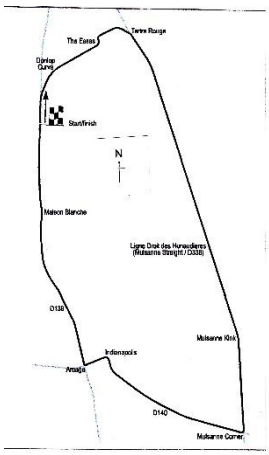
Note 142 Le Mans Fastest Laps, 1932 – 1967

The first 24 Hour race for touring cars was held on a circuit of closed public roads just outside Le Mans in 1923.

This circuit was altered in 1932 to cut off the part which reached into the city by a private bypass at the North end. The lap length was then 8.378 miles. This remained unaltered up to 1955, when a tragic accident showed that the pits straight was dangerously narrow. The following year this was widened – which would not have affected the lap speed - but there was an easing of the "Dunlop" curve just after the pits, which will have had some slight effect, and altered the official lap length to 8.365 miles. The speed effect has been ignored here. This Note then carries on to 1967, after which aero downforce effect would have become significant but impossible to relate to car specification. A diagram of the circuit for which Lap Speeds have been studied is given at the RHS.



The outstanding feature of the circuit has always been the Mulsanne straight which, in the 1932-1967 period, was 3.7 miles long, 44% of the lap.

Lap Speeds 1932 – 1967

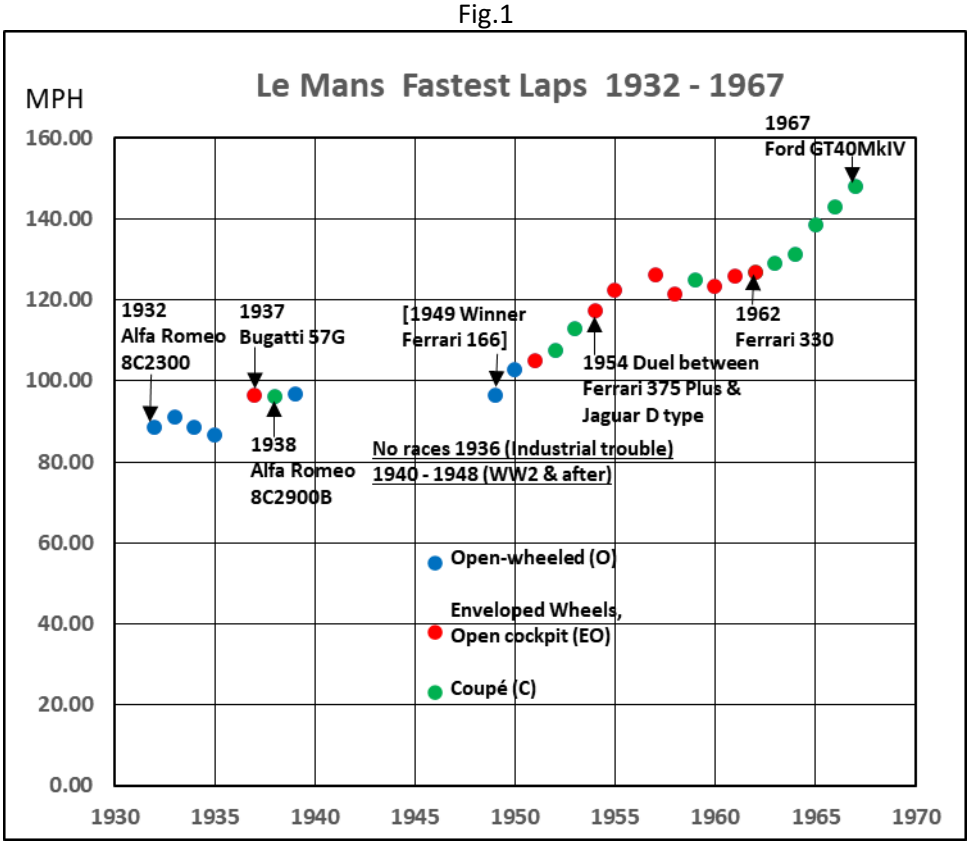
Fig. 1 below shows the Lap Speeds for the chosen period classed by bodywork, since this will have affected the figures. The groups are shown by different coloured markers, as follows:-

Blue Open-wheeled (O);

Red Enveloped Wheels, Open cockpit (EO);

Green Coupé (C).

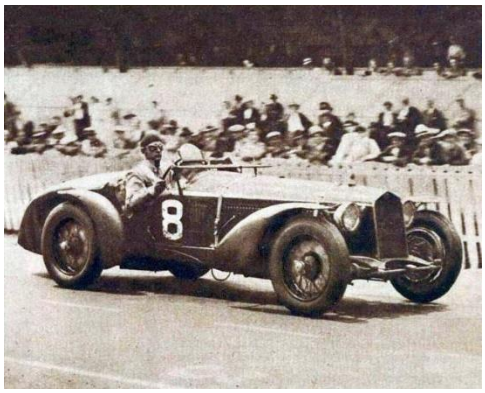
Fig.1



Data are given in Appendix A on P.6.

Illustrations

1932



commons.wikipedia.org

Alfa Romeo 8C2300 MSC 2.34L Group O

Winner.

The private car of Raymond Sommer, which had special "streamlined" mudguards. He drove for 21 hours because his co-driver Luigi Chinetti was unwell.

The Fastest Lap by Ferdinando Minoia was a works Alfa 8C2300. It may have had more than 155CV.

(MSC = Mechanically-Supercharged.)

1937

Bugatti 57G NA 3.26L Group EO

Winner and Fastest Lap.

Driven by Jean-Pierre Wimille and Robert Benoist to the first French win since 1926.

Ettore Bugatti reprised the aerodynamic shape he had tried for his 1923 Grand Prix cars, to produce **the first wheel enclosure seen at Le Mans**. Note the spotlight in the body aimed at the road edge.

(NA = Naturally-Aspirated.)

carbodydesign.com

1938 Alfa Romeo 8C2900B MSC 2.9L Group C

carthrottle.com

The first coupé (group C) at Le Mans. Secured the Fastest Lap but had engine trouble and DNF when leading easily near the end. Drivers were Sommer and Clemente Biondetti. Wind-tunnel tested to have a Drag Coefficient of 0.37.

1949 Ferrari 166 NA 2L Group EO

Winner but not Fastest Lap.

Driven by Luigi Chinetti for 23 hours (the owner, Lord Selsdon did an hour but became ill. Selsdon had co-driven one of the 4.5L Lagondas in 1939).

This was the smallest capacity NA car ever to win the GP d'Endurance (a 2L Renault which won in 1978 was TurboCharged)**.**

picclic.uk

1954. The NA duel between the new Jaguar 3.4L D-type and the Ferrari 4.9L 375 Plus is analysed and illustrated in a later section

racingsportscara.com

1962 Ferrari 330LM NA 3.97L Group EO

The last Group EO car at Le Mans.

Winner and Fastest Lap, driven by Phil Hill and Olivier Gendebien.

Full windscreens were required by the regulations in 1956.

The last car in the period to 1967

1967 Ford GT40 MkIV NA 7L Group C

Winner and Fastest Lap, driven by the all-American team of Dan Gurney and A. J. Foyt. The MkIV was the first of the GT40 series to be built in the USA and it remains the only Le Mans winner to be so originated.

The type number was the design height of the car in inches at the windscreen, this screen height being required by the regulations.

The GT40 series was mid-engined. This engine position had been introduced to the Le Mans podium by the winning 1963 Ferrari 250P.

roadandtrack.com

Analysis of Fastest Laps

(All speeds are taken from DASO 769)

The Lap Speeds have been analysed by a Multi-variable Regression Analysis (MRA) with variables of:- Power (PP - HP); Weight (W – Cwt), including a nominal 3 Cwt for the loaded condition when setting the fastest Lap; and Envelope Area (AE – sq, ft.), which is obtained as a surrogate for the true Frontal Area from Track x Height*.

This MRA gave the *very surprising* result that only PP was significant!

The actual return of the analysis was:-

$$\text{Lap Speed} = 20.2 \times \frac{(PP)^{0.377}}{[\,(W)^{0.087} \times (AE)^{0.038}\,]}$$

R^2 = 0.89 i.e. not a bad correlation.

A plot using *only PP* is shown below on P.4, Fig.2.

*DASO 125 gives the actual Frontal Area of the 1955 Jaguar D type as 12.8 sq.ft. . The AE was calculated as 12.5.

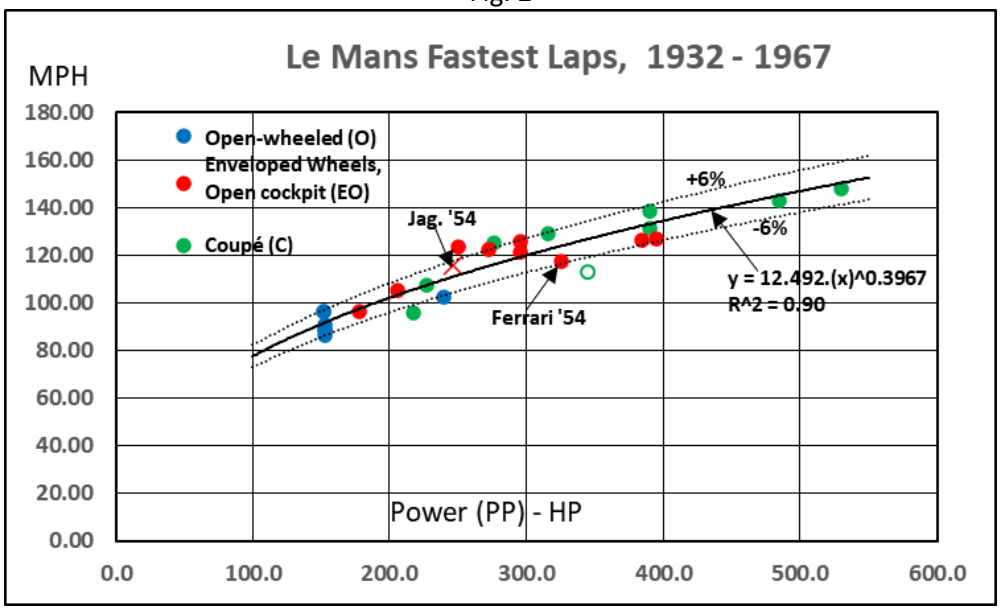
Examining Fig.2 it was clear that the speed for the 1953 Ferrari 375MM coupé (345 HP/112.79 MPH) was anomalous (green circle). No reason for this is apparent**.

**Perhaps Ascari was unsure of the engine and kept revs in hand. If so, he was right to do so because the clutch failed and the car eventually DNF.

The trendline shown in Fig.2 is therefore for the other 24 entries. It is not a particularly good correlation, with an average error of 4.3%. Some of this, apart from mentioning the usual caution about time-related effects, is that cars of a given bodywork group (O, EO, C) could have quite different Drag Coefficients.

. This is brought out in the section below describing the 1954 duel between the D-type Jaguar and the Ferrari 375Plus.

Fig. 2



Data are given in Appendix A on P.6.

<u>The 1954 duel between Ferrari and Jaguar</u>

This duel is worth a detailed review because it contrasted two very different approaches to winning at Le Mans.

Jaguar, having won in 1951 with the C-type and again in 1953 with an improved C-type, designed a new car for 1954, the D-type. This was aimed specifically at the highest speed on the Mulsanne straight, 44% of the lap. Malcolm Sayer produced a particularly smooth EO body which needed a fin to give stability. Jaguar retained their 3,441 cc IL6 engine with a power increment from 220 BHP to 246 (+11.8%). It would be 3 years before they were able to supply a 3,781 cc unit to enable Ecurie Ecosse to win at Le Mans in 1957 (and 10 years before stretching the size to 4,235 cc). Frontal area was reduced by adopting a dry sump oil system. The new body had 9.4% less frontal area (true 12.5 sq,ft. from 13.8) (power and area gains from DASO 125).

Ferrari, whose 375MM coupé had been beaten by Jaguar in 1953, simply increased their V12 engine size from 4,523 cc to 4,954 and had 330 CV (325.5 BHP). According to DASO 1252 this 375Plus type was 20 CV less than the previous engine but it would have had much more torque at lower RPM. The body, reverting to *barchetta* EO type, could be described as "*bluff*".

The cars were very similar in empty weight:- Jag. 17.4 Cwt; Ferrari17.7. On the Envelope Area calculation they were the same at 12.5 sq. ft..

The rivals are illustrated below.

<u>1954 Jaguar D-type</u>.
The damage to the LH corner was caused when a slower car forced Rolt off the road.
simanaitssays.com

<u>1954 Ferrari 375Plus.</u>
pinterest.com

Race performance

In the race the performance of the rivals in the dry early part (there was much rain later) was:-

	D type	375Plus	Ferrari/Jaguar
Lap Speed MPH	115.65 (Moss)	117.45 (Gonzalez)	+1.6%
Max. Speed on Mulsanne straight	172.9	160.1	-7.4%

After about 33 laps the whole 3-car Jaguar team began to suffer from mis-firing. Pit stops were made to try to rectify this. Eventually it was found that the fuel filters were *too* effective, collecting enough dirt to reduce flow. Removing or by-passing the filters (accounts differ) cured the problem but by then cars were up to 2 laps behind the 3 works Ferraris.

To cut to the chase after various incidents, by the time of the last scheduled Ferrari fuel stop, in heavy rain, both teams were down to single runners –Froilan Gonzalez (about to take over from Maurice Trintignant, although not a well man) and, 2 laps behind, Tony Rolt (driving)/Duncan Hamilton. The 375Plus proved very hard to re-start (burnt valves?). Rolt was able to regain a lap. Hamilton was then put into the Jaguar because he was ready with a vizor and Rolt was handicapped with goggles. Despite his best efforts the 24 hours ran out with the D-type behind the Ferrari, but by only 105 seconds!

Clearly, the filter delay had caused Jaguar to lose the race.

Curiously, while William Heynes (the then Jaguar Technical Director) in DASO 125 referred to the Ferrari not suffering a performance loss from its drum brakes relative to the superior disc brakes of the D-type, because the rain kept them cool, he does *not* mention the filter problem*. Yet it had a significant lesson, that precautionary design (in that case against dirty fuel) can be overdone and may end up being self-defeating**.

*Heynes also passes over the fact that their disc brakes were still not completely reliable. Moss ,around midnight, had his servo pump fail at the end of the Mulsanne straight. Only the continuing D338 as an escape road saved a smash.

**In Note 137 at P. 13 there is given another example of this, which cost Lotus the 1968 Indy 500.

When the two EO group cars are plotted on Fig.2, the D-type was 4.2% *above* the trend line and the 375Plus was 5.3% *below* it. It is reasonable to believe that this arose from the different Drag Coefficients***. The 32% power advantage of the Italian car gave it the 1.6% better Lap Speed, despite the 7.4% slower Mulsanne speed.

***Aero Drag Coefficients (CD) have been estimated for both cars and details can be found in Appendix B on P.7:-
D-type 0.42; 375Plus 0.74.

If Jaguar had introduced the 3.8L engine in 1954 (a 4 mm Bore increase on 83 in the same block, retaining 106 Stroke) they would have had about +10% of power. This would have been worth about 4% higher Lap Speed, i.e. about 120 MPH, 2.4% faster than the 375Plus.

Conclusions

For the 1932 – 1967 period at Le Mans, with its unusual 44% straight, the winning formula was:-

- Highest Power;
- Lowest aero Drag Coefficient – hence the emergence of the coupé*;
- Superior brakes.

References. Details of D52, D125 are given in Appendix 3.

*The aero Drag Coefficient (CD) for the 1967 Ford GT 40 Mk.IV, which reached 212.6 MPH along the Mulsanne straight in the race (source *mulsanne's.corner.com*) has been estimated as 0.40
(see Appendix B on P.7).

Other CD

1932 Alfa Romeo 8C2300:- Max. speed 120 MPH (Note 132); Allowing for frontal area at 80% of AE, CD = 0.72.

1937 Bugatti 57G:- Max. speed 140 MPH (the 1st streamlined winner at Le Mans; DASO 308); CD = 0.44.

P.S. See top of P. 6.

P.S. The 1954 Ferrari 375Plus

It is clear that there is something amiss with the aero calculations for the group EO 1954 Ferrari 375Plus – the CD is 0.74, where the 1932 group O Alfa is 0.72. If the Ferrari power was over-stated by 10% as a "flash" reading, not sustainable, the amended calculation would be 0.66 – still considered much too high. It may be that the cooling drag was excessive – the 375s were easily the most powerful engines run at Le Mans up to 1954. It is also possible that, to avoid an excessive coolant temperature, the throttle had to be eased off on the Mulsanne straight. However, there is no historical backing for these speculations.

Appendix A

Le Mans Fastest Laps, 1932 - 1967										
Lap - 8.378 miles										
Year	1932	1933	1934	1935	1937	1938	1939	1949	1950	1951
Make	A. Romeo	A. Romeo	A. Romeo	A. Romeo	Bugatti	A. Romeo	Delahaye	Delahaye	L. Talbot	Jaguar
Model	8C 2300	8C 2300	8C 2300	8C 2300	T57G	8C2900B	135S	135S	T26C-GS	C
Capacity-Litres	2.34	2.34	2.34	2.34	3.26	2.9	3.56	3.56	4.48	3.44
Type of car	O	O	O	O	EO	C	O	O	O	EO
Driver	**F. Minoia**	**R.Sommer**	**P. Etancelin**	**Earl Howe**	**J-P Wimille**	**R. Sommer**	**R. Mazaud**	**A. Simon**	**L.Rosier**	**S. Moss**
Lap Time - Min	5	5	5	5	5	5	5	5	4	4
Lap Time - sec	41	31.4	41	47.9	13	13.8	12.1	12.5	53.5	46.8
Lap Speed - MPH	88.45	91.01	88.45	86.69	96.36	96.11	96.64	96.51	102.76	105.16
Power CV	155.00	155.00	155.00	155.00	180.00	220.00				
Power PP HP	152.9	152.9	152.9	152.9	177.5	217.0	152	152	240	206
Dry weight lb	2200.0	2200.0	2200.0	2200.0	2756	2425	2800	2800	2205	2240
Dry Weight Cwt	19.6	19.6	19.6	19.6	24.6	21.7	25.0	25.0	19.7	20.0
+ Load= 3 Cwt										
Weight W Cwt	22.6	22.6	22.6	22.6	27.6	24.7	28.0	28.0	22.7	23.0
PP/W HP/Cwt	6.75	6.75	6.75	6.75	6.43	8.80	5.43	5.43	10.58	8.96
Track ft	4.525	4.525	4.525	4.525	4.425	4.425	4.525	4.525	4.5	4.267
Height ft	3.93	3.93	3.93	3.93	3.65	4.37	3.17	3.17	2.86	3.22
Envelope Area Sq Ft AE	**17.8**	**17.8**	**17.8**	**17.8**	**16.2**	**19.3**	**14.3**	**14.3**	**12.9**	**13.7**

Appendix A continued

Lap - 8.378 miles					8.365					
Year	1952	1953	1954	1955	1957	1958	1959	1960	1961	1962
Make	Ferrari	Ferrari	Ferrari	Jaguar	Ferrari	Ferrari	Ferrari	Maserati	Ferrari	Ferrari
Model	250S	375MM	375Plus	D	335MM	250TR	250GT	T61	250TR	330LM
Capacity-Litres	2.95	4.52	4.95	3.44	4.02	2.95	2.95	2.89	2.95	3.97
Type of car	C	C	EO	EO	EO	EO	C	EO	EO	EO
Driver	**A. Ascari**	**A. Ascari**	**F. Gonzalez**	**M. Hawthorn**	**M. Hawthorn**	**M. Hawthorn**	**J. Behra**	**M. Gregory**	**R.Rodriguez**	**P.Hill**
Lap Time - Min	4	4	4	4	3	4	4	4	3	3
Lap Time - sec	40.5	27.4	16.8	6.6	58.7	8	0.9	4	59.09	57.3
Lap Speed - MPH	107.53	112.79	117.45	122.31	126.16	121.43	125.01	123.42	125.95	126.90
Power CV	230.00	350.00	330.00		390.00	300.00	280.00		300.00	400.00
Power PP HP	226.9	345.2	325.5	272	384.7	295.9	276.2	250	295.9	394.5
Dry weight lb	1874	1984	1984	1929	1940	1764	2116	1323	1764	2094
Dry Weight Cwt	16.7	17.7	17.7	17.2	17.3	15.8	18.9	11.8	15.8	18.7
+ Load= 3 Cwt										
Weight W Cwt	19.7	20.7	20.7	20.2	20.3	18.8	21.9	14.8	18.8	21.7
PP/W HP/Cwt	11.50	16.67	15.71	13.45	18.93	15.78	12.61	16.88	15.78	18.18
Track ft	4.193	4.347	4.347	4.167	4.252	4.291	4.442	4.1	4.291	4.665
Height ft	4.84	2.88	2.88	3	2.85	2.92	4.134	3.28	2.92	4.05
Envelope Area Sq Ft AE	**20.3**	**12.5**	**12.5**	**12.5**	**12.1**	**12.5**	**18.4**	**13.4**	**12.5**	**18.9**

Appendix A completed

Lap - 8.365 miles					
Year	1963	1964	1965	1966	1967
Make	Ferrari	Ford	Ford	Ford	Ford
Model	250P	GT40	GT40	GT40Mk2	GT40Mk4
Capacity-Litres	3.29	4.74	4.74	6.98	6.98
Type of car	C	C	C	C	C
Driver	**J. Surtees**	**P.Hill**	**P.Hill**	**D. Gurney**	**D. Hulme**
Lap Time - Min	3	3	3	3	3
Lap Time - sec	53.3	49.2	37.5	30.6	23.6
Lap Speed - MPH	129.08	131.39	138.46	142.99	147.91
Power CV	320.00				
Power PP HP	315.6	390	390	485	530
Dry weight lb	1808	2315	2315	2661	2425
Dry Weight Cwt	16.1	20.7	20.7	23.8	21.7
+ Load= 3 Cwt					
Weight W Cwt	19.1	23.7	23.7	26.8	24.7
PP/W HP/Cwt	16.49	16.48	16.48	18.12	21.50
Track ft	4.429	4.583	4.583	4.75	4.625
Height ft	3.66	3.38	3.38	3.38	3.28
Envelope Area Sq Ft AE	**16.2**	**15.5**	**15.5**	**16.1**	**15.2**

Appendix B			
Determination of Aero Drag Coefficients			
Car	54 Jag D	54 F375+	67 GT40/4
Where:_			
PP = Crank Peak Power - BHP	246	325.5	530
T = Proportion of Power lost in Transmission*	0.15	0.15	0.15
ρ= Standard Air density =[2.3783/1000] Slugs per Cu. Ft.	0.002378	0.002378	0.002378
A8 A = Frontal Area - Sq. Ft.	12.5	12.5	15.2
V = Speed on Mulsanne straight - MPH	172.9	160.1	212.6
A10 V = Speed on Mulsanne straight - Ft./Sec. = V x 88/60	253.6	234.8	311.8
W = Loaded Weight - Cwt = Empty Weight + 3 Cwt	20.4	20.7	24.7
W = Tons	1.02	1.035	1.235
A13 Tyre Resistance ={ *Function of* MPH}**x W lbf	48.9	42.2	93.7
R = Rolling resistance of Tyres - HP = (A13 x A10)/550	22.5	18.0	53.1
*See detailed study in X-engineer.org **See Fig.3.			
A18 Power at driving wheels = [PP(1-T) - R] - BHP	186.6	258.7	397.4
A19 Dynamic Pressure = ½ x ρ x V^2 [matching units] Lbf/Sq.Ft.	76.5	65.6	115.6
CD = (550 x A18)/(A8 x A19 x A10)	0.42	0.74	0.40

Fig. 3

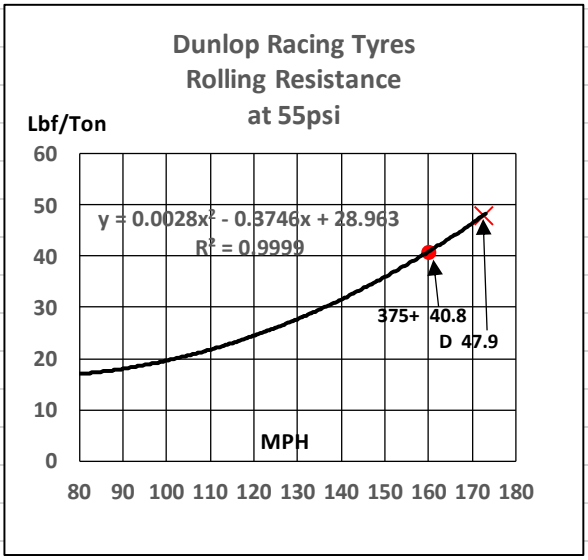


Fig. 3 produced from graphs in DASO 52 at p. 150 for 6.50/16 tyres. These were published in 1957 so should be applicable to 1954. The curve fitted to 150 MPH (the published limit) has been extrapolated to 1954 speeds to obtain the specific rolling resistances, as shown.