Origins of the V-12 Engine

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Auto racing and aviation were powerful drivers for the creation of the first V-12 engines, which grew logically from the success of both the in-line six and the V-8. Widely used technology employing individual cylinders eased the transition to the V-12, although designers took differing approaches to the design of the connecting-rod big ends of facing cylinders. The first marine V-12 was British in 1904, first passenger car American in 1908, first aviation engine French by 1911 and first V-12 racing car British in 1913. Introduction in 1915 by America's Packard of a production V-12 for cars and by Rolls-Royce of its Eagle for aircraft confirmed the role of this charismatic engine in the engineering mainstream.

KEYWORDS: V-12, Vincent, Packard, Sunbeam, Schebler, Coatalen

Early Engine Considerations

It may seem obvious that more cylinders produce more power, but how to use those cylinders and how to deploy them strained the best brains of the motor industry in the first years of the twentieth century. Power was not the only issue, of course. Other early engine-related challenges included smoothness of power application, vibration-related failures, durability, fuel economy and cost. The number of cylinders and their disposition would play an important role in power-unit design in the years leading up to World War I.

After the turn of the century the world motor industry effectively standardised its use of in-line four-cylinder engines. Their archetype was the 1901 Mercedes, designed for the Daimler Motor Company by Wilhelm Maybach. It used mechanically operated rather than automatic inlet valves and placed its valves in the 'T-head' configuration, beside the cylinders and parallel to them with the inlet valves on one side and exhausts on the other, operated by two camshafts placed low in the block alongside the crankshaft. This obliged the use of a wide combustion chamber, extending across the engine from valve to valve above the piston, which was not unduly onerous at a time when compression ratios were still low, less than 4.0:1.

The in-line four had many advantages for early autos and aircraft. It could easily be assembled from four individual cylinders on a common crankcase. During the first decade of the twentieth century cylinders would be cast in pairs and finally as a single cylinder block, after machinists gained confidence that their techniques were good enough to produce four good bores — and the other necessary apertures

— in a single casting. Machining errors in a single cylinder had less disastrous consequences.

Engineers still struggling with inlet-manifold design found the four-cylinder engine relatively easy to feed from their updraft carburettors. A simple Y manifold from a single instrument to a pair of siamesed inlet ports would give near-equality of distribution. Ignition too was straightforward. Cranking a four to start it was not difficult, aided by the massive flywheel that a four needed to smooth out its power delivery. The engine did not require excessive space and gave excellent access to all its parts for service. The four's fewer parts, most engineers reckoned, meant that fewer of them were likely to fail.

Introduction of Sixes

America's first six was the Gasmobile, a lone prototype introduced at the 1902 New York Show. Europe's first was the Dutch Spyker of 1903, though it too remained a prototype. Also in 1903 Montague Napier and Selwyn F. Edge of Napiers introduced England's first series-production six , a type for which Edge would be an active and successful advocate. In 1904 both Napier and Sunbeam offered sixes.

Two companies, Stevens-Duryea and National, introduced sixes to the American market in 1905, followed a year later by Ford. No sooner had Henry Ford introduced his six, however, than he abandoned it, saying, 'A car should not have any more cylinders than a cow has teats.' National, too, gave up its production of sixes in 1909.

'Most makers furnish the six-cylinder power plant on the larger models,' reported Victor Pagé in 1911, 'because it is an advantage to increase the number of cylinders rather than their cubic capacity when more powerful motors are needed.' The six was quieter too, Pagé averred, because

> the lapping of the expulsion of spent gases means that the flow through the muffler is continuous, making for more uniform pressure in the silencer and tending to minimise the noise produced as the gas is discharged in the outer air.

Given the state of the industry's early art, however, an in-line six posed engineering challenges. The most severe was twisting of its crankshaft. Big cylinder bores combined with small main and big-end bearings to create spindly and stretched-out crankshafts that contorted excessively. For this reason, wrote Briton S.C.H. Davis, 'the early versions possessed a fierce crankshaft vibration expressing itself in an abominable rattling noise.' One pioneer motorist referred to the 'octaves of chatter from the quivering crankshaft' of his sixes.

Overcoming this torsional flexing and resulting fractures was possible but only with bottom-end components that were more massive and thus heavier than the engine's power and torque levels mandated. A more superficial approach, said Davis, was adopted by Napier's arch-publicist Selwyn Edge, who 'made the most of it by calling it a "power rattle."'

Induction was another challenge. The simplicity of feeding four cylinders contrasted with the bizarre convolutions to which some designers resorted for six-cylinder carburetion from a single instrument. In many early sixes, equality of fuel/air-mixture distribution among the cylinders was more by chance than calculation. Starting was another bugbear, with a huge six anything but easy to crank. By 1911 the introduction of self-starting devices began to overcome this handicap. Finally, these engines were long as well as heavy, taking up valuable chassis space.

The V-8 Solution

The moment of truth came for American engineer Wilfred Leland after a drive from Washington to New York in a new Hudson six. With his father Henry, Leland was a guiding light of Detroit's Cadillac, renowned in its early years for the precision of design, machining and assembly insisted upon — and implemented — by both Lelands.

Cadillac's engineers were developing an in-line six, but Wilfred Leland had severe reservations about its potential smoothness. 'Noisy sixes, even though more powerful than fours, could not be allowed to walk away with a competitor's prize,' recalled Wilfred's widow. 'Wilfred's mind was occupied with these vibrations and how to overcome them.'

After his Hudson drives the younger Leland turned over the problem in his mind, including a sleepless night on the drive from New York back to Detroit. His solution was novel albeit not unique: 'putting two fours together at an angle,' his wife remembered. He dictated his concept to her: 'Eight smaller cylinders would produce lighter impulses, more frequent impulses and smoother action.' Accepting his idea, Cadillac stopped work on its six and built an influential V-8 instead. It was introduced in September 1914 as a 1915 model.

Here was a solution that perfectly suited the needs of the time. A V-8 could draw on all the knowledge already invested in in-line fours, including their induction and ignition. Its short crankshaft presented few torsional-vibration problems. By setting its banks at a 90-degree included angle, a V-8 could be made to generate power impulses at regular intervals. With a much lighter crankcase and crankshaft, the V-8 could also weigh less than a six of comparable output.

Vee-Configuration Predecessors

Such was Cadillac's reputation — as the two-times winner of Britain's prestigious Dewar Trophy — that its introduction of a V-8 was the strongest vote yet in favour of a vee-type engine for cars, Figure 1. But we should note that it had a number of predecessors.

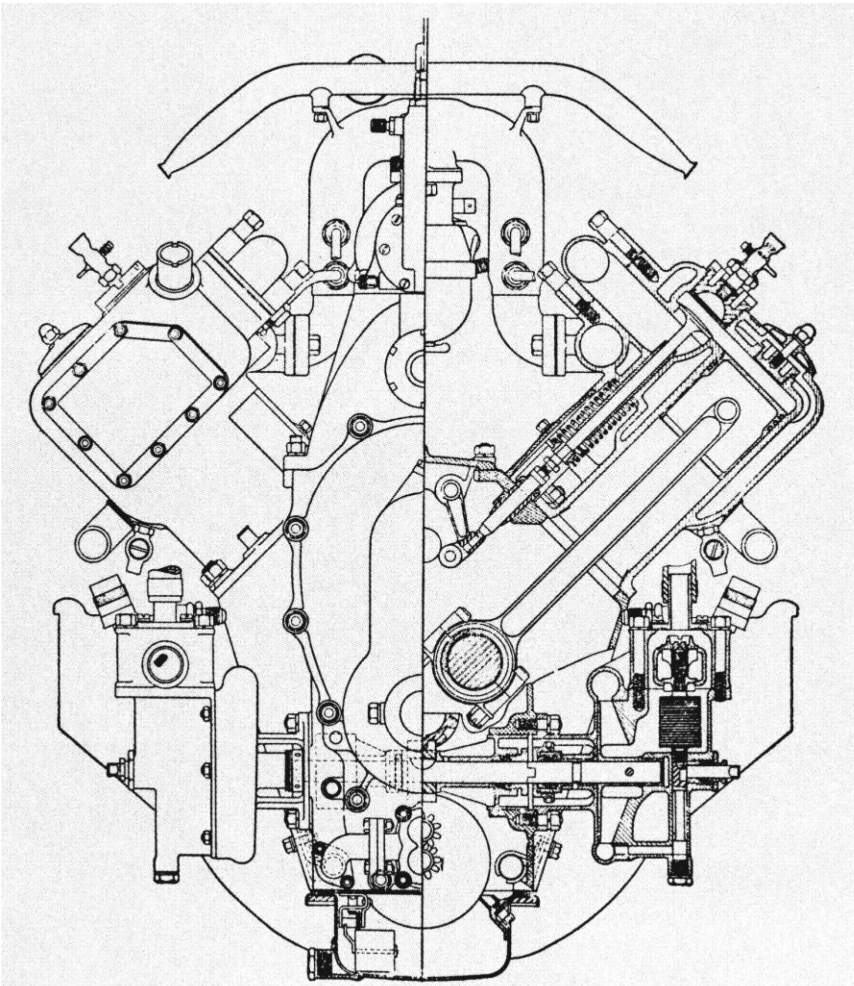

Figure 1. Cadillac V-8 Lateral Section.

Composed of the tandem mounting of two V-4s, the first V-8 to be used in a car powered three of Clément-Agnès, Ader's entries in the aborted Paris-Madrid Race of 1903. Also in France, Léon Levavasseur was designing and building ultra-light water-cooled V-8s for use in racing boats and aircraft, Figure 2. Made by the Société Antoinette, named in honour of its chairman's daughter, from 1905 these engines powered the successful early years of French aviation.

It was noteworthy that Levavasseur did not attempt a V-12. Instead, he added power by adding V-8 modules. For boat racing he built an Antoinette V-16 this way, and then a V-24 with its clusters of four individual opposing cylinders all on a single crankcase.

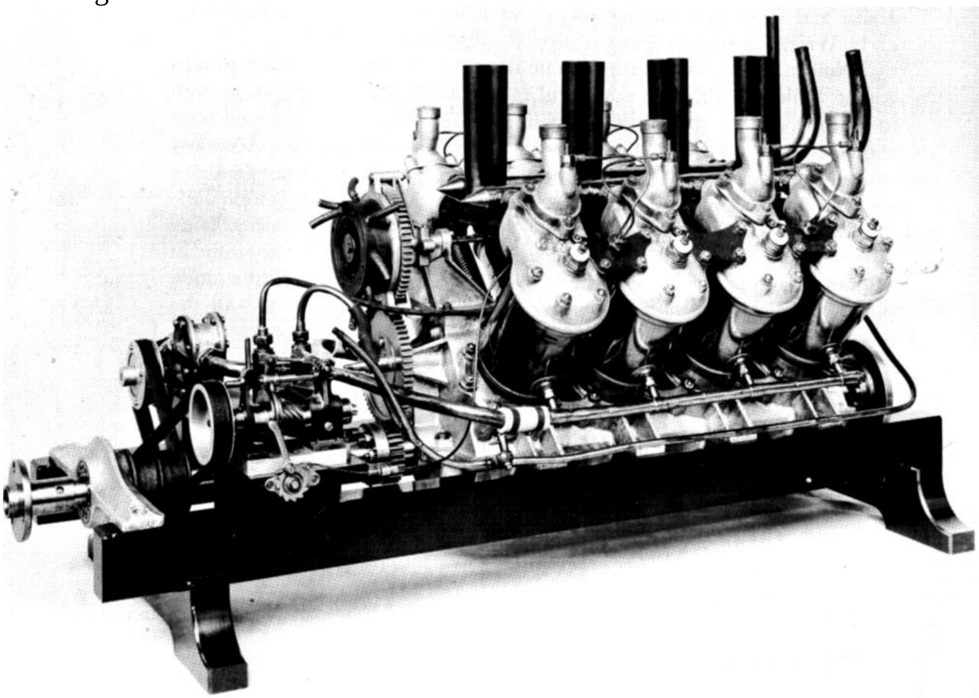

Figure 2. Antoinette V-8.

With what Ettore Bugatti called ‘delicatessen engineering, manipulating cylinders like strings of sausages,’ Levavasseur even built a V-32 and then a V-48 but, as Griff Borgeson wrote, ‘this was beyond the point of diminishing returns’. ‘Delicatessen engineering’ was inadequate to keep the rapid pace of the growing aero industry and Antoinette engines — and even a short-lived Antoinette V-8 automobile — were soon obsolete.

Connecting-Rod Designs

With lightness and simplicity a major virtue of the Antoinettes, we should spare a moment to consider how they tackled the problem of two facing cylinders that shared a common big-end journal on a crankshaft. Here was one of the toughest challenges facing the early engineers. Some of them argued that with two pistons and connecting rods driven by and driving onto a journal, the loads on the journal were much higher than they were on an in-line engine. Others maintained that the loads came at different times and from different directions so the journal’s burden wasn’t that much greater. Whatever the situation, a means of attaching two connecting rods to one journal had to be found.

Léon Levavasseur's solution was to offset one bank of cylinders longitudinally from the other — the right-hand bank being shifted forward in this case — so that facing con-rod big ends could sit side-by-side on the same crankshaft journal, Figure 3. Although some critics felt that this would make the engine too long, with the wide bearings that were then customary, this was not a disadvantage of the Antoinettes, which also enjoyed five main bearings that took up additional room along their crankshafts. The French engines ran reliably albeit at speeds of little more than 1,100 rpm.

At Cadillac the Lelands chose a different solution. They elected to use fork-and-blade big ends, Figure 3. These had been a feature of the first-ever vee-type Otto-cycle engine for cars, the 565 cc twin introduced in 1889 by Germany's Daimler.[1] Designed by Wilhem Maybach, the 17-degree V-2 powered Daimler's *Stahlradwagen* and the Panhards and Peugeots that competed in 1894's Paris-Rouen Trials.

Maybach's fork-and-blade concept allowed the facing cylinders to be directly opposite each other by having one conventional-looking rod — the 'blade' — embraced by a sister rod that was forked — hence its name — to fit around the blade rod and be held by two big-end bearings instead of one. Although several configurations were devised, this generally required the forked rod to have a separate journal inside its big end on which the blade rod's bearing ran.

Compared to side-by-side rods, the fork-and-blade design achieved a shorter engine because it did not require the blocks to be offset. A slight improvement in dynamic balance resulted because facing cylinders and pistons were in the same lateral plane. It was clearly more costly, with the need to make two different kinds of connecting rods, one with a more elaborate big-end design.

Added cost was not an obstacle in aero engines, built in smaller numbers under less cost constraints, so fork-and-blade rods were often used there. Examples were an experimental aero V-12 made by Harry Miller in 1917 and the Liberty V-12, America's most-produced aero engine of the First World War.

A third method of accommodating connecting-rod pairs in a vee engine was the use of a master rod and articulated link, Figure 4. Like the fork-and-blade pairing, this allowed cylinders to face each other directly to create a light and compact engine. One rod looked conventional, with a big end that occupied the full crank journal. It differed, however, in having a pivot point near its big end. From this pivot a link rod extended to the facing piston. Master and link rods were joined by a pin not unlike a wrist or gudgeon pin. Although inelegant-looking, the articulated link was in fact a valid and often-used mechanism for vee-type engines. Its reciprocating masses were the lightest of all three solutions. A peculiarity was that the motion of the link pin, as the crank rotated, was not circular but elliptical, and in a manner that tended to give the linked piston a longer stroke than its master-rodded partner. In large engines with lower compression ratios running at moderate speeds this was not a matter for concern.

Thus like fork-and-blade rods the link-rod system was widely used in aero engines, such as the first Rolls-Royce V-12s produced in 1915. This was the Eagle of 20,329 cc (114.3 x 165.1 mm), which in its initial format produced 240 bhp at

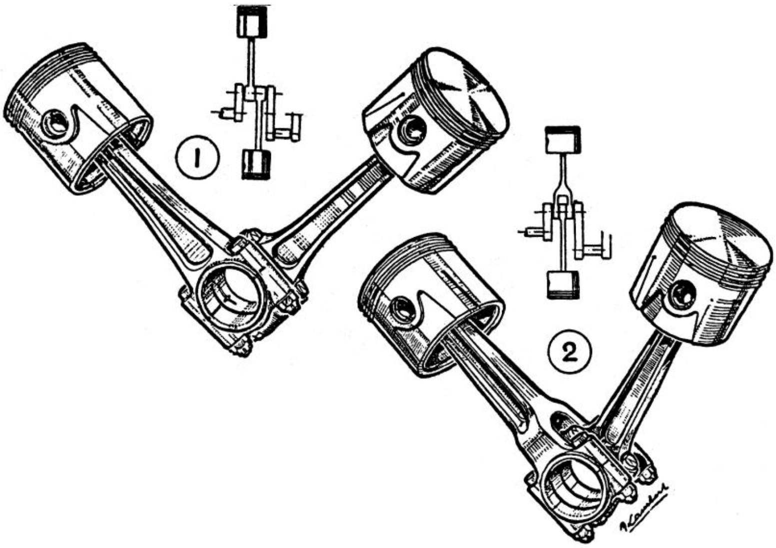

Figure 3. Side-by-side big ends (1) and fork-and-blade big ends (2).

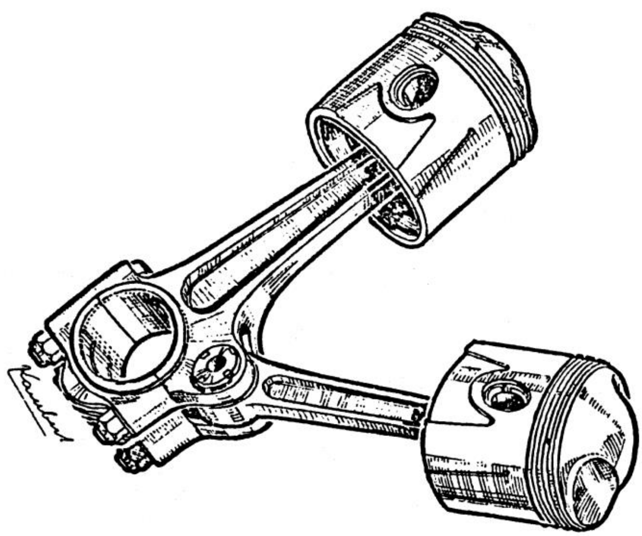

Figure 4. Master rod and link rod.

1,600 rpm. Active throughout the 1920s, in its final form the Eagle produced a maximum of 390 bhp at 2,000 rpm, Figure 5. It was the scion of a series of great Rolls-Royce twelves that ultimately led to the immortal Merlin

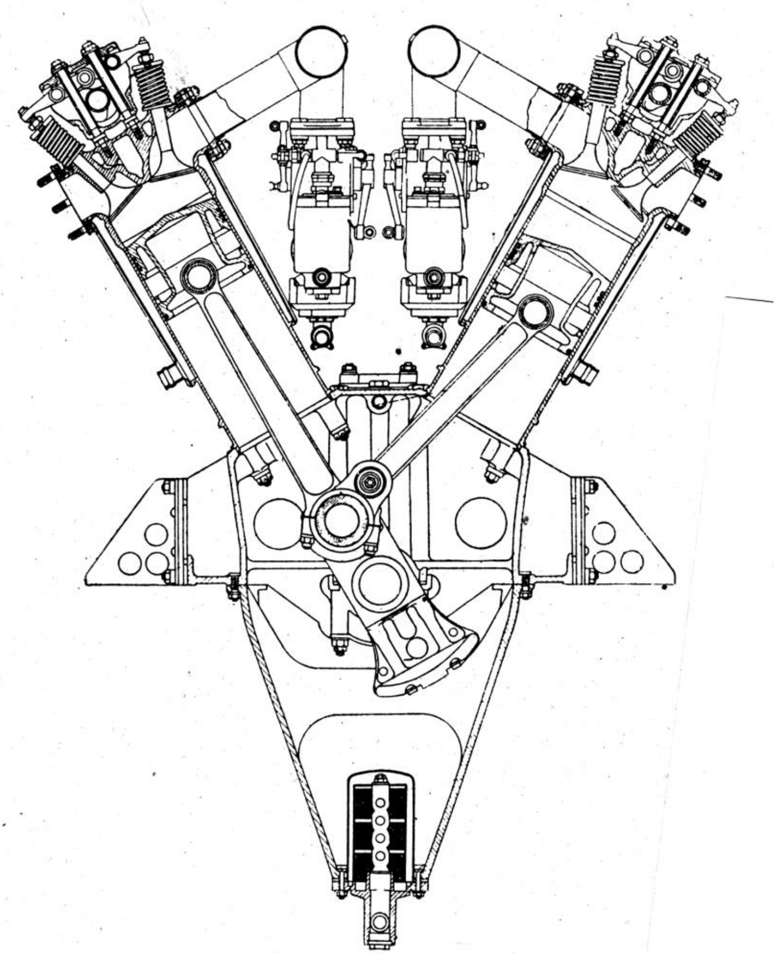

Figure 5. Rolls-Royce Eagle V-12.

Pioneering Marine Twelves

Both aviation and marine engines played their part in the early evolution of vee engines with twelve cylinders. Nautical impetus came from the annual motor-boating carnivals in the sea off Monaco and the races that were their highlight.

Mention has already been made of the Antoinette vee-type engines that competed there. In 1904 London's Putney Motor Works completed a new marine racing engine: the first vee-twelve ever made for any purpose. Like the cars the company also produced, it was known as the Craig-Dörwald engine after Putney's founding partners, Figure 6.

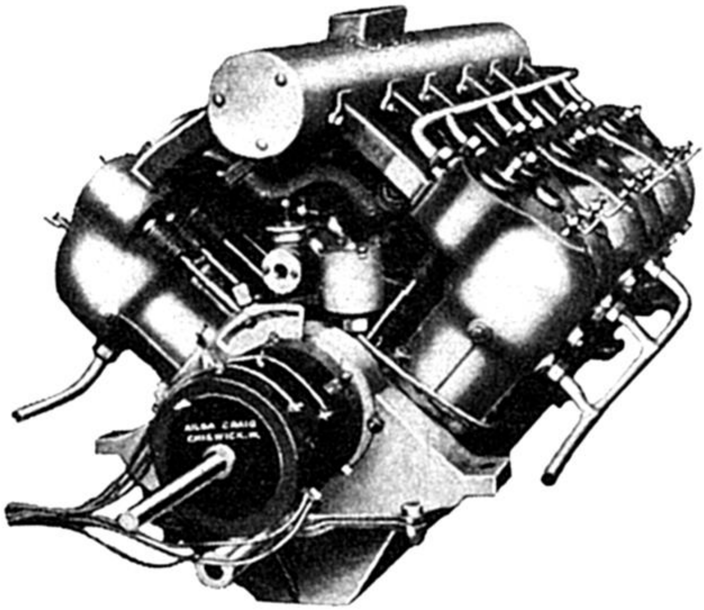

Figure 6. Craig-Dörwald V-12.

The Putney artisans mounted pairs of L-head cylinders at a 90-degree included angle on an aluminium crankcase, using the same cylinder pairs that powered the company's standard two-cylinder car. The Craig-Dörwald twelve had a single camshaft running down its central vee to open its valves directly.[2] As in many marine engines the camshaft could be slid in its bearings to give timing that reversed the engine's rotation.

Tubular connecting rods sat side-by-side on the Craig-Dörwald's rod journals, with the cylinder banks offset. To cope with the problem of the long crankshaft, the twelve's main bearings increased in diameter as they approached the flywheel. Its crankshaft was described as having 'fluted webs'.

Induction arrangements were exemplary with three carburettors, each feeding four cylinders, nestling underneath a cylindrical collector that carried exhaust gases away. Trembler-coil ignition was used to start the twelve after its cylinders had been suffused with a fresh charge. Displacing 18,345 cc (123.8 x 127 mm), the Craig-Dörwald V-12 weighed 950 pounds and developed 155 bhp at 1,000 rpm.

Little is known of the pioneering twelve's achievements in the 40-foot hull for which it was intended, while a plan to power heavy freight vehicles never came to fruition.[3] Nevertheless the Craig-Dörwald engine marked a significant and historic breakthrough in engine thinking toward twelve cylinders in a vee formation.

Motorboat racing of 1909-10 saw two more V-12s in action, one of them big and the other of veritably Brobdignagian dimensions. Side-by-side rods and offset blocks were used in the 25,560 cc (133.4 x 152.4 mm) V-12 built by Clinton Iowa's Lamb Boat & Engine Company for the organisation's 32-foot Lamb IV. Its weight was massive at 2,114 pounds.

Weight was not quoted for the V-12 built by the Orleans Motor Company but in view of its capacity of 56,758 cc (177.8 x 190.5 mm) it must have been substantial. Output was quoted as 'nearly 400 bhp' for a twelve of 'F-head' design, this having side exhaust valves and overhead inlets both operated from a single central camshaft. Two such huge engines were installed in a Canadian boat, Maple Leaf IV.

By 1914, when Panhard built two 38,611 cc (127 x 254 mm) V-12s with four-valve cylinder heads to power a single racer at Monaco, the V-12 was well established in motorboat competition.

Aviation Adopts the V-12

Although weight was not a primary concern in marine engines, it certainly was in cars and aircraft. Here, as noted earlier, the early in-line six was at a disadvantage if the torsional vibration of its long and spindly crankshaft were to be suppressed. As in-line sixes became better established, however, in the air as well as on water, the idea of doubling them up to make V-12s grew apace.

A pioneer here was Renault, which had cast its lot with air-cooled vee engines for aviation use. The Renault V-12, Figure 7, had individual finned cylinders of F-head design with overhead exhausts and side inlets opened by a camshaft in the crankcase. Soon after building a 90-degree V-8 with side-by-side rods in 1909, Renault introduced a 60-degree V-12 with articulated rods. A first version, measuring 90 x 140 mm, was followed by one with a larger bore of 96 mm (12,160 cc).

With a 4.0:1 compression ratio, Renault's V-12 produced 138 bhp at 1,800 rpm for a weight of 772 pounds. An ingenious feature was the driving of its propeller from the nose of the camshaft in the central vee, which gave an automatic half-speed reduction to the screw, improving efficiency. Later World War I Renault twelves had overhead camshafts, liquid cooling and a narrower vee angle of 47.5 degrees.

Renault's designs were followed closely in Britain by the Royal Aircraft Factory. Although established in 1909 to build better balloons, the Factory was moved by its new director Mervyn O'Gorman into heavier-than-air aeroplanes and aircraft engines.

Like its Renault counterpart the Factory's V-12 had articulated rods, but all valves were overhead with their carburetion on the engine's flanks. In RAF-4 form the engine displaced 13,195 cc (100 x 140 mm) and produced 140 bhp at 1,800 rpm from 637 pounds. Its RAF-4A derivative was produced in substantial numbers during the war.

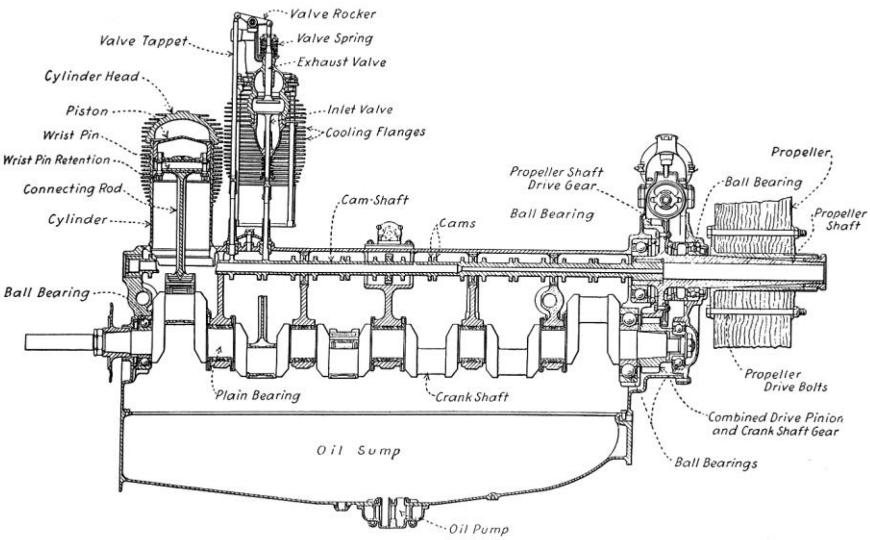

Figure 7. Renault air-cooled V-12.

Early British V-12 aero engines were also produced by London's ABC Motors Ltd., where Granville Bradshaw was chief engineer. By 1912 ABC was offering a water-cooled V-12 of 17,375 cc (127 x 114.3 mm), claimed to produce 170 bhp at 1,400 rpm and to weigh only 390 pounds — 520 pounds with its radiator and coolant.

Though this sounded promising, late in the war ABC submitted its air-cooled nine-cylinder radial engine, the Dragonfly, to the government with a promised 340 horsepower. This was so appealing that a substantial order was placed, well over 1,000 being built, but the radial Dragonfly proved a lamentable failure.

Sunbeam Enters the Scene

Another British V-12 made its official bow in at the 1914 Aero Show at London's Olympia exhibition halls. This was the Mohawk, Figure 8, built by Wolverhampton's Sunbeam Motor Car Company. Sunbeam traced its origins back to 1887, when it was founded by John Marston as the Sunbeamland Cycle Factory to build bicycles of quality. In 1899 it built its first automobile, and in 1909 it gained a new chief engineer who was to transform its fortunes. Wrote W. F. Bradley, ‘He brought the company to a high commercial, technical and sporting level.’

The new man was Louis Hervé Coatalen, then just 30. Born in Brittany, after three years at the École des Arts et Métiers in Brest young Coatalen tried his hand at Panhard, Clement and De Dion Bouton before concluding, at the age of 21, that his prospects were better in England where the motor industry was not overburdened with qualified engineers. He soon settled at Humber where Coatalen designed that company’s first successful cars.

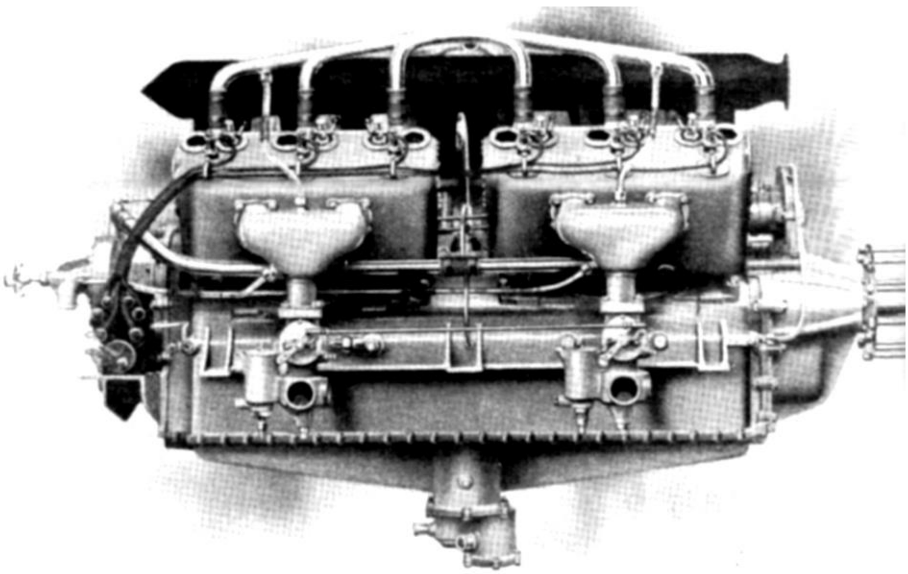

Figure 8. Sunbeam Mohawk aero V-12.

Having shown at Humber what he could do in the way of fast autos, the confident Coatalen soon involved Sunbeam in racing and record-breaking, making full use of the high-banked Brooklands racetrack on the outskirts of south-west London. Taking part in racing, he said, “crushes out the conservatism which is always apt to prevail in a works, bucking up the designers and constructors and putting everyone on his mettle”.

While advancing Sunbeam’s production cars, Louis Coatalen warmed up the company’s competition side with a series of record cars named ‘Toodles’ after his wife Olive’s nickname. He added a triumphant sweep of the 3.0-litre category in the 1912 Coupe de l’Auto at Dieppe that astonished his countrymen. At the end of 1912 Coatalen began testing his first aero engine, a V-8 based on a side-valve six-cylinder Grand Prix engine being developed in parallel.

First V-12 Sunbeam Automobile

On 4 October 1913 a new single-seat Sunbeam racer, Toodles V, was entered in the 100 mph Short and Long Handicap races at Brooklands, Figure 9 and 10. With its steel artillery wheels and shrouded radiator Coatalen's latest Toodles was a mélange of automotive ideas old and new. Under its strapped-down bonnet was something entirely novel: Europe's first V-12 engine to be installed in a car.

The car's chassis was that of the Sunbeam 25/30, a Coatalen six-cylinder design that had been introduced in 1911. In single-seater form it had already shown its record-breaking form as Toodles IV. Its wheelbase was 126 inches, springing was semi-elliptic leafs with Houdaille shock absorbers. The rearmost two feet of both sides of its frame were filled with lead to shift more of its weight to the rear. The tail also carried an oil reservoir for the engine's novel dry-sump oiling system, pipes to and from it running outside the car on the left to cool the oil.

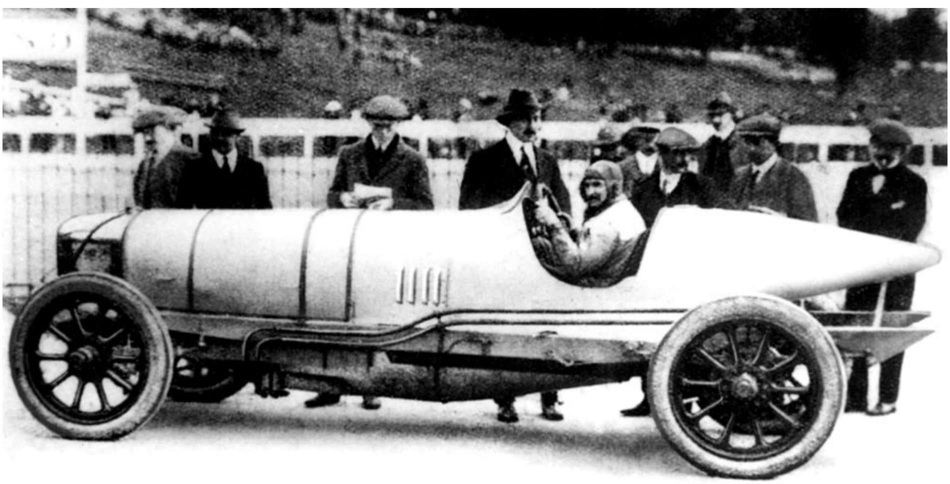

Figure 9. Sunbeam Toodles V at Brooklands.

Mounted at three points in the front of the racer's chassis was a subframe which carried its V-12 engine. With the same bore and stroke as Coatalen's V-8 (80 x 150 mm), the twelve displaced 9,048 cc. Its cylinder banks were at an angle of 60 degrees, which with the V-12 configuration gave evenly spaced power impulses, Figure 10. An aluminium crankcase carried two blocks of three cylinders along each side, cast of iron with integral cylinder heads.

The Sunbeam's combustion-chamber design was L-head, with inlet and exhaust valves in rows down the centre of the vee and driven from a single camshaft. Valve clearance was set by grinding the relevant parts, the engine lacking any easy means of adjustment. This pointed to Coatalen's ultimate aim of using his new V-12 in aircraft, where any adjustment method that could go wrong in flight was to be avoided.

The left-hand bank of the Sunbeam's cylinders was shifted forward enough to permit side-by-side connecting-rod big ends on a crankshaft that was supported by seven main bearings, those at the centre and drive end being wider than their sisters. Long, slim connecting rods controlled steel pistons.

A gear train at the front of the V-12 — as it was installed in the car — turned its camshaft and its accessories: the two oil pumps and a water pump. Two Bosch HL6 six-cylinder magnetos — one for each bank — were mounted transversely and driven from the camshaft nose by a skew-geared shaft. Thanks to its dry-sump

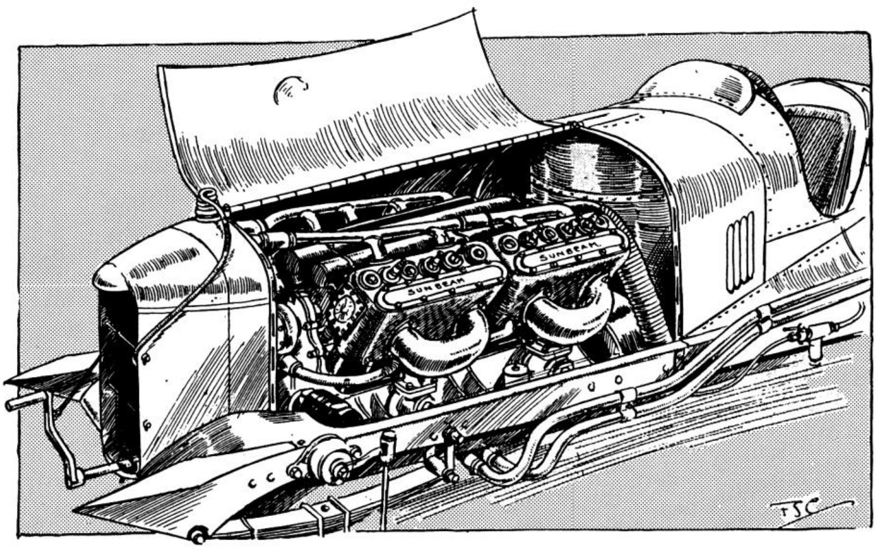

Figure 10 V-12 engine of Sunbeam Toodles V

oiling the finned copper sump was shallow, which aided the engine's installation in Toodles V.[4] Oil pressure was 40 psi.

The racer's twelve exhaust ports vented into the central vee, from which piping took the exhaust down and away beneath the chassis. Each block of three cylinders had two inlet ports on its outer surface, through which the mixture found its way to the block's three inlet valves through cast-in passages. At first these ports were fed by long pipes from a pair of carburettors under the scuttle, but this gave way to a water-warmed updraft Y-type manifold and Claudel-Hobson carburettor for each block — the same layout that the V-12's airborne version would use.

Performance of Toodles V

As initially built, the Sunbeam V-12 in Toodles V was rated at 200 bhp at 2,400 rpm, and would have weighed much the same as its aero-engine version at 725 pounds, Figure 11. Shorn of the reduction gear needed for aerial use, its crankshaft drove a cone clutch directly and then a four-speed transmission. The rear axle dispensed with a differential—presumably not needed on the Brooklands track—and had a ratio of 2.0:1, giving 100 mph at about 2,000 rpm. Torque reactions were taken by a pressed-steel arm from the axle forward to the frame, alongside the propeller shaft. As was then customary, braking was on the rear wheels only.

Although not excessively weighty at 2,800 pounds, Toodles V was heavy metal indeed. Disappointment was great when problems with its cone clutch — never the car's strong point — forced it to non-start in an August 1913 meeting at Brooklands, but by October it was fit and ready. Although Louis Coatalen had driven his previous Toodles creations, and well, he tapped talented countryman Jean Chassagne to drive the fifth in the Toodles series.

In the Short Handicap the Sunbeam started from scratch alongside the Talbot of Percy Lambert, a combination that earlier in 1913 had set a world one-hour record at better than 100 mph, the first time the magic figure had been broken. Chassagne defeated Lambert (but not two earlier starters in the handicapped race) and clocked a fastest lap of 114.49 mph. In the subsequent Long Handicap the Sunbeam was the winner at an average of 110 mph, the first Brooklands race to be won at such a speed. Its fastest lap was a dizzying 118.58 mph, tantalisingly close to two miles a minute.

Jean Chassagne stayed in England to back Coatalen's bid to seize the coveted world one-hour speed record, which then stood at 106.2 miles. After one try was aborted by tyre failure, another attempt was launched on 11 October 1913. With Chassagne treading lightly to save his tyres and the Sunbeam 'emitting a steady, continuous growl' the record was taken with 107.95 miles covered. Coatalen waved Toodles V onward and managed a 53-second change of tyres that let her continue to the 250-kilometre distance, just over 150 miles, and thus claim a total of nine outright world records, most of which were not surpassed until 1924.

During the 1914 season Italian Dario Resta was nominated to handle Toodles V, newly shod with Rudge wire wheels, with knock-off hubs. She performed well both at Brooklands and on Saltburn Sands and set short-distance Class H records at Brooklands including a one-mile speed of 120.73 mph.

The other relevant event of 1914 was the showing of the aero-engine version of Toodles V's engine at Olympia in March with its aviation designation of 'Mohawk'. Racing it in 1913 had helped prove its design. This encouraged a 10 mm increase in its bore to 90 mm, its rated output now being 225 bhp at 2,000 rpm.[5] Significant differences from the car engine included wet-sump oiling and water jackets of electrolytically deposited copper, lightening the cylinders.

The most powerful engine available to British aviation at the start of the war,

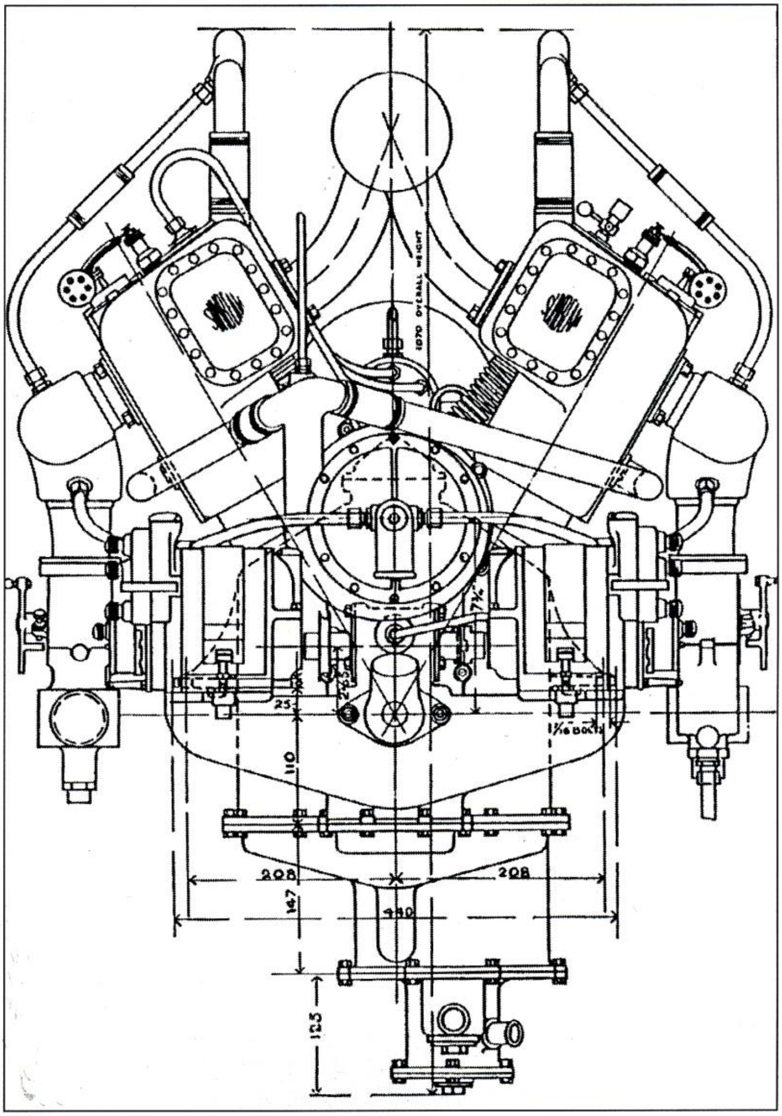

Figure 11 Sunbeam Mohawk/Toodles V V-12

Sunbeam's Mohawk was taken up by the British Navy for its seaplanes and served with distinction in Short's 827 and 184.[6] Further enlargement to 100 x 150 mm created a 240-horsepower V-12, the Gurkha.

Sunbeam's Toodles V in America

Meanwhile the Mohawk's test bed, Toodles V, had a new lease of life in the New World. In 1915 she was shipped to America, where she was driven by Ralph

DePalma to win two match races on the two-mile Sheepshead Bay board track against Bob Burman's powerful Blitzen Benz. They were four-mile and six-mile races on 2 November, called 'the most exciting of the afternoon, the finishes being so close that one car was alongside of the other.' Her best winning speed was 113.86 mph.

The Sunbeam's later career in America was less distinguished. Fitted with a two-seat body she non-finished at Corona in 1916 and placed seventh at Ascot, driven by Hughie Hughes. Toodles V led from the start of a 100-mile dirt-track race at Kalamazoo, Michigan but then skidded and collected its pursuers in a terrible crash. 'Within a few minutes,' said a witness, 'there were ten dead, all piled in a heap of wrecked cars.' Thereafter there is no record of the fate of the remains of the Sunbeam.

Toodles V had crossed the Atlantic because she had been purchased by Detroit's Packard Motor Company.[7] Packard's chief engineer, Jesse Gurney Vincent, was not averse to acquiring interesting cars if he felt they could be of value to his company, and the speedy Toodles V caught his fancy.[8]

The fact that the racer was powered by Europe's first V-12 auto engine was naturally of interest, for by 1915 Packard had launched production of the world's first passenger car to be V-12-powered — its Twin Six. That Ralph DePalma had driven the Sunbeam at New York's Sheepshead Bay was not a chance assignment, for the handsome Italian was a close associate of Packard. After the board-track races Packard's most senior executives — clearly bitten by the speed bug — stayed on to try both the Sunbeam and their own stripped V-12 at speeds of better than 100 mph.

Possible Impact of Sunbeam on Packard

Without mentioning Packard, Sunbeam's Louis Coatalen went on record as stating that an American company had robbed Sunbeam of its rightful patrimony. In December 1916, at his company's annual meeting, Coatalen made a statement that included the following:

> At the outbreak of war the Sunbeam Company had something quite new in cars, notably the twelve-cylinder machine, with which they established many World's Records something like twelve months before the commencement of the campaign. This was the first car in the world of such a type, and it would have been marketed but for the war. As it was, they sent it to America where it performed notably and was bought by a motor manufacturing firm of perhaps the highest reputation in that continent. In consequent that firm studied the engine and standardised the twelve-cylinder car from the Sunbeam Company's machine with a degree of success that had compelled it to more than double its works, to increase its capital two-fold and it had, moreover, enabled the Company to pay a dividend of 50 per cent on that doubled capital for its financial year just concluded.

Thus, wrote Anthony Heal, Coatalen 'wished to draw attention to the fact that the war had robbed the Sunbeam Company of the credit and the profit of being the first in the world to market a twelve-cylinder car.'

This was strong stuff, obviously referring to Packard. Had Coatalen's accusation any basis in fact? If we are to attribute Sunbeam's influence to Packard's purchase of Toodles V, this seems unlikely. She first competed in England toward the end of the 1913 season, and the Packard Twin Six, Figure 12, was revealed in all its detail in May 1915. Even if Packard had acquired the racer during the 1914-15 winter — and it is likely to have been bought later — that would hardly have given time for its detailed design to influence the Twin Six.[9]

Not excluded is the possibility that Packard's engineers saw the V-12 Sunbeam at Brooklands as early as the end of 1913. In the 1906-1910 period Packard engineers spent 'many months' in Europe each year looking at the latest in-line sixes before they built their own, a habit they were not likely to have broken. Seeing a new engine, however, and perhaps being inspired by it, is not the same as studying the actual artefact in the manner suggested by Coatalen. The evidence thus suggests that the Sunbeam engineer's accusation was unjustified.

Of course Louis Coatalen could have proposed that Sunbeam build a V-12 road car. In his statement he suggested that such plans were afoot but were interrupted by the outbreak of war. He would go on to build aviation engines in wild profusion and more record-breaking cars with V-12 engines, but never a road-going twelve.

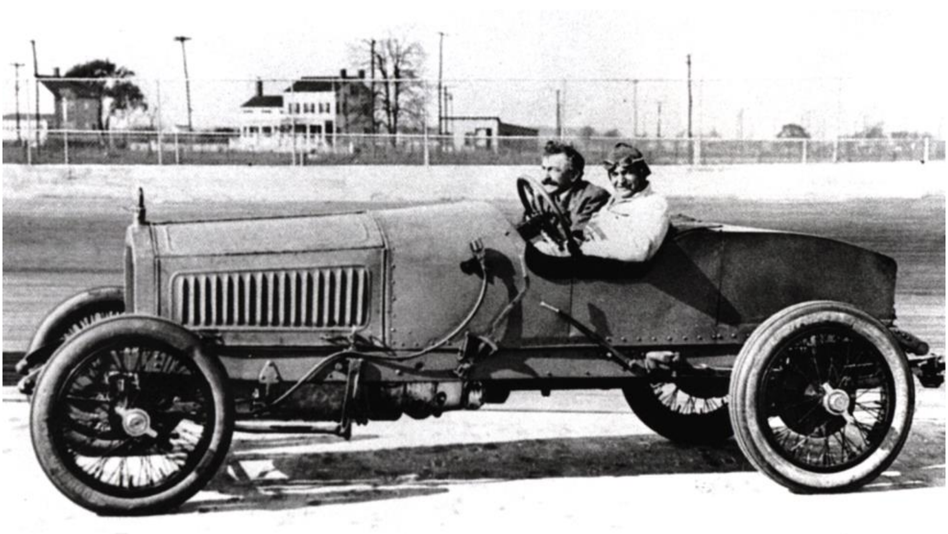

Figure 12. Packard Twin-Six 'Typhoon' at Sheepshead Bay.

'Louis Coatalen gives the impression of being very mercurial,' wrote Alec Brew, 'easily bored with whatever project he was working on, and anxious to move on to the next.' Coatalen clearly declared in 1913 that the engine in Toodles V was intended for aviation use — as its design features indicated — and was only being tested in a car. Only in retrospect, it seems, did Coatalen appreciate what he might have achieved with a V-12 in a production car, then seeking to justify his actions by implying the Packard to be a straight derivative, if not a near Chinese copy.

The two engines were not without similarities. Both had aluminium crankcases carrying cast-iron cylinder blocks whose heads were integral, and a single central camshaft operating L-head valve gear. Both had their left-hand cylinder banks offset forward to allow side-by-side connecting rods.

But where the Sunbeam had two blocks for each bank, the Packard had only one. Induction was through the tops of the Packard cylinder heads instead of through the sides, and the American engine's pistons were aluminium instead of steel. Packard made do with three main bearings rather than seven and placed its spark plugs above the exhaust valves instead of in the centre of the combustion chambers. In short, at worst the Americans could be accused of being inept at copying Sunbeam's historic twelve.

Prime Movers at Packard

We are obliged to look elsewhere for inspiration for Packard's trail-blazing Twin Six, Figure 13. By 1913, when its decision to build a V-12 had to be taken, both marine and aviation examples of twelves were active and well publicised, especially in Europe. The type was gaining a credible track record. In August of that year Sunbeam's V-12 racer first broke cover at Brooklands, although it did not race. Interestingly, however, there was a role model closer to home for Detroit-based Packard.

Although the Packard Motor Car Company gave the impression of being a conservative auto maker, it was run by a man whose name betrayed his pleasure in life. Scion of a wealthy Detroit family, Henry Joy became active in the Packard company in 1902 after discovering the car's merits. He put both cash and his great enthusiasm into Packard, which moved from its original home in Ohio to Detroit's West Grand Boulevard at the end of 1903. In 1910 Joy hired Alvan Macauley as general manager. The ying to Joy's yang, Macauley became the conservative and meticulous soul of Packard.

Macauley oversaw the 1912 launch of Packard's new range of six-cylinder cars. First to make its bow was a big six of 8.6 litres, followed in 1913 by a smaller six of 6.8 litres. Both had T-head valve gear, blocks cast as three pairs and seven main bearings — indicative of the challenge that engineers faced in coping with the six's crankshaft oscillations. Starting problems were solved by the use of Delco's electrical system. New though these engines were, they were replaced by 1914 by similarly sized L-head sixes with pairs of three-cylinder blocks.

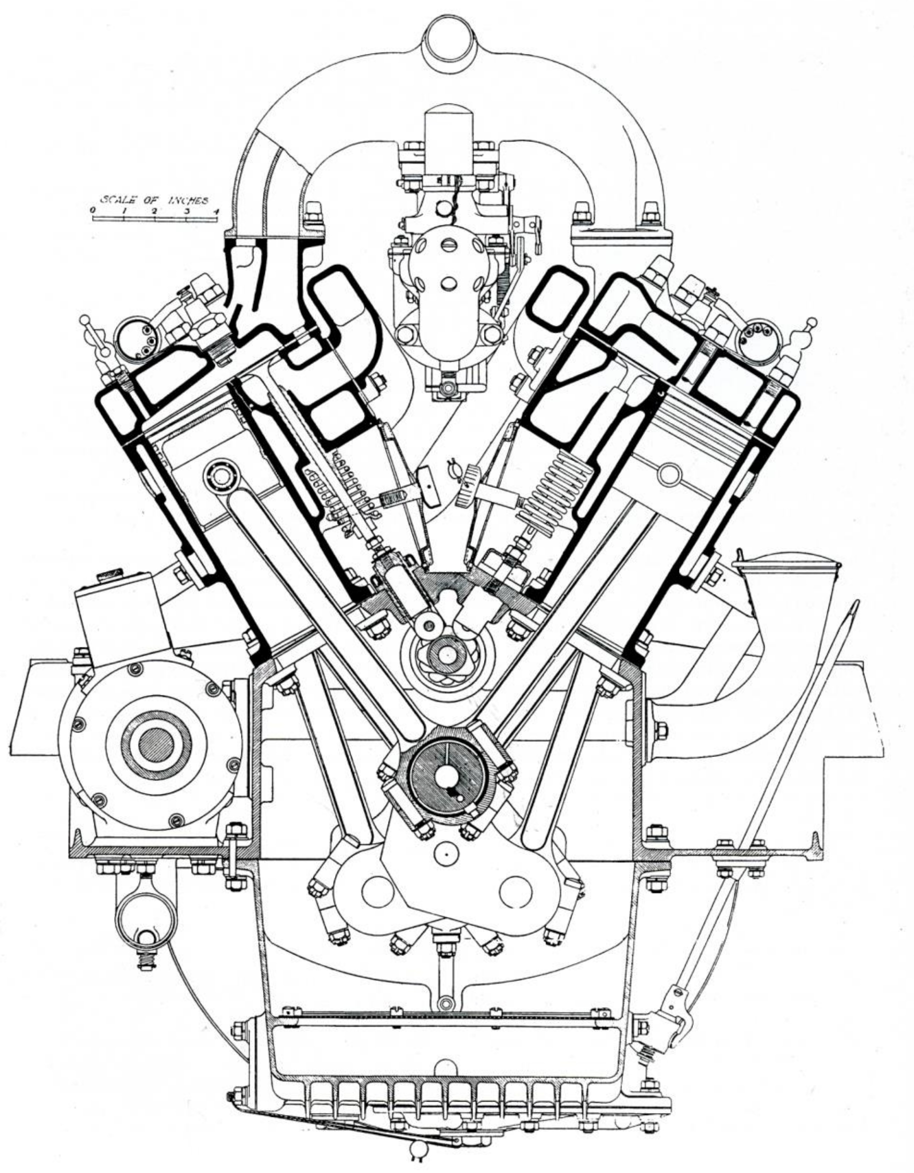

Figure 13. Packard Twin Six V-12 in 1918.

Contributions to the design of the new 1914 sixes were made by a former colleague of Alvan Macauley's at the Burroughs Adding Machine Company, Jesse

Vincent. Born in Arkansas, Vincent made up for his scant brushes with higher education with a distinct knack for mechanical problem-solving.

His passion for cars led Vincent to leave Burroughs to become Hudson's chief engineer at the end of 1910. He was plucked from Hudson by Macauley to join Packard at the end of July 1912. The team was now in place that would lead Packard for decades to come.

The Influence of Indianapolis

While Packard — like most makers in those days — had no proving ground of its own, it did enjoy privileged access to one of America's newest and finest high-speed tracks. The Indianapolis Motor Speedway had been open for business since 1909. One of its leading lights was Carl G. Fisher, Packard dealer in that Indiana city. June 1914 found two standard Packard sixes making one-hour speed runs on the 2½-mile oval, the fastest averaging 70.447 mph. The runs served both for research and for the positive publicity that Jesse Vincent relished.

Another partner in the Speedway was Frank H. Wheeler, proprietor of carburettor maker Wheeler-Schebler. Inventor of the company's carburettor and chief engineer was George Schebler. Such was Schebler's creativity that, not satisfied with his carburettor work, in 1907 he decided to build a car with the help of one of the company's engineers, Philip Schmoll. By 1908 it was complete and running: a Raceabout-style roadster that was the world's first V-12-powered car, Figure 14.[10] Schebler and Schmoll installed their engine in a chassis made by another Indianapolis company, Marion.[11]

Schebler's twelve had individual cylinders set at an included angle of 45 degrees. Each monobloc cylinder was of F-head design, with side inlets and overhead exhausts operated by pushrods and rockers from a single central camshaft. Bore and stroke were 82.6 x 127 mm for a capacity of 8,157 cc. The cylinders were directly opposite each other; thanks to the use of articulated connecting rods. Unusually the rods were made of bronze. No chances were taken with the crankshaft, which ran in seven main bearings. Twin updraft Schebler carburettors hovered above the engine's centre to feed a pair of manifolds that curved down to feed the inlet ports. Each carburettor was separately controlled, which allowed the engine to be run either as a six or a twelve. 'Mr. Schebler employs six cylinders when the roads are good and no difficulties are met with,' reported *Motor Age*, 'and twelve when a sand pit is encountered or the car is required to pull through deep mud.' Schebler and Schmoll adapted a twelve-contact distributor to a Mea six-cylinder magneto, which ran at triple crankshaft speed.

Here was a remarkable car which vividly demonstrated the practicability of the V-12 engine for automobiles. The Indianapolis connections to Packard were so intimate that it is inconceivable that Schebler's roadster didn't come to the attention of Jesse Vincent, an ardent admirer of fast cars.

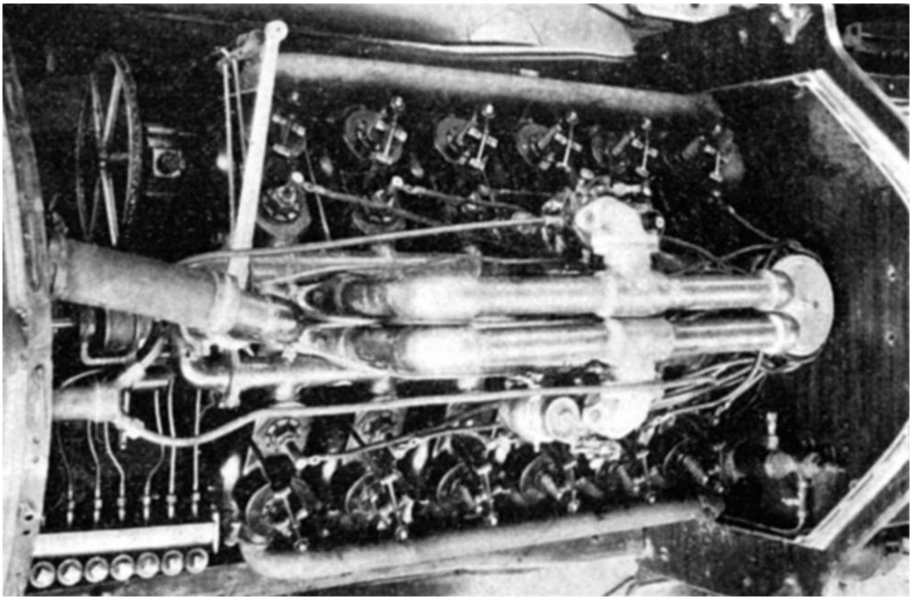

Figure 14. Schebler V-12 of 1908.

Packard's V-12 of 1915 bore no resemblance to this Indianapolis one-off; it could only have served as inspiration - but it would have been quite some inspiration. 'According to Mr. Schmoll,' *Motor Age* continued, 'no one has had the courage to keep both throttles wide open for any length of time.' Here was an attribute many future twelves would share.

Acknowledgements

The text of this paper has been adapted from that of the author's book, *The V12 Engine*, published by Haynes in 2005. Described and discussed in the book are all the V-12 engines that had been produced up to that date for automobiles of all kinds.

Research for the book was conducted in the books and periodicals in the author's Ludvigsen Library at Hawkedon, Bury St Edmunds, Suffolk. A key source of the early material discussed in this paper consisted of the Van Wyck Hewlett Papers in the Ludvigsen Library. An automotive engineer on New York's Long Island, Van was an indefatigable collector and clipper of technical periodicals from the turn of the century.

Notes and References

The very first such engine, delivered in December 1888, was destined not for cars but for a Spohn locomotive. Credited as it was with 6 horsepower, it must have been considerably bigger than the car version, which produced 1.5 bhp at 600 rpm.

[2] Griff Borgeson wrote that its vee angle was 120 degrees, but this seems to be a misreading of a not-very-clear description of

the engine's design. A photograph shows a 90-degree vee to be more likely.

[3] In the 1970s the engine was said still to be running in a Hong Kong junk.

[4] Anthony Heal reported that the sump's scavenge pump was too small, requiring the engine's oil pan to be emptied before it started a race or record run at Brooklands lest it overflow during the contest.

[5] At the end of 1913 Sunbeam released a concept drawing of a car with this larger engine whose dual rear tyres were intended to help it attack speed records on French roads, but no such Sunbeam was ever built.

[6] Post-WWI a Mohawk was installed in a Napier chassis which Cyril Bone acquired and stripped of its four-seat body to race at Brooklands. Fitted with 'B' hubcaps, the awesome Bone Sunbeam-Napier first failed and then crashed in its two 1925 attempts at the Surrey track and was not seen again.

[7] The author is indebted to Robert J. Neal's magnificent book, *Packards at Speed*, for this information.

[8] In 1925 Vincent bought a supercharged 2.0-litre front-drive Miller Indianapolis car and in 1926 a supercharged Mercedes while on a trip to Europe.

[9] At the time of the Sheepshead Bay races in November 1915 Packard was said to have purchased the Sunbeam 'some months ago'.

[0] Historian Griff Borgeson hypothesized that Schebler was inspired by the V-4, V-6 and V-8 engines built earlier in the decade by Indianapolis's Howard Marmon, but these were air-cooled engines.

[1] This has given rise to erroneous reports that Marion produced a V-12-powered car

Notes on Contributor

Karl Ludvigsen's career took him to senior management positions at General Motors, Fiat Motors of North America and Ford of Europe. While at GM he helped develop strategies for exploitation of the Cadillac 'V-Future' V12 that is one of the might-have-beens of *The V12 Engine*, his comprehensive history of vee-twelve engines in cars.

Having studied both mechanical engineering (MIT) and industrial design (Pratt Institute), Ludvigsen appreciates both the technology and the aesthetics of the great cars that have been and are V-12-powered.

A former editor of *Car and Driver*, Karl Ludvigsen has been active for over 50 years as an executive, consultant, author and historian. As an author, co-author or editor he has more than four dozen books to his credit. Three of his books have received the Nicholas-Joseph Cugnot Award from the Society of Automotive Historians, which in 2002 awarded him its highest accolade, Friend of Automotive History.

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