## CORRECTIONS & ADDITIONS: Part 2



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## 6 September 2019

## Significant Other: SO6: 1920 Ballot 3L

DASO 1224 (see ref. below) has a longitudinal section of the 1920 Ballot 3L 8-cylinder engine which is sharper than that provided in SO6 and also gives an "exploded" illustration of how the 4-piece crank was built-up to allow un-split crankshaft ball-bearings to be used. These drawings are reproduced below. [It is hoped that there will not be objections to their use here in a not-for-profit website which is intended purely for study.]





The crank-pins were 42 mm diameter and the ball-bearings were Hoffman.

## **Reference**

DASO 1224 BALLOT D. Cabart & G. Sen Dalton Watson 2019. Advised by courtesy of Bernard Heurteux. E-mail 31 August 2019.

#### **CORRECTIONS & ADDITIONS**

#### 17 September 2019

#### ADDITION

#### **Appendix 8 Illustrations**

A former colleague, Bernard Heurteux, has brought back to the author's attention an omission from this collection of piston aero engines of the 1914 V8 Peugeot, built for the French government. This unit is of particular interest in a website aimed principally at racing engines, because it was based by Ernest Henri on his successful 1913 Grand Prix engine. Two of the 100 mm x 180 mm cast-iron DOHC 4 valves-per-cylinder blocks, modified only to insert additional sparking-plugs to conform to standard aero practice, were mounted at 90°. The bottom-end was also to Henri's 1913 redesign pattern, the 4-throw balanced crank rotating in 3 large-diameter ball-bearings. The centre bearing being un-split required a 2-piece crank, with a bolted-up taper joint (the design is illustrated, as used by Henri in the 1920 3L Ballot, at C & A Part 2 on P.1). Steel pistons were carried by fork-and-blade con. rods.

The engine section is shown below.

1914 Peugeot DASO 371 (see Refs. below) 90V8 100 mm/180 = 0.555 11,310 cc Rated at 210 HP @ 2,000 RPM 1:2 crank-speed spur gear reduction Weight 395 kg





The engine was not a success. It found a belated home in only the Voisin type 8 night bomber, but gave "little satisfaction" and was superseded in the type 10 by a new Renault engine (ref. Bomber Aircraft Pocketbook R. Cross Batsford 1964). This was partly because its Weight/Power ratio of 395/210 = 1.88 kg/HP was poor – for comparison the novel aluminium-alloy block Hispano-Suiza V8 of Marc Birkigt was developed in 1917 to 240/220 = 1.09 when also fitted with a propeller-speed reduction gear (these engines were reserved for SPAD fighters). Henri left Peugeot in February 1915 so it cannot be known how he might have developed his aero engine. There were other factors against the unit as a practical military engine. The Mean Piston Speed (MPS) of 12 m/s, compared to the 8.5 m/s of the Hispano was too high, bearing in mind that reciprocating stress varies as MPS<sup>2</sup> (x2). The 32 valves needing frequent clearance adjustment and grinding-in at overhaul plus 4 camshafts to be re-timed then, were too labour-intensive.

In the UK Louis Coatalen of Sunbeam used pirated Henri racing technology to build many types of aero engine during WW1, but these also were not judged successful (evidence of George Bulman and W.O. Bentley given in DASO 1097 at Note 16).

It is noteworthy that the two best aero engines used by the Allies in WW1 were the designs of Hispano-Suiza and Rolls-Royce, who had learnt pre War to build long-life, quiet luxury car engines, not the units produced from a racing engine base.

#### **References**

DASO 371 Test records of some Petrol Engines A. Berriman IAE 1919. DASO 1053 AEROSPHERE G. Angle Aircraft Publications 1939. DASO 1097 EAGLE-HENRY ROYCE'S FIRST AERO ENGINE D.S.Taulbut R-R Heritage Trust 2011.

13 November 2019

## ADDITION

## The Unique Cosworth Story

A 1978 power curve for the Cosworth DFV has been provided by DASO 1225 (see refs. below) by courtesy of correspondent Stephen Cansick. This has enabled an update to the power of this engine at various stages of its development given in chart form on CORRECTIONS & ADDITIONSt P. 40. The tabulated 1978 data is given on P. 5. A power of 483 HP@ 10,750 RPM lies between the "Typical" 475 and "Best" 495 given for the DFV in Eg. 58 of The Unique Cosworth Story The updated comparison curves are shown on Figs. 1 and 2 below







#### Comparison with Ferrari 312B(T3)

DASO 1225 also provided a contemporary power curve for the 11-year rival unit , the Ferrari 180V12 (F12) 312Bin its 1978 T3 chassis specification (see P. 5). The two engines are compared on Figs. 3 and 4 on P. 4.



#### The 1978 winner

In 1978 the Drivers' and Constructors' Championships were won, respectively, by Mario Andretti (6 wins) and the Lotus "Ground-hugging" designs L78 (first 2 races) and L79 (6 races), total 8 wins (2 by Ronnie Peterson). With 1 DFV-powered Tyrrell win by Patrick Depailler, the DFV total was 9 wins to the Ferrari's 5 (1 by the T2 specn.).

As recorded in The Unique Cosworth Story, Andretti was sometimes able to win while restricting his DFV to a max. 10,250 RPM, providing 476 HP, or a little more in a Cosworth development engine, as supplied to favoured customers. The rival Ferrari had a peak of over 500 HP. This illustrates the advantage of the Lotus' ground-effect, even though the Ferrari that season was on the new Michelin radial-ply tyres (versus cross-ply Goodyears).

#### <u>1979</u>

However, Ferrari won the last 4 races of 1978. This foreshadowed their return of Championshipwinning form in 1979, with the T4 specn. This was the year that Colin Chapman over-reached himself in ground-effect with the L80 and the new ground-effect Williams FW07 did not peak in form until past mid-season.

In turn, the 1980 Ferrari 312B(T5) was a flop! For comments on the Lotus over 1978-1979 and the Ferrari over 1979-1980 see the piece on "<u>Spectacular Loss of Performance between seasons</u>". <u>Reference</u>

DASO 1225 Motor 5 April 1980 advised by courtesy of Stephen Cansick, E-mail 31 October 2019.

| POWER C               | <u>JRVES</u>            |    |  |   |             |
|-----------------------|-------------------------|----|--|---|-------------|
| Eg.                   | 58                      |    |  |   |             |
| DASO                  | 1225                    | _  |  |   |             |
| YEAR<br>Make<br>Model | 1978<br>Cosworth<br>DFV |    | The s<br>believ<br>Metri<br>and h<br>reduc | ource is<br>ved to be<br>ic Horsepon<br>has been<br>ced by 1.4% | wer<br>6 to |
| Vcc<br>Ind.           | 2993.1                  |    | give t                                     | зпр.  |             |
| System                | NA                      |    |  |   |             |
| Confign.              | 90V8                    |    |  |   |             |
| Bmm                   | 85.6742                 |    |  |   |             |
| Smm                   | 64.77                   |    |  |   |             |
|                       | N                       |    | Р  | MPS   | BMEP        |
|                       | kRPM                    | Н  | Р  | m/s   | Bar         |
|                       | 7                       | 31 | 7  | 15.11   | 13.54       |
|                       | 7.5                     | 34 | 0  | 16.19   | 13.55       |
|                       | 8                       | 37 | 5  | 17.27   | 14.01       |
|                       | 8.5                     | 41 | 1  | 18.35   | 14.46       |
|                       | 9                       | 44 | 1  | 19.43   | 14.65       |
|                       | 9.5                     | 45 | 8  | 20.51   | 14.41       |
|                       | 10                      | 47 | 3  | 21.59   | 14.14       |
|                       | 10.5                    | 47 | 8  | 22.67   | 13.61       |
|                       | 10.75                   | 48 | ত  | 23.21   | 13.43       |
|                       | 11                      | 47 | Ø  | 23.75   | 12.99       |

# POWER CURVES

| POWER C  | <u>URVES</u> |       |     |       |       |                        |
|----------|--------------|-------|-----|-------|-------|------------------------|
| PEP      |              | N     | Р   | MPS   | BMEP  |                        |
| DASO     | 1225         | kRPM  | HP  | m/s   | Bar   |                        |
| YEAR     | 1978         |       |     |       |       |                        |
| Make     | Ferrari      |       |     |       |       |                        |
| Model    | )            | 7     | 256 | 11.57 | 10.94 |                        |
|          |              | 7.5   | 306 | 12.40 | 12.20 |                        |
| Vcc      | 2992         | 8     | 345 | 13.23 | 12.90 |                        |
| Ind.     |              |       |     |       |       |                        |
| System   | NA           | 8.5   | 378 | 14.05 | 13.30 |                        |
| Confign. | 180V12       | 9     | 402 | 14.88 | 13.36 | Powers as published    |
| Bmm      | 80           | 9.5   | 431 | 15.71 | 13.57 | were Italian CV and    |
| Smm      | 49.6         | 10    | 449 | 16.53 | 13.43 | have been divided by   |
|          |              | 10.5  | 460 | 17.36 | 13.10 | 1.014 to convert to HP |
|          |              | 11    | 476 | 18.19 | 12.94 | ·                      |
|          |              | 11.5  | 488 | 19.01 | 12.69 |                        |
|          |              | 12    | 497 | 19.84 | 12.39 |                        |
|          |              | 12.25 | 501 | 20.25 | 12.23 |                        |
|          |              | 12.5  | 498 | 20.67 | 11.92 |                        |
|          |              |       |     |       |       |                        |

#### 19 November 2019

#### ADDITION

#### 1<sup>st</sup> Pressure-Charged Era (1PC)

## Egs. 12,14,15,16, & 17 Bugatti

DASO 1226 (see refs. below), advised by courtesy of correspondent Stephen Cansick, provides a power curve for the Bugatti type 35B\*. This is charted below in Figs 1 and 2. Added to this are spot points for all Bugattis which were Grand Prix Cars-of-the-Year (CoY):-

1926 T39A; 1928 T35C; 1929 T35B; 1930 T35C and 1931 T51.



\* Tested at Monaco Engineering by A. Maclachlan on fuel 60% Methanol+20% Benzole+20% Petrol. The works Bugattis ran on Elcosine:- 44% Ethanol+53% Benzole+2% Ether+1% Castor oil.





hiveminer.com

Contd. on P.7

#### Bugatti T59

Although far from being CoY, the Bugatti T59 is interesting as a survivor from the "Old School" of Grand Prix cars overlapping – with the Alfa Romeo P3B – the start of the "Teutonic Era" in 1934-1935. It was PC IL8 72 mm/100 = 0.72, 3,257 cc with the DOHC introduced on the T50 production and T51 GP car which was CoY in 1931. The chassis remained as before with beam axles and leaf springs.

DASO 1227, also provided by Stephen Cansick, is his analysis of Bugatti T59 test records, specifically for its final development prepared for the 1935 Belgian GP. The year previously a T59 driven by René Dreyfus had won that event, the last classic GP victory for Bugatti – admittedly in the absence of the German teams and after two leading P3Bs had run into trouble.

In 1935 at Spa Mercedes-Benz were there in full force, the W25s now fitted with M25C 4,309 cc engines. The Mercedes gained 1<sup>st</sup> and 2<sup>nd</sup> places ahead of 2 Alfas and Robert Benoist could only finish 5<sup>th</sup>, 3 laps in arrears. Figs. 3 and 4 show how hopeless the T59 power was compared with the M25C.





| Mercedes-Benz W25/M25C | 397   | 165.7 |
|------------------------|-------|-------|
| Bugatti T59            | 262   | 155.1 |
|                        |       |       |
| Ratio Mercedes/Bugatti | 1.515 | 1.068 |

Remembering Laurence Pomeroy's empirical correlation for pre-War cars (in eg. DASO 32 p.264) that:-

Lap Speed varied as the 6<sup>th</sup> root of (Power/Frontal Area),

noting that the Frontal Area of the T59 was rather more than the W25 but that the two cars were equal in Weight by rule, it is found that  $(1.515)^{1/6} = 1.072$ .

## T59 "Rated Power"

The T59 output was "Rated" at that obtained at 5,500 RPM because of crank vibration. Possibly, if shorter duration inlet valve timing had been used, the slightly higher true power peak could have been brought into the working range, with a fatter torque curve.



T59

bonhams

## <u>References</u>

DASO 32 DESIGN & BEHAVIOUR OF THE RACING CAR S. Moss & L. Pomeroy Kimber 1963. DASO 1226 Autocar 12 March 1983 Advised by courtesy of S. Cansick E-mail 31 October 2019/9.08. DASO 1227 E-mail S. Cansick 31 October 2019/9.17. DASO 1228 www.kolumbus.f1/leif.snellman.

## CORRECTIONS & ADDITIONS: PART 2

## 27 November 2019

## ADDITION Appendix 5 and Illustrations for Appendix 5: Maserati 4CLT/48

This is to give some background to the 1948 Maserati 4CLT/48, a contender in the post-WW2 Grand Prix arena after this adopted for supercharged engines the pre-war 1.5 L Voiturette capacity. Maserati had built for sale over 1932 -1939 three types of engines in that racing class and the 3<sup>rd</sup> design (4CL) was the basis for the post-war car. The 4CL, designed by Ernesto Maserati, showed an awareness of the link between "Bottom-end" and "Top-end" architecture through choice of Bore/Stroke ratio and Valve Operating Systems. This is the reason for this piece, whose main source. is DASO 27 (see refs. below)..

## <u>4C-1500</u>

In 1932 the Maserati voiturette offering was the 4C-1500, an IL4 DOHC 2v/c 69 mm/100 = 0.69 1,496 cc enlargement of a parallel 4C-1100 65 mm/82 = 0.79 1,088 cc engine which is illustrated below.

Maserati 4C-1100



maserati-alfieri.co.uk

The 1.5 L unit was claimed to give 130 HP @ 5,500 RPM (BMPP = 14.1 Bar @ MPSP = 18.3 m/s). 6CM

Over 1934-1935 the 4C-1500 Maserati was defeated by the new ERAs, A and B types. Therefore in 1936 the firm produced the 6CM, IL6 DOHC 2v/c 65 mm/75 = 0.87 1,493 cc, which had a claimed 155 HP @ 6,200 RPM (15.0 Bar @ 15.5 m/s). DASO 27 suggests that this was optimistic, which remark probably also applies to a later figure of 175 HP @ 6,700 RPM (15.7 Bar @ 16.8 m/s)

Maserati 6CM



#### maserati-alfieri.co.uk

During 1936 -1938 the 6CM "Held the fort" for Maserati. In 1936 Felice Trossi beat Dick Seaman's Ramponi-rejuvenated 1927 Delage 15-S-8 in the Voiturette races Eifelrennen and Coppa Ciano but, after losing to that combination in the Coppa Acerbo withdrew from meeting it at Berne. By 1938 the C type ERAs, with Porsche IFS and high-pressure Zoller superchargers, had the legs of the 6CM. Furthermore, the Alfa Romeo 158 appeared in August. It was IL8 DOHC 2v/c 58 mm/70 = 0.83 1,480 cc and as 1<sup>st</sup> raced claimed 195 HP @ 7,000 RPM (16.8 Bar @ 16.3 m/s). This won its first race (Coppa Ciano), lost the 2<sup>nd</sup>, won the 3<sup>rd</sup> but lost its 4<sup>th</sup>. With the writing on the wall for the 158's return better-developed in 1939, coupled with the Italian racing authority's decision in September 1938 that future races on Italian soil would be 1.5 L, Ernesto Maserati decided that a new engine was needed.

## <u>4CL</u>

Maserati chose to return to the IL4 configuration. From a consistently-competitive point of view over the years this turned out to be a bad decision, but the company had to make affordable and easily-maintainable cars for private owners. To get the best out of IL4 a "Square" Bore/Stroke ratio, 78 mm/78 1,491 cc, was adopted, something not used in automobile racing since well before WW1. However, Ernesto Maserati would have been well aware of the Italian motor-cycle firm of Moto Guzzi using B/S = 1 since 1926\* for their successful 1-cylinder 250cc and, since 1933, for a  $120^{\circ}$  V2 which had won the "Blue Riband" Senior TT in 1935 with Stanley Woods aboard (DASO 1190). The Guzzi engines had SOHC and 2v/c, but Ernesto took no chance of the valve gear restricting his RPM by using DOHC and, for the first time,  $\frac{4v/c}{2}$ .

Maserati 4CL



velocetoday.com

supercars.net

With 1-stage Roots-type supercharging as before, power claimed was 220 HP @ 6,600 RPM (20.0 Bar @ 17.2 m/s).

#### The 1939 Tripoli race

The first works race for the new 4CL was in the Italian Libyan colony at Tripoli on 7 May 1939. Having reduced this race to 1.5 L the organisers fully expected a "home" victory. Alas for them, their Axis "partners" in the form of Mercedes-Benz had used their enormous resources and vast experience to build in secret in only 8 months and then enter two rival 1.5 L cars! These were W165/M165 90V8 DOHC 4v/c 64 mm/58 = 1.10 1,493 cc (see <u>Significant Other</u> SO13). With 2-stage supercharging reserved for later development (Mercedes expected the Grand Prix formula to become 1.5 L in 1941), the 1-stage Tripoli engines gave 243 HP @ 7,500 RPM (19.4 Bar @ 14.5 m/s).

By this date the Alfa Romeo 158 was producing 225 HP @ 7,500 RPM (18.1 Bar @ 17.5 m/s) (DASO 31).

The main works contenders therefore had:-

|      | Power HP | <u>Mean Piston Speed (MPS) m/s</u> | <u>(MPS</u> ) <sup>2</sup> | (m/s) <sup>2</sup> |
|------|----------|------------------------------------|----------------------------|--------------------|
| W165 | 243      | 14.5                               | 210                        | Datum              |
| 158  | 225      | 17.5                               | 306                        | +46%               |
| 4CL  | 220      | 17.2                               | 296                        | +41%               |
|      |          |                                    |                            |                    |

Bearing in mind that "Bottom-end" stresses vary as (MPS)<sup>2</sup>, the Italian cars were likely to be in trouble compared to their Teutonic rivals.

However, Maserati had a secret weapon! This was a fully streamlined body on Luigi Villoresi's car (see below).

!939 Maserati 4CL
Tripoli Streamliner
(1/43<sup>rd</sup> scale model)
The rear wheels were left
without fairings to permit fast
tyre changes.



#### racingdioramics.us

Villoresi took Pole at 132.1 MPH (212.6 kph)\*\* (DASO 1228), but Hermann Lang was only 0.24% slower with the open-wheeled W165.

On the very hot race day, the race was a triumph for Mercedes and Lang and an utter disaster for Maserati and Alfa Romeo. Villoresi's gearbox broke at the start and the other two works 4CLs broke pistons on the first lap! Of 6 type 158s entered, 5 retired before half-distance from overheating and the last was 3<sup>rd</sup>, 4 minutes behind Rudolf Carraciola who was 2<sup>nd</sup> on the other Stuttgart car, Emilio Villoresi having kept his revs right down. The designers in Swabia had obviously prepared their engines better for the Libyan conditions than Gioachino Colombo 400 miles further South in Emilia, although the Italian blamed the Alfa team manager for lowering the cooling pressure in practice. The fact remains that the 158 cooling system was redesigned after the race. A year later in Tripoli, when the Germans had given themselves other things to do but Benito Mussolini was still waiting to join the war, Giuseppe Farina, after a practice lap 2% higher than Lang's, won with a 158 at a 4% higher race speed than the W165's. So an Italian *bella figura* was achieved!

Post-war, when both Italian cars (with development) contested Grands Prix, the perhaps unavoidable decision of Ernesto Maserati to make the 1939 engine IL4 meant that whenever it met the Alfa Romeo IL8 it was defeated. In 4CLT/48 2-stage supercharged tubular chassis form it *did* beat the new 1.5 L Ferrari and the new 4.5 L un-supercharged Lago-Talbot *once* in 1949 (British GP), but that was the year that Alfa did not enter while developing their 1900 production car.

\*Carlo Guzzi had actually built his first motorcycle in 1919 as an aircooled single-cylinder with B/S of 88 mm/82 = 1.073 499 cc, and had shown his awareness of appropriate cylinder architecture by fitting SOHC with  $\frac{4v}{c}$  (DASO 1190). As developed in 1924 it powered the winners of the German and European GPs.

\*\*The body was built in Bologna after consultation with the coachwork specialist Stabilimenti Farina of Turin. Clearly it was stable at very high speed, unlike the two Auto Union streamliners taken to Reims in 1938 for the French Grand Prix, which both crashed in practice and were withdrawn from the race. The difference *may* have lain in being front-engined instead of mid-engined.

References DASO 27 MASERATI a history A Pritchard Arco 1976 DASO 31 Profile No. 30 D. Hodges ca 1965 DASO 1190 ITALIAN RACING MOTORCYCLES M. Walker Redline 1998 DASO 1228 www.kolumbusf1/leif.snellman

## **CORRECTIONS & ADDITIONS: PART 2**

## 21 December 2019

#### ADDITION

## 1<sup>st</sup> Pressure-Charged Era (1PC)

.Eg. 18 Alfa Romeo Type B (P3)

(1).Central camshaft drive

In this Eg. it was noted that Vittorio Jano's inspiration for the central camshaft drive for the 1931 8C-2300 and the subsequent Type B was from Emile Petit's 1927 IL8 Salmson. Recently a section drawing of this latter engine was discovered on the internet and it is reproduced below



desmodromology

1927 Salmson IL8 49.9 mm/70 = 0.713 1,095 cc 100 HP @ 5,800 RPM

It is not a clear enough drawing to show how the crankshaft halves were joined.

This engine was not very successful. Salmson closed their racing department in 1929.

#### (2).Magnesium-alloy crankcase

Considering other un-successful attempts to use magnesium-alloy in racing engines, its application by Jano in the P3 (and later Alfa engines) was not sufficiently emphasised by the author. The obvious advantage of a Specific Gravity only  $2/3^{rd}$  of aluminium-alloy is partially offset by its lower stress capability needing thicker sections, but Jano found it worthwhile. The alloy used was almost certainly the proprietary Elektron and probably the original 1908 German composition of 90% Mg + 9% Al + 1% other.

Regarding the problem of using Mg-alloy, in 1927 Roy Fedden had included a forged Mg-alloy crankcase in his revised *Mercury* aircooled radial engine for the Short-Bristow *Crusader* seaplane entry for that year's Schneider Trophy. On the bench the large forging proved to be weaker than small test pieces had indicated (studs pulled loose) and it had to be replaced with an Al-alloy part (part DASO 225). [The author cannot now find the reference, but has read somewhere that a Mg-

alloy case was fitted later and, after the aircraft sank at Venice and was salvaged a week later, the sea-water had dissolved most of it!].

When Gioachino Colombo, Jano's long-time assistant, designed the Alfa Romeo type 158 in 1937, he used cast Elektron for the crankcase, which showed that it had not given problems in earlier Alfas (it may have been a later specification, as the suppliers continued to improve the alloy). As this engine was developed to 2-stage supercharging after WW2, some cracking around the bearing housings was experienced. Tie rods were fitted to take the extra loads and saw the engine through the increase to well over 2 x times its original power by 1951 (DASO 31).

The success of Mg-alloy in Alfa engines is high-lighted by the fact that Cosworth found it unsuitable for the DFV block in 1977 (see "<u>The Unique Cosworth Story</u>" at P. 18).

#### CORRECTIONS & ADDITIONS: PART 2

#### ADDITION

23 December 2019

## <u>1<sup>st</sup> Pressure-Charged Era (1PC) Part 1</u> Alfa Romeo Power Curves 1923 – 1935

Having recently obtained power curves for the 1934 and 1935 derivatives of the Alfa Romeo type B (P3) (DASO 1230, see ref. below) the opportunity has been taken to provide comparative charts of all the Grand Prix Alfas from 1924 to 1935 on P.13.

| Brief specs. are as follows | (more details are | given in <u>Appendix 1</u> ):- |
|-----------------------------|-------------------|--------------------------------|
|-----------------------------|-------------------|--------------------------------|

| <u>All PC, DOHC, 2 v/c</u> |                    |                   |                   |                    |                     |                   |
|----------------------------|--------------------|-------------------|-------------------|--------------------|---------------------|-------------------|
| Date                       | <u>1924</u>        | <u>1924</u>       | <u>1932</u>       | <u>1934</u>        | <u>1935</u>         | <u>1935</u>       |
| Source                     | 938                | 1133,25           | 1133,25           | 1230,25            | 1230,25             | 25                |
| DASO                       |                    |                   |                   |                    |                     |                   |
| Туре                       | P1                 | P2                | B (P3)            | P3B                | P3B                 | 8C-35             |
|                            |                    | CoY Eg. 10        | CoY Eg. 18        | CoY Eg. 20         |                     |                   |
| Configuration              | IL6                | IL8               | IL8               | IL8                | IL8                 | IL8               |
| B/S mm                     | 65/100             | 61/85             | 65/100            | 68/100             | 71/100              | 78/100            |
| = B/S                      | 0.65               | 0.718             | 0.65              | 0.65               | 0.71                | 0.78              |
| V cc                       | 1991               | 1987              | 2655v             | 2905               | 3167                | 3823              |
| PP—HP*                     | <mark>116**</mark> | <mark>143</mark>  | <mark>212</mark>  | <mark>251.5</mark> | <mark>261***</mark> | <mark>325</mark>  |
| <mark>@ RPM</mark>         | <mark>5000</mark>  | <mark>5500</mark> | <mark>5600</mark> | <mark>5400</mark>  | <mark>5400</mark>   | <mark>5400</mark> |
| <b>BMPP Bar</b>            | <b>10.4</b>        | <b>11.7</b>       | <mark>12.8</mark> | <mark>14.3</mark>  | <b>13.7</b>         | <mark>14.1</mark> |
| @MPSP                      | <mark>16.7</mark>  | <mark>15.6</mark> | <mark>18.7</mark> | <mark>18</mark>    | <mark>18</mark>     | <mark>18</mark>   |
| <mark>m/s</mark>           |                    |                   |                   |                    |                     |                   |
| Principal                  |                    |                   |                   |                    |                     |                   |
| GP victory                 |                    | French            | French            | French             | German              | Magyar '36        |

\*Powers as published were Italian CV and have been divided by 1.014 to convert to HP.

\*\*The original P1 of 1923 was NA with 94 HP @ 5,000 RPM (8.4 Bar @ 16.7 m/s). See P.13. \*\*\*The 9% volume enlargement from 1934 yielded only just under 4% more power, probably because the inlet valves were not enlarged. In contrast, the 32% enlargement of the revised 8C-35 gave 29% more power.

<u>P1</u>

The P1, designed by Giuseppe Merosi, never raced. The 1923 original crashed in practice for the Italian GP, killing Ugo Sivocci.

## <u> 1932 - 1935</u>

All the other cars tabled were designed by Vittorio Jano, who joined Alfa Romeo from FIAT in 1923

1923 Alfa Romeo P1



DASO 25





The lower speed BMEP curves for the 1932 -1935 engines are suspect.

The most famous Grand Prix victory of the 1934 P3B in the hands of Louis Chiron was its defeat of the full teams of Mercedes-Benz and Auto Union at Montlhery in the French classic.

This was surpassed by Tazio Nuvolari's winning of the 1935 German Grand Prix at the Nurburgring with the up-dated P3B, in a battle with both home teams. His car had the 9% enlarged engine of 3.2 L (often stated in reputable sources to be 3.8 L, but <u>www.kolumbus</u> has shown that engine, being developed for the 8C-35, was too long to be fitted in the P3). The suspension had been revised to Dubonnet single leading-link IFS and reversed ¼-elliptic rear (see plan below), which one would have thought gave an understeering characteristic, hardly ideal for the Nurburgring. At any rate, after a wet track dried by Lap 8 (of 22) Nuvolari was in the lead at ½ distance but lost much time at his refuelling stop because the handle broke on the pump. He recovered to be on the tail of von Brauchitsch's Mercedes W25B (M25C engine, power curve shown) on the last lap. That driver, with his usual tail-sliding style (see <u>Note 114</u>), then had his left rear tyre burst and the little maestro passed him to win – and provided his own record of the Italian national anthem!.

#### 1935 revised Alfa Romeo P3B

Dubonnet single leading-link independent front suspension (IFS), replacing beam axle mounted on semi-elliptical leaf springs.

Rear suspension by reversed ¼-elliptic leaf springs, replacing semi-elliptical leaf springs.

Probably converting an oversteering characteristic into understeering. A significant advantage would be the elimination of front wheel-flap by gyroscopic precession on onewheel-bump.



cyclekartclub.com

#### 8C-35

This was developed to replace the P3 series and first raced to 2<sup>nd</sup> place in the 1935 Italian Grand Prix at Monza late in the year. The engine followed the P3 pattern. Suspension was revised again, with Porsche-type double-trailing-link IFS (giving positive control of brake reaction, unlike the Dubonnet) and rear swing axles. A fascinating comparison of the two 1935 suspension systems in action post-War is shown in the illustration below.



conceptcarz.com

The pursuing P3B is identified as a 1935 revision by the beam across the front.

# Minor corrections

- Appendix 3 at foot of P.2:- For 240 cc read 300 cc.
- Illustrations for Appendix 6:- Figure 7 on P.3; The Alfa Romeo 8C-2300 did *not* win the 1935 Mille Miglia.
- Note 2 Footnote:- Should read
  - Power proportional to  $1/\sqrt{(Absolute ambient Temperature)}$ .

## **CORRECTIONS & ADDITIONS: PART2**

## 20 March 2020

## ADDITION

## Corrections & Additions at P.49 re Daimler-Benz DB601 & DB605.

## Con.-rod Bearings

The DB601 had roller *split-race* bearings in its master con.-rods on its 1-piece crank (which had 7 plain lead-bronze bearings). There were 3 rows of 24 rollers on each rod. The forked slave rods rotated in 2 plain lead-bronze bearings on the outside of the master's bearing housing.

When the 33.9 Litres DB601 was enlarged from 150 mm bore to 154 mm (same 160 mm stroke) to give 35.7 Litres, among the changes was the conversion to plain master con.-rod bearings. This was done probably to reduce production time, as well as to save weight. The DB605 entered service in the Bf109 in February 1942. It was well before the attacks by the USAAF on the main roller bearing factories of Schweinfurt in August and October 1943, intended to cripple German engines. The Germans *may* have foreseen that possibility.

However, the bearing change is reported to have caused unreliability, even causing fires, partly due to poorer quality lubricant as the war progressed. The problems were not resolved by the end of the war (source Wikipedia).

DB601 showing the forked slave con.-rod and twin plain bearings.

Flight



20 March 2020

#### ADDITION

## Appendix 8 Aero Piston Engines The Wright brothers 1<sup>st</sup> flight engine

This engine is described in Ref. A (see below), which has recently come to hand, and it provides a starting point for Appendix 8. The author, Leonard Hobbs, a famous Pratt & Whitney Chief Engineer, tried to reproduce the thinking of Orville and Wilbur Wright in its design, as well as giving the resultant details. A section of the water-cooled unit (not seen before) is shown below. It was "*The Adam of Aero Engines*" (Ref. C). The aircraft was a biplane with wing area 510 sq. ft. to support a weight with pilot of 750 lb. (Ref.C).





The partial crankcase and block were cast in an alloy of 92% Al with 8% Cu. The sheet-steel "lid" of the case, provided to permit assembly, was screwed-on. The 5 crank main journals were split at 45<sup>°</sup> to ease the build. Separate cast-iron cylinders each had a transverse <u>uncooled</u> cast-iron combustion chamber containing 2 valves of equal 2" diameter (IVD & EVD), made in 2 pieces; iron heads with screwed-in steel stems. The inlets were suction-operated and so the opening duration (IOD) was under 180<sup>°</sup> and lift (IVL) unknown. Cast-iron pistons. "Make-and-break" low-tension ignition; the internal sparking mechanism, which Hobbs noted was not susceptible to oil-fouling, can be seen in the drawing,. It was operated by a camshaft driven off the exhaust camshaft.

Other details:- MJ 1.2"; CP 1.2"; GP 1"; CRL 10", so CRL/S = 2.5; PH 5".

This engine was made by the brothers themselves, with the assistance of their single employee Charlie Taylor, in two months, with a first run in February 1903. <u>Comments</u>

<u>Compression ratio</u> (**R**):- Hobbs believes that the brothers understood that this was too high for the fuel of the time (afterwards rated on the 1927 Edgar scale as ca. 45 Octane), because they reduced R to about 3.5 in later engines (see below).

<u>Power (PP)</u>:- The brothers' target for power was 8 HP. After the first test, Orville Wright stated in a letter (Ref.A) that by fitting "heavier" springs for the inlet valves nearly16 HP had been obtained, and Ref.A and B put this at 1,200 RPM (3.6 Bar @ 4.1 m/s). But this, it is agreed, was a "Flash" rating – as the uncooled combustion chamber and valves heated-up power fell off seriously; Ref. C says after 15 seconds. The evidence from Wright's separate propeller tests is that 12 HP@ 1,100 RPM (3 Bar @ 3.7 m/s) was the *sustainable* level. Nevertheless, if the flight attempts were made before the engine was hot, the "Flash" power would have been a great help for take-off.

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## Continued on P.17

Specific Fuel Consumption (SFC):- At the same time as mentioning the power gain from the spring change, Orville Wright noted that the SFC had been halved. Elsewhere in Ref. A he is noted later as having used 0.6 Lb/HP.Hr for a similar engine. If this is taken, with petrol Lower Calorific Value as 19,000 BTU/Lb, the Brake Thermal Efficiency (BThE) was about 22 %. This compares with the 1917 Rolls-Royce *Eagle* VIII fourteen years later at just under 25% at max. power. The deduced Volumetric Efficiency (EV) for the Wright was about 35%. This with suction inlet valves after the charge had found its way into the cylinder via a very tortuous passage! For the *Eagle*, with overhead-mechanically-operated valves, EV was 85%.

<u>Weight (W):</u> There are several figures for weight and it is the usual problem of what is included. The best interpretation by this author is as follows:-

152 lb. Ref. C Bare engine <u>excluding</u> magneto and the heavy flywheel necessary to provide smooth power to the driving chains for the twin contra-rotating pusher propellers;

170 lb. Ref. C Plus magneto and other items;

"205" lb. Ref. D The Ref. quotes Wilbur Wright as saying it weighed "More than 200 pounds". The author believes that it included the flywheel. This is the figure given above (93 kg).

240 lb. Ref. D The Ref. says that the Science Museum (which had the aircraft on loan from 1928 until 1948 and examined it carefully) gave this figure. It almost certainly included the cooling water tank and possibly estimates for the water and oil and even some fuel, i.e. the total needed in the design process.

## The First Flight (details from Ref. C)

In 1900 the Wright brothers chose a beach near Kittyhawk, North Carolina for their glider trials because of its recorded <u>average</u> high winds, although they found that these were actually quite variable. After 3 years of improving glider trials there (1900 – 1902) they were ready to build their first attempt at a powered aircraft. They arrived at their hut near Kill Devil Hill in late September 1903. Propeller shaft troubles had to be sorted out but they were ready for flight trials on 14 December, with a launch from the low Hill. Wilbur stalled the aircraft and there was slight damage. After repairs the starting track was relaid on level ground and on 17 December 1903 the 4 flights were made in turn by the brothers which were the first manned, powered, sustained and controlled level flights ever made. The longest, by Wilbur, was 59 seconds, to cover 852 feet. The density of the near-0<sup>0</sup> temperature at sea-level, flying into the 24 MPH wind and possibly the "Flash" power boost for take-off had contributed to this achievement. Shortly afterwards a gust of wind overturned the machine and it was wrecked, not to be rebuilt until 1916 for exhibition. Ref. B says that they had spent about \$1,000 up to their success.

#### The competition

Apart from centuries of attempts by men to fly, the immediate competition to the Wrights was from an aircraft designed by Prof. Samuel Langley, Secretary of the prestigious Smithsonian Institute of Washington and a well-respected man of science. After he obtained successful flights by model aircraft powered by steam in 1896, he was awarded in 1898 \$50, 000 by the US Government and \$20,000 by the Smithsonian to build a man-carrying aircraft. Powered by a radial 5-cylinder water-cooled petrol engine of 540 cid built by Charles Manly, which was tested to give 52 HP for 136 lb. weight, the Langley machine was twice catapult-launched with Manly aboard from a houseboat in the Potomac river late in 1903 – and twice immediately crashed! (Data source Wikipedia). The 2<sup>nd</sup> failure was just a week before the Wright triumph near Kittyhawk

The Manly power may have been a "Flash" reading but, even if so, it was over 3 times that of the Wright engine for less weight. If only it could have been married to the Wright airframe! Continued on P.18

#### The Wrights in 1904 - 1905

As stated, the original aircraft – "Flyer I" – was never returned to flight. Instead, the Wrights built a new but similar version, "Flyer II". This had another flat four engine enlarged to 4 1/8''/4'' = 1.031 and V = 213.8 cid (3,504 cc) and a sustained rating of 15 HP (Ref. B). But, at the Dayton home of the Wrights in Ohio, in May 1904, "Flyer II" would not take-off! As the Press were present this must have been humiliating for the brothers! Ref. B explains the reasons:- 815 feet altitude at  $27^{\circ}$ C with high humidity, light wind and 800 lb. All-Up-Weight instead of 750. The brothers then built a weight-powered catapult and succeeded in getting Flyer II airborne in September 1904. Steady progress was made and in cooler December weather a 3 minutes flight was obtained.

Further improvements in 1905 produced a 39 minutes duration in October.

The Wrights then decided to do no more flying while they negotiated contracts with the US Government and others. Although there was scepticism about their achievements, because they would not supply design details before contracts were signed, such contracts were obtained.by May 1908. It was then necessary to make good their performance. This they did over 1908, to receive general recognition as the pioneers of manned flight (but not from the Smithsonian for many years).

#### Later engines

The improved engines built over 1908 to 1915, which included vertical IL4, a single 90<sup>0</sup> V8 and IL6 types can be read in Ref. A. on the internet so are not detailed here. The IL4 was licenced for manufacture in France and Germany. When the Hon. Charles Rolls proposed to the board of Rolls-Royce in February 1909 that the company should take a manufacturing licence from the Wrights, this would have been the engine involved. However, he may have meant the aeroplane to be fitted with a Royce design. Anyway, the board turned down his suggestion. Had it been approved the Company would have had a head start in the aero business 5 years before it did enter it in the emergency of WW1.

#### **References**

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wright-brothers.org The first flight, 17 December 1903: Orville Wright on board, Wilbur alongside. 120 feet. Photograph by Coastguardsman J. Daniels (Ref. C).

#### ADDITION

#### Appendix 8 Aero Piston Engines

## The 1903 Manly engine

This article is a continuation of that on PP 16 – 18 describing the 1903 Wright engine which powered the 1<sup>st</sup> flight and that should be read first. There is described the competition for a 1<sup>st</sup> flight from the Prof. Langley machine (which he named the "Aerodrome"). This failed to fly on two occasions shortly before the Wright "Flyer I" succeeded, due to wing structural failures under aero loads (Ref. C). The Smithsonian Institute, for which Langley was the Secretary, involved both financially and emotionally in the Aerodrome, refused to give 1st flight priority to the Wright brothers for 39 years. They even indulged in sharp practice by having the Aerodrome heavily modified in 1914 to prove that it *could have flown.* They eventually conceded the priority in a statement agreed by Orville Wright in 1942.

What was *not* disputed was the high quality of the Aerodrome engine built by Charles Manly, Prof. Langley's chief assistant, because it was established by endurance testing. Ref. E (now retrieved, see below) gives details. A section of this novel radial engine is shown below.



The construction was all-steel except for very-thin cast-iron cylinders. The inlet valves (IVD) were suction-operated, 2.15" head diameter, with a very-much better inflow than the Wright engine. Steel pistons. Ignition was high-tension with spark plugs. Also unlike the Wright the combustionchamber was completely water-cooled. The engine had the first Master-and-Slave con.-rod system. The Master, with a split crank-pin bearing, had the 4 Slaves mounted on it through "slipper" bearings.



These were retained by male conical rod ends fitting into female rings around the crank-pin– the section makes this arrangement clear.

Other details:- MJ 1.7" & 2"; CP 1.85"; GP 0.85"; CRL 8" so CRL/S = 1.45; PH 4.15".

This radial engine was mounted with the plane of the cylinders in-line with the aircraft axis (see photo below) – possible with water-cooling. It appears that it drove the twin contra-rotating propellers by shafts extending from each end of the crank to right-angle (one reversing) gearboxes.



## Origin (Wikipedia)

After receiving promises of \$70,000 funding in 1898 (see P. 17. Equivalent to \$2 million in 2020) Langley had originally given a contract to Stephen Balzer of New York to build an engine for his

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man-carrying machine, targeted at 12 HP. Balzer chose 5 cylinders in a rotary configuration, presumably to obtain air-cooling. By 1899 it was clear to Manly that it could not deliver the required power. He then took the job over, converted it to (probably) the world's first radial engine and added water-cooling. After the initial redesign flew successfully in a ¼ scale model of the intended full-size machine in 1901, Manly started on a larger engine for the latter. By August 1903 successful endurance tests had qualified this engine for installation in the Aerodrome.

## **Comments**

<u>Compression ratio (R)</u>:- Not given in Ref. E, but calculated by the author from the section.

<u>Power (PP)</u>:- In August 1903 Ref.E states that, over a run 10 minutes short of 10 hours the engine had <u>averaged</u> 52.4 HP! It is likely that no petrol engine had ever run a 10 hour test before. This represented 5.58 Bar @ 4.42 m/s. The Volume Specific output was 52.4 HP/8.848 L = 5.9 HP/L. This far outshone the Wright engine at a *sustained* 12 HP/3.295 L = 3.6. Comparing it to the 1903 Panhard racing car, that IL4 engine achieved 90 CV (88.8 HP)/13.672 L = 6.5 (DASO 4). The French engine had the advantage of mechanically-operated inlet valves (DASO 1). in place of suction

<u>Weight (W)</u>:- It was in its low weight that the Manly engine completely out-classed all other contemporary units. Ref.E gives full details, as follows:-

|                  | <u>Grams</u>  |   |
|------------------|---------------|---|
| Bare engine      | 56,223        |   |
| plus 2 flywheels | 5 7,280       | fitted to smooth power into prop. drives.           |
|                  |               | They were large-diameter, made like bicycle wheels. |
| Ignition system  | 6,800         |   |
| Carburetter      | 3,751         |   |
| Inlet manifold   | 756           |   |
| Water pump       | 807           |   |
|                  | <u>75,617</u> | (166.7 lb) not including the radiator.              |

## Weight/Power (W/PP) ratio

The three 1903 engines given above had the following W/PP:-

| Wright  | 93 kg/12 HP = 7.75     |
|---------|------------------------|
| Panhard | 317 kg/88.8 HP = 3.57  |
| Manly   | 75.6 kg/52.4 HP = 1.44 |

It is a pity that the lavishly-funded Manly engine with this superior performance ratio was wasted on an attempt at a manned flying machine which, according to Ref.C had:-

- a wing camber (1/12) which the Wrights had found in their 1901 glider trials was unstable (their Flyer I had 1/20);
- a wing aspect ratio of just under 2 which the Wright's wind-tunnel tests in 1901/02 showed was inefficient (theirs was 6.2);
- usable control only in the horizontal plane (they had control in 3 dimensions);
- a wing structure having the single spar and its wire-bracing *aft* of the centre of air pressure, so torsional distortion was bound to occur in motion.

## The Manly as pioneer

With its outstanding **W/PP** ratio it might be thought that other engine makers would hasten to copy it. That did not happen. There were three later developments which *may* have owed something to the 1903 Manly:-

• The 1911 <u>water-cooled radial</u> 7-cylinder 11 L design of two Swiss engineers, G. Canton and P. Unné, which was developed into 9-cylinders and eventually into a 2-row 18-cylinder.

These engines were produced by Salmson and also built under licence in the UK during WW1 (Wikipedia). They were the only water-cooled radials ever built (after the Manly). The main attraction of the radial engine, despite its high drag, was simple air-cooling.

- The 1912 Le Rhone 9-cylinder rotary designed by L. Verdet had slipper bearings for 6 con.-rods (DASO 285).
- The 1912 Daimler DF80 *Kaiserpreiz* IL6 7.3L engine with welded-steel upperworks (see <u>Illustrations for Appendix 5 Part1</u> Fig.2). Ref. E had appeared in 1911 and *may* have inspired the DF80 construction.

<u>References</u>

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