss in winning used a maximum of 9,150 RPM and his W196 averaged 32.5 L/100 k (979) at 139 kph on the Aintree circuit. For comparison the consumption at the first W196 race at Rheims in 1954 with the streamlined cars had been around 43 L/ !00 km (468) at 188 kph.

Circuit speed prediction

Mercedes-Benz continued their pre-WW2 practice of estimating the lap speeds possible on each circuit. A result for Monza in 1954 was published in early 1955 (787).A power interruption of 0.3 seconds was included per manual gear change in these estimates so that, with a total of 10 changes at Monza, 3 seconds were expected to be powerless in a lap time by Fangio of 119 seconds or 2.5%. Analysis of the figures showed that a cornering lateral acceleration of 1 g (i.e. a coefficient of tyre-to-road friction =1) had been assumed. However, ref. (468) reports that post-season skid-pan tests had shown that the Continental tyres, made by a company which had not equipped GP cars for 14 years, could only generate 0.7 g. Improvements were made for 1955 which (468) states *did* produce 1 g. Ref. (77), published after the 1955 season, does state a coefficient of 1 was possible "*with very adhesive road surfaces*" and claimed a prediction accuracy within 1%. This report included some interesting times taken at Monaco in 1955 from 120 metres before the Gasometer hairpin (as it then was) to 120 metres after it, as follows (lap times added for comparison:-

| Driver | Car | Seconds | Tyres | Fastest Practice Lap-Seconds |
|---|---|---|---|---|
| Moss | W196 IL8 Short-chassis | 11.9 | Continental | 101.2 |
| Fangio | " | 12.0 | " | 101.1 |
| Ascari | Lancia D50 V8 | 12.4 | Pirelli | 101.1 |
| Behra | Maserati 250F IL6 | 12.4 | " | 102.6 |
| Farina | Ferrari 625 IL4 | 12.5 | Englebert | 106.0 |
| Hawthorn | Vanwall IL4 | 14.0 | Pirelli | 105.6 |

[Note the technical diversity allowed by the 1954 Formula:- 2 x different IL4s; IL6; IL8; V8, and 3 tyre manufacturers. What a contrast with 2013 rules!]

Some comments on design features

The M196 was the only Grand Prix engine ever to succeed with Desmodromic valves up to the present day, as Ducati has been and still is the only firm building racing motorcycles to succeed with that system. BRM (810, 943), Maserati (506, 792), Cosworth (59), OSCA (794), and Norton (480) all experimented with it (OSCA did race it in sports cars). Scarab used a copy of the M196 system (943) in its unsuccessful IL4 GP entries of 1960.

Mercedes-Benz abandoned finally the fabricated steel upper-works in their equally-successful Sports-Racing 3L version of the M196 for 1955, using for that engine a fixed-head - still conservative! - Al-alloy casting.

They were experimenting with plain main and big-end bearings in the 3L when a policy change cancelled all racing programmes at the end of 1955. No GP CoY has since used an all-roller bottom-end.

Cost

Probably, in constant money terms, the M196 was the most costly Grand Prix CoY engine ever built in relation to swept volume, but "*Cost-No-Objection!*" was then still a basic principle of Daimler-Benz where racing was concerned and the results justified that policy.

Conclusion

Having largely succeeded in everything entered by the end of the 1955 season except the 24 Hours at Le Mans, where the team was withdrawn at 40% time when running 1st and 3rd because the other car had been involved in the earlier tragedy, Daimler-Benz withdrew from racing for many years.

Their next connection with a Grand Prix CoY engine will be described for 1998 (Eg. 82).

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Figs. 32A and 33A are shown on P.7 and a Power Curve for the 1955 M196 on P.8.

Fig.32A

1954 Mercedes-Benz M196

IL8 76/68.8 = 1.105 2,497 cc

Note the mechanically-closed valves, down-draught inlet ports, direct fuel injection nozzle spraying towards the exhaust valve (the opposite of the proposed 1938 direction), all-roller-bearing built-up Hirth-system crank, fabricated integral cylinder block and head and 37$^{0}$ inclination from the horizontal.

DASO 468 p.319

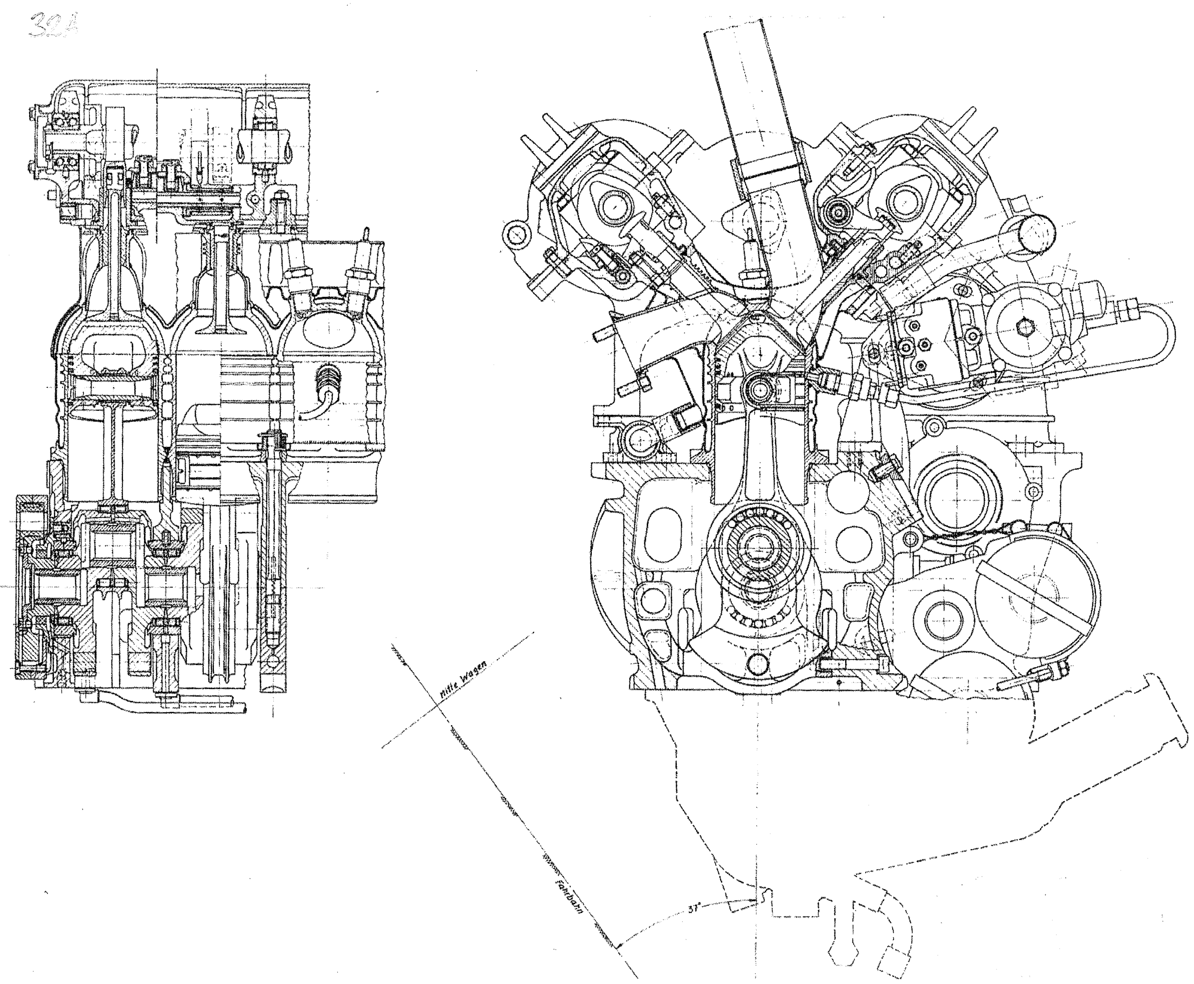
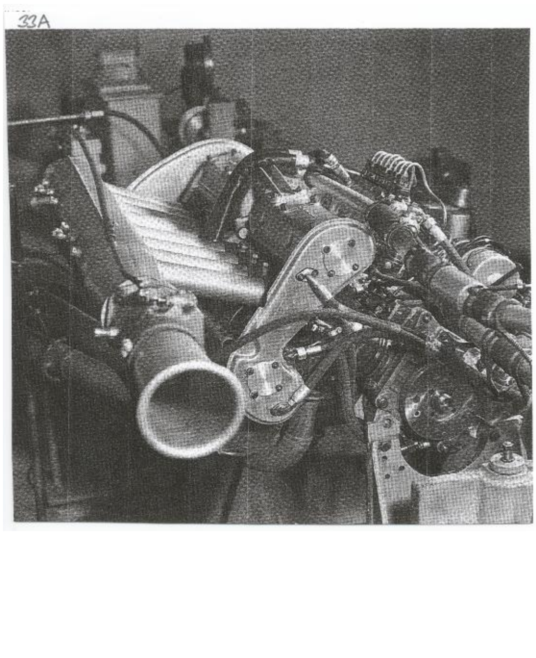


Fig. 33A

The 1955 M196 engine on a test-bed showing the straight inlet pipes adopted that year, drawing cool air from a bonnet-top ram intake. In 1954 the pipes were curled round sharply to a manifold drawing from behind the radiator (except only at the German GP where a bonnet-top intake was used). The Bosch fuel-injection pump is on the right.

DASO 468 p.338

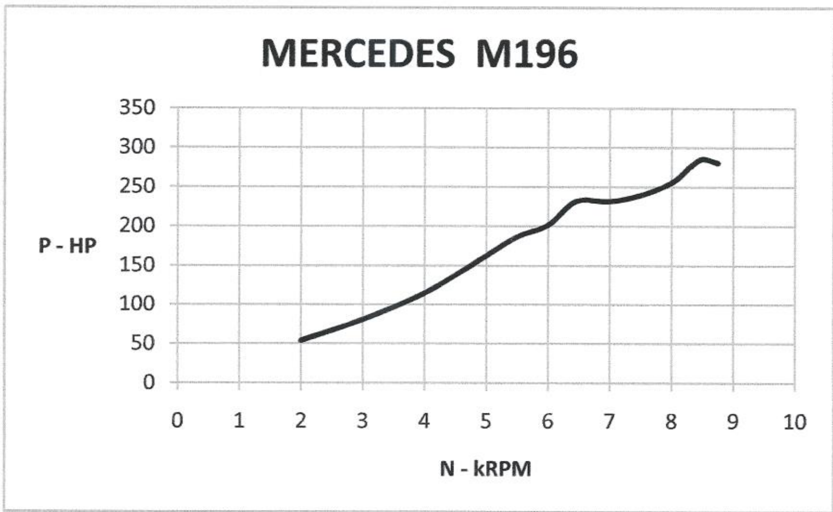


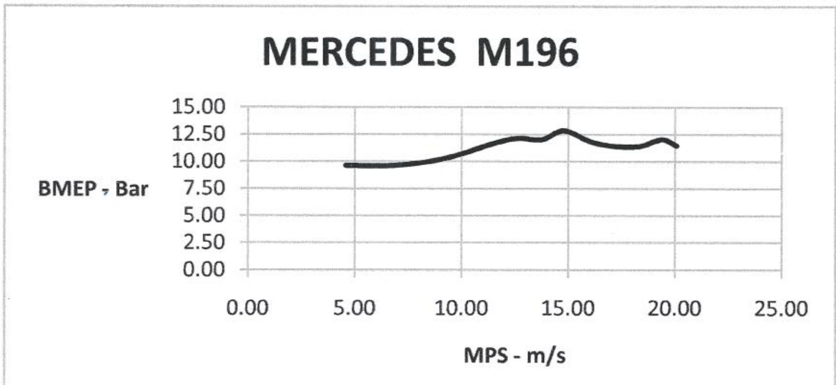
POWER CURVES

| | |
|---|---|
| Eg. | 33 |
| DASO | 29 |
| YEAR | 1955 |
| Make | Mercedes |
| Model | M196 |
| Vcc | 2497 |
| Ind. System | NA |
| Confign. | IL8 |
| Bmm | 76 |
| Smm | 68.8 |

| N<br>kRPM | P<br>HP | MPS<br>m/s | BMEP<br>Bar |
|---|---|---|---|
| 2 | 54 | 4.59 | 9.68 |
| 3 | 81 | 6.88 | 9.68 |
| 4 | 115 | 9.17 | 10.30 |
| 5 | 163 | 11.47 | 11.68 |
| 5.5 | 187 | 12.61 | 12.18 |
| 6 | 202 | 13.76 | 12.07 |
| 6.45 | 232 | 14.79 | 12.89 |
| 7 | 232 | 16.05 | 11.88 |
| 7.5 | 240 | 17.20 | 11.47 |
| 8 | 256 | 18.35 | 11.47 |
| 8.3 | 276 | 19.03 | 11.92 |
| 8.5 | 286 | 19.49 | 12.06 |
| 8.75 | 281 | 20.07 | 11.51 |

Powers as published were German PS and have been divided by 1.014 to convert to HP.




The Desmodromic valve-gear, permitting very-high Mean Valve Speed (MVS enabled the Inlet Open Duration (IOD) to be restricted to $256^0$ with adequate Lift (IVL) and with only $34^0$ of Overlap (OL) and so gave a *relatively* flat and extended Torque (BMEP) curve. The Fuel Injection will have helped extend the useable RPM range.

**34. 1956 Ferrari D50; 2,488 cc; 270 HP @ 8,200 RPM** (see Figs. 34A, 34B and 34C)

The Lancia D50–Ferrari which was CoY in 1956 was basically the car designed at Lancia in 1952 - 1953 by Ettore Mina (engine) and Francesco Faleo (chassis) (789) under the technical direction of Vittorio Jano (who had joined Lancia in 1938 from Alfa Romeo) with a few Ferrari modifications to the chassis. The D50had been on test by Lancia since early 1954, first raced at the end of that year and appeared in a few events of 1955 before the team's No.1 driver, Alberto Ascari (a double World Champion) was killed in an off-duty Ferrari sports car accident. This precipitated the abandonment of racing by the company where the costs had already become a serious concern to the Lancia family ownership.

The Lancia-to-Ferrari transfer

In a transfer for which FIAT promised a 5 year racing subsidy (793) the entire Grand Prix equipment (less 2 cars retained as exhibits) was handed over to Enzo Ferrari. Jano rejoined his old colleague as a consultant. Aurelio Lampredi, whose 4-cylinder cars had finally been out-classed by Mercedes-Benz in 1955, left Ferrari and went to FIAT as part of the deal.

D50 design details

The 90V8 2.5L engine, which became the 1st V8 CoY unit in 1956, drew on experience gained by Mina with his D20 sports-racing 60V6 3L engine of 1952 (this had itself benefitted from the 1950 60V6 Aurelia of Francesco de Virgilio). It provided a short-stroke with a short, stiff 2-plane ($90^0$) crank giving very good balance (372) and needing no damper. The V8 engine shape was easy to build into the chassis space frame as a stressed structural member (a weight-saving novelty). It also facilitated a short chassis as Jano wished to reduce the polar moment of inertia (7 cm – 3% - (1063) less than the 1954 W196 – but Mercedes shortened their cars by 14 and 20 cm in 1955!).

The general design largely had by-then-conventional features:-

- All Al-alloy static structure;
- All plain bearings;
- Individual, tuned inlet and exhaust tracts;
- 2 valves-per-cylinder;
- 2 plugs per cylinder
- DOHC (per bank) – with chain drive, *not* usual but following its use by Colombo in his 1947 type 125 for Ferrari and later V12s including Lampredi's.

All valve stems were drilled to reduce mass (1030), probably with semi-hollow heads as in the preceding D20 (1033) and probably both valves containing sodium for internal cooling.

The engine was the subject of considerable experimentation before it raced (later receiving input from a D100 1-cylinder research unit in 1955), as follows:-

- B/S ratios of 76/68.5 = 1.11; 73.6/73.1 = 1.01; 74/72 = 1.03 were tried, probably with different liners, pistons and cranks in a common block;
- VIA of $80^0$ at first and $74^0$* later were tried in the detachable cylinder heads (the 1st CoY with this feature since 1949 and which became universal subsequently). The $74^0$ permitted a shorte and lighter inlet valve.
- Hairpin Valve Return System (HVRS) with finger followers at first, giving way to coil springs and "classic Jano" valve-mounted tappets.

The racing specification was initially B/S = 73.6/73.1 and $74^0$ *VIA.

[Corrected to $74^0$ by (1089) (see "Corrections and Additions" from $75^0$ in Appendix 1]

Engine/chassis integration

As mentioned, the engine, with a $12^0$inclination in plan view to permit a low driving seat, was incorporated integrally into the space frame chassis not just as a stiffener but actually taking the place of the top tubes between the front suspension mounting structure and the cockpit bulkhead. However, Ferrari's men did not like this and top rails were bolted-in to share the loads.

Fuel tanks

The D50 chassis had carried the fuel uniquely in pannier tanks out-rigged between the wheels to not only reduce the polar moment compared to a tail tank but also to reduce wheel aero drag and to maintain constant weight distribution with fuel usage. This presented a fire risk in the event of a sideways crash and the Lancia layout was superseded in Ferrari's hands by a tail tank with smaller inboard side tanks. Full width inter-wheel bodywork was retained in 1956 but it reverted to normal in 1957 so presumably the drag reduction was not thought worth the extra weight.

Exhaust system

The original simple exhaust system of the Lancia was replaced by the novel use of completely individual pipes from each cylinder ending in short curved megaphones ejecting sideways in a blast of sound which must have deafened drivers alongside on the grid! The 1956 power gain over 1955 is given variously as 10 to 20 HP (depending on data source). An average of 13 HP or 5% seems reasonable if all was due to the new exhaust system which added, say, 4 Kg or 0.5% of a mid-race car weight. The modification was retained into 1957.

Performance early-1956

With MGVP = 58.5* m/s the early-1956 engine obtained BMPP = 11.8 Bar at MPSP = 20 m/s and R = 11.9 on high-alcohol-content fuel. ECOM was 44.3%**, virtually the same as the M196. The combustion chamber was certainly as inefficient as the Mercedes M196, with a high-crowned (and heavy piston) (R x VIA = 11.9 x $74^0$ = $881^0$). The valve gear ran at MVSP = 3.2 m/s.

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*[Corrected from (1089) for IVD = 43 mm not 42.5 in Appendix 1]

** After adjusting to Petrol from Alcohol using **1/1.12 –** see Key to Appendix 1 at Line 43.

Mid-1956 Specification

The above is the early-1956 B = 73.6 mm engine as detailed in Appendix 1 [with corrections shown* from ref. (1089)].

In mid-season at Rheims Ferrari adopted one of the experimental Lancia specifications of B/S = 76/68.5 = 1.11and V = 2,486 cc. It may be that this change was simply a matter of parts availability but the shorter stroke would have been an advantage on that faster circuit.

Ref. (1063) based on official Ferrari data gives the performance of this specification as:-
280 CV (276 HP) @ 8,000 RPM so that BMPP = 12.4 Bar @ 18.3 m/s with R = 11.5, so ECOM = 46.8%**.

The same source gives two details of interest for this build:-

Oil tank capacity 15L and radiator 9L (presumably additional to the water in the engine itself;

Fuel tank capacity 230L so that at the longest non-stop race of 506 km at Rheims the consumption would have been around 45L/100 km at 197 kph.

**P.S. to Eg.34**

Ref. (1089) came to hand late. It provides a possible explanation of why the 'Top End' of the D50 was redesigned at some date between November 1952 (Lancia drawing C1470) and May 1953 (C1471). In a list of D50 variants the leading two are both shown with B/S = 76/68.5 = 1.109 but the first had IVD = 45 mm, EVD = 42 mm at VIA = $80^0$; the second had 43/38 and $74^0$. The first revved to a maximum of only7.500 RPM; the second to 9.000 RPM maximum. This suggests that the larger valves with hairpin springs were found to limit the engine – an output of only 218 CV (215 HP) was listed with R = 10. Smaller valves with 'Jano' tappets and coil springs were then adopted.

All other D50 variants listed by Lancia retained the 43/36/$74^0$ specification, at varying B/S.

A weight of around 170 Kg was shown.

The D100 1-cylinder research unit drawing was dated 25 June 1954. It was 76/68.5. It was tested with direct fuel injection.

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Figs. 34A, 34B and 34C are shown on PP 11 and 12.

**P.S.2 to Eg. 34**

It is known that Lancia made and tested a 4-wheel-drive version but the drivers disliked it and it was dropped.

Fig.34A
Representing
1956 Ferrari Lancia D50
90V8 73.6/73.1 = 1.007 2,488 cc
This figure is taken from Lancia D50 design scheme C1471 (apparently dated 6/5/53).
Note the double-flanged cylinder liner, the lower providing the location and notched for coolant flow, the upper being the support for the sealing gasket.
The big-ends were split at an angle to allow rod withdrawal upwards.
The main bearing caps were double-bolted.

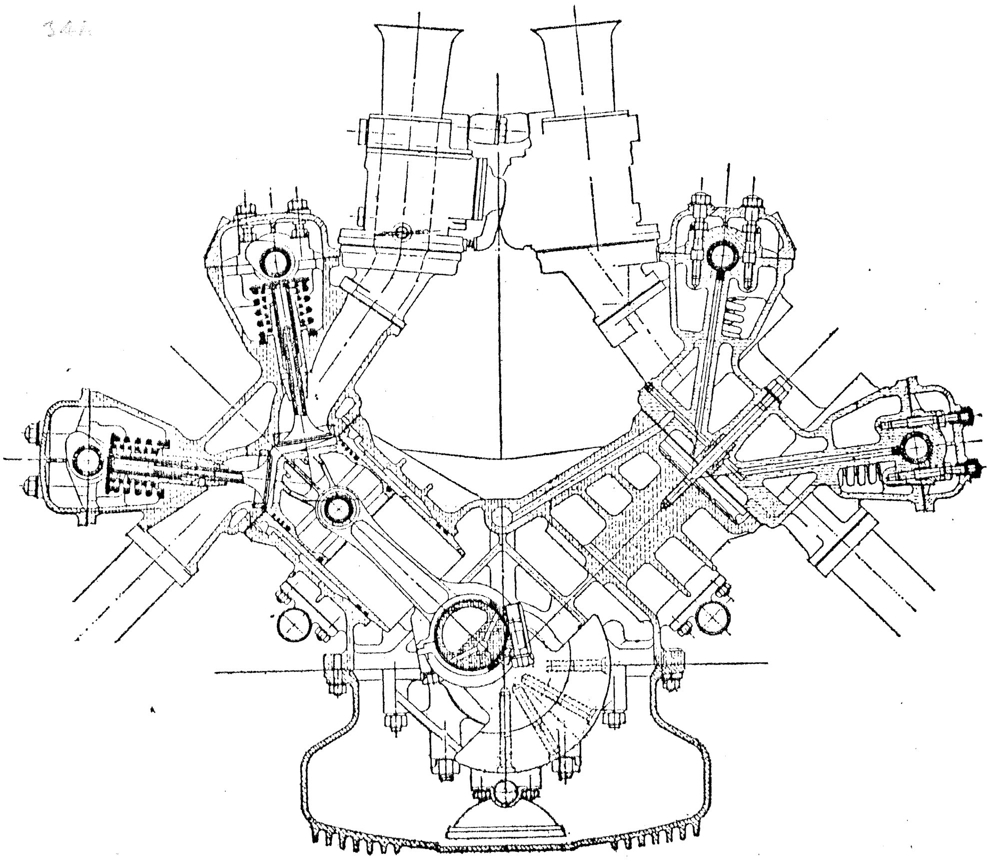

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Fig. 34B
This figure is taken from Lancia D38 design scheme C1470 dated 30/11/52 and, as it had the horizontally-topped carburetters known to have been supplied by Weber for that prototype build (8), was undoubtedly the hairpin-valve-spring engine which was subsequently re-designed for coil springs as shown on Fig. 34A, which also had Solex carburetters.
It can be taken as representative of the 'Bottom-End' of the engine as raced by Ferrari.
Note the chain camshaft drive Figs. 34A & B both DASO 184

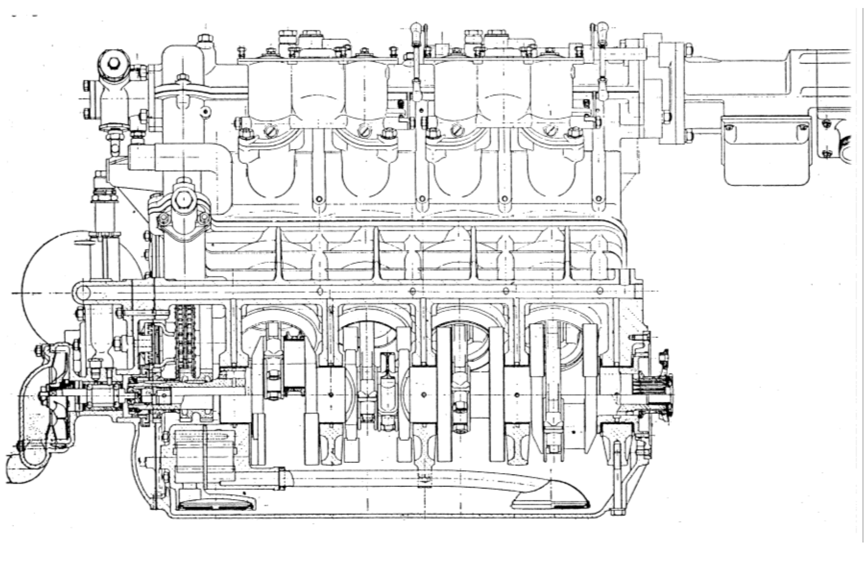


Fig.34C

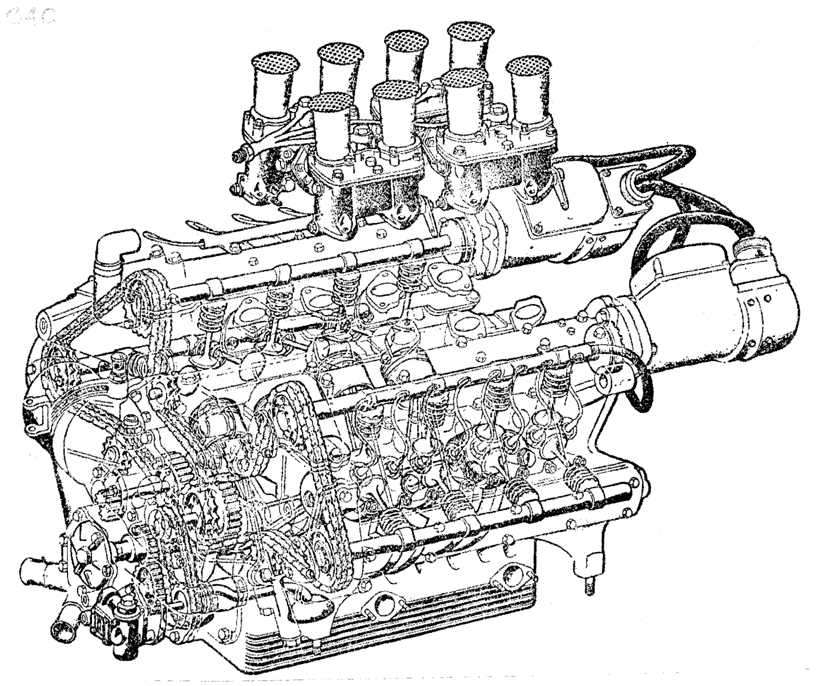
1956 Ferrari Lancia D50

Probably the specification raced after mid-season

90V8 76/68.5 = 1.109 2,486 cc

The sump ribbing is on the side and not at the bottom as shown on Fig. 34A.

DASO 8 p.81



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Eg. 35 is shown on P.13

**35. 1957 Maserati 250F1; 2,494cc; 270 HP @ 7,500 RPM (*probably optimistic)***

See Fig. 35A

The Maserati 250F1 of 1957 was a modest improvement by Guilio Alfieri on the original GP engine design produced in 1953 by Gioachino Colombo and Vittorio Bellentani, which was itself based on the Alberto Massimino-designed, Colombo-developed F2 IL6 2L of that year with B/S = 76.2/72 = 1.058*. The GP unit was an IL6 2.5L with B/S increased slightly to 84/75 = 1.12. Unlike Lampredi's successful Ferrari NA engines, the Maseratis had detachable heads but dispensed with a gasket, the pieces being lapped together as in their 1933 3L engine. Uniquely 1/3rd wet-at-the-top, 2/3rds dry cast iron liners were fitted to the block and great care was needed to ensure that these sealed against the head (see Note 55).

The side thrust of the DOHC was taken by short finger followers which, despite having a direct oil supply to the rubbing faces (ref.(140) shows the 2L method) at first wore rapidly, as did the cams. These parts had to be replaced after a 500 km GP. The wear would also reduce the valve-open period and hence power – the reduced lift would be insignificant directly**. Alf Francis cured this problem in 1954 in Stirling Moss' private 250F by hard Cr –plating the fingers and improving the oil supply (147). Presumably the works alleviated the problem similarly but, when a 60V12 was designed as a successor to the IL6 in 1956, ordinary tappets were used instead of the fingers, with hairpin valve springs instead of triple coils (508).

A spare 250Fengine in 1954 cost 3.5 million lire, equivalent at mid-2013 levels to £46,000 (see Note 56).

During 1954-1957 development, although the inlet and exhaust valve diameters remained unchanged (IVA/PA = 0.30),the Weber carburettors were increased from 42 to 45mm bore (+15% area – with main jets increased from 1.9 to 2.6mm bore, +87% area!). The camshafts were unchanged also, but the exhaust timing was set back to increase overlap from 68 to $84^0$ (all above data from Maserati build records (882)). In 1957 the fuel had a Nitro-Methane oxygen-bearing additive, believed to be 5% (see Appendix 2 item 34B which considers this point). The jet increase also indicates a very much richer mixture was used.

Although Fangio stated much later (791) that he had used 9,000 RPM successfully (*"Nueve mil"* – "*with a new engine for every race*", confirmed contemporaneously by (795)), which was 22.5 m/s and no crank damper was fitted, this 250F engine apparently had none of the usual torsional vibration problems of an IL6. The reason for this may lie in the crank having 2 balance weights opposite each throw (i.e. 12 such weights where 4 are usual for such a shaft (158)) so that the fundamental natural frequency was greatly reduced by these extra masses and it was probably below the operational range of the engine.

The 9,000 RPM quoted was an index of 3 years mechanical development, since the mid-1954 red line was 8,200 RPM (20.5 m/s)(790) and at that speed much oil was lost, almost certainly due to piston ring flutter (see Note 13 Part II). The usefulness of the higher revs., 'way beyond peak power (7,500) would lie in the ability to use a lower gear ratio to improve acceleration.

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* Other sources give B = 76.5mm.

** The 4CL Maserati series of 1938-1950 had the same problem with the fingers (660) – the 'L' designation referred to the 'linguetta' meaning 'tongues', as the firm described the fingers (949). It will be recollected that Eg. 13, the 1927 Delage, also suffered from the wear problem.

Maserati claimed 270 HP – probably with 10% exaggeration relative to stabilised-temperature running (see Note 6) – a BMPP of 12.9 Bar at MPSP = 18.8 m/s with R = 11.8 (for comparison an official 1956 power curve is attached on P.15). Deducting 10% of power, ECOM = 43.6%*.
The high (R x VIA) of 944$^0$ was somewhat offset in its deleterious effect on combustion chamber shape by having the piston crown fit very closely to the hemisphere where possible. However, since valve-clearance pockets were necessary over ½ of the circumference, squish was limited by leakage. Ref. (32) actually shows a cylinder-head sketch having substantial transverse squish plateaux on either side of the valve pair but this was never used in a race engine (see Note 57).

The MGVP = 57.4 m/s and MVSP = 3.3 m/s, a modest increase over a then-typical 3.0 for DOHC, using triple non-interference coil springs, but perhaps explaining the initial cam and follower wear rate.

The 250F1 was the last of only 3 IL6 engines to be GP CoY (the others being the 1922 FIAT and the derivative 1923 Sunbeam).

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* After adjusting to Petrol from Alcohol using **1/1.12 –** see Key to Appendix 1 at Line 43.

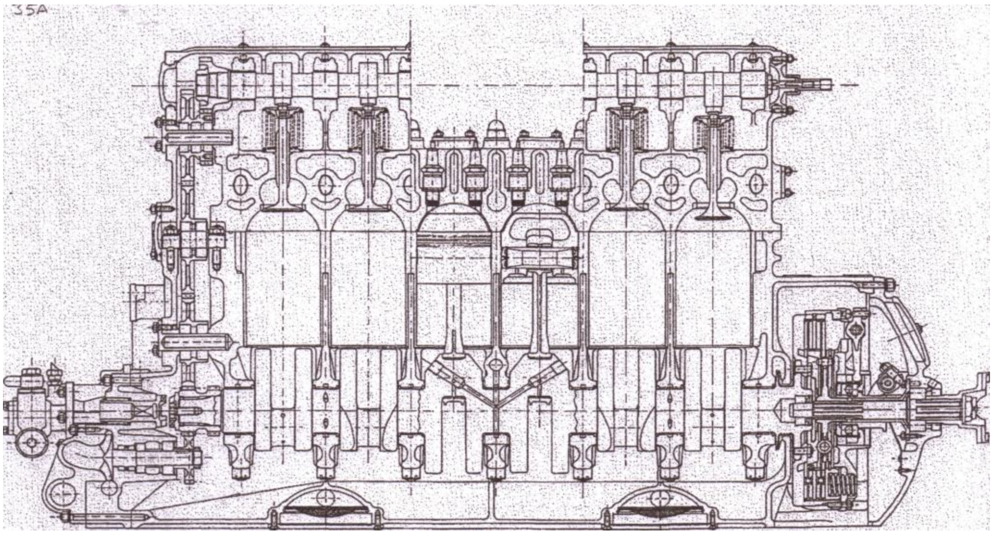
Fig. 35A

1957 Maserati 250F1

IL6 B/S = 84/75 =1.120 2,494cc

The only thing of note about this engine is that there was nothing of note! As it was designed for sale to private owners to race nothing out-of-the-ordinary for the time was included, except perhaps the cylinder liners only having contact with water at the top 1/3rd of their length.

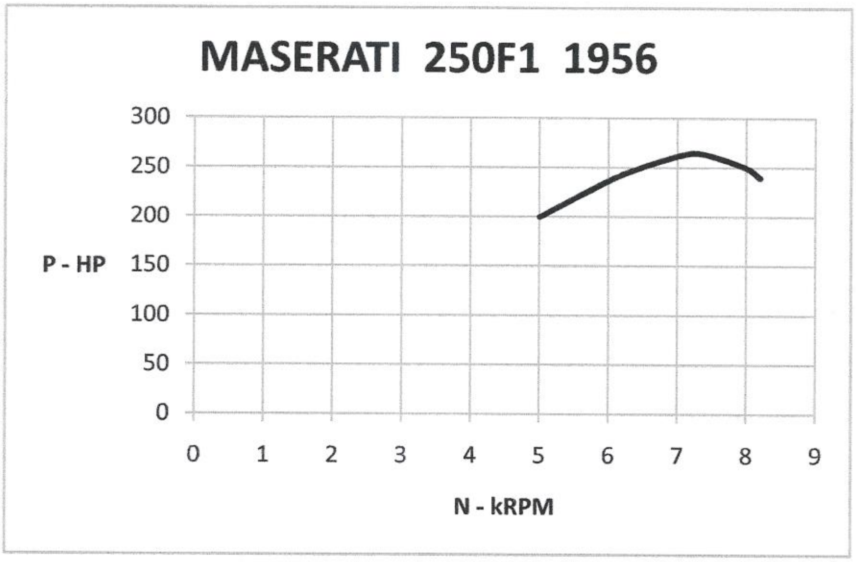
DASO949: *Maserati: the Grand Prix cars, 1926-2003: M. Tabucchi: Georgio Nada Editore: 2003*

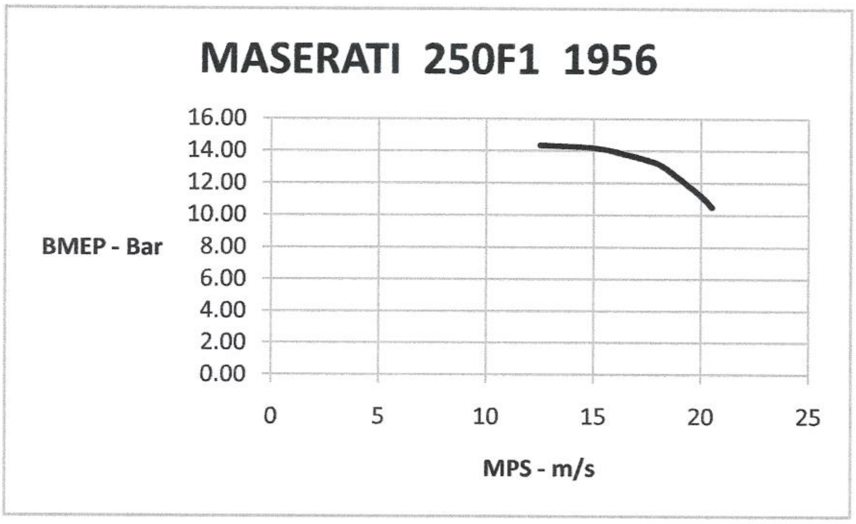


POWER CURVES

| | | | | |
|---|---|---|---|---|
| Eg. | | For comparison with Eg.35 | | |
| DASO | 32 | | | |
| YEAR | 1956 | | | |
| Make | Maserati | | | |
| Model | 250F1 | | | |
| Vcc | 2494 | | | |
| Ind. System | NA | | | |
| Confign. | IL6 | | | |
| Bmm | 84 | | | |
| Smm | 75 | | | |
| | N | P | MPS | BMEP |
| | kRPM | HP | m/s | Bar |
| | 5 | 200 | 12.5 | 14.35 |
| | 6 | 237 | 15 | 14.17 |
| | 6.5 | 251 | 16.25 | 13.86 |
| | 7 | 262 | 17.5 | 13.43 |
| | 7.25 | 265 | 18.13 | 13.11 |
| | 7.5 | 262 | 18.75 | 12.53 |
| | 8 | 250 | 20 | 11.21 |
| | 8.2 | 240 | 20.5 | 10.50 |

Curve provided by Omer Orsi to L. Pomeroy




End of 2nd Naturally-Aspirated Era (2NA): Part 1. 1952 - 1957; Egs. 30 to 35.

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