Packard as an Aero Engine Builder 1919 - 1923

By Robert J. Neal

Packard's interest in aircraft engines began in the fall of 1914, directly following the outbreak of war in Europe. Henry Joy was then President of Packard and it was he who said "Just as sure as God made little green apples. We will some day be forced to participate in this war."

Joy was impressed with the importance of the airplane in modern warfare and, looking about, realized how poorly prepared the United States was to produce, as he put it, "an automotive power plant for aerial warfare." He then authorized Jesse G. Vincent, Packard's Vice President of Engineering and chief engine designer, to put together a qualified engineering organization that could design and develop a first-class aircraft engine. As Vincent later stated, "This was not an easy task, but I was finally able to secure the nucleus of an aircraft engine development staff, and in the spring of 1915 work was started on the first Packard aircraft engine."

That first engine was called the "299" model by Packard. The name was chosen because the engine displaced 299 cubic inches. This was the beginning of a procedure that continued to be used by Packard to name all non-automotive engines until the end of the company in the mid-1950s. The format was expanded somewhat in 1919 to accommodate an expanded variety of engines and, after that point, was not changed.

Packard engine model nomenclature

Packard's non-automotive engines from 1915 to 1919 were given names reflecting their displacement only. Their first aircraft engine displaced 299 cubic inches and was known as the "299" model. Their second aircraft engine displaced 905 cubic inches and was called their "905" model. They built two "299" engines, both of the same design. They built three "905" engines, each slightly different in design from it predecessor. They called all three "905" engines. The last "905" was built immediately following our entry into World War I in April of 1917. It was thought at the time that it might be put into production as a military engine but it rapidly became evident that its power was under that required and its power-to-weight ratio was too high. Thus Packard did not further develop its own engine designs until after the end of World War I.

When that time came, they decided they needed to expand their model designations to accommodate the greater variety of engines they could foresee they would design. I will explain their system using the first aero engine they designed following the war. It displaced 744 cubic inches. Thus it had 744 included in the model name. It was the first design of the basic model. Thus a "1" proceeded the name. Any later designs of that model would be prefixed with 2, 3, 4 etc. It was an aircraft engine. Thus an "A" for aircraft was inserted. They would shortly begin to design and produce marine engines and these used the designation "M" in the name. Thus they got the name **1A-744.**

World War I

The United States entered the war on April 6, 1917 and on May 27 Jesse Vincent went to Washington to try to either sell Packard's "905" engine to the Army or help them design one that would do the job needed to power their combat aircraft. He ended up doing the latter and the result was the Liberty series of engines, of which the *Liberty* 12A became the most used and most famous. Vincent was its co-designer, along with Elbert J. Hall of the Hall-Scott Motor Car. Co. That series of engines represents a book-sized story in itself on which the author is currently working and expects to see in print within a year or so.

Vincent co-designed the *Liberty* and Packard was chosen to build a group of eleven prototype engines. They also were chosen as one of its series producers and, because of their initial work on the prototypes, were the first to get into regular production and thus saddled with the job of working out most of the early design and production wrinkles. There were eventually six major producers, of which Packard was the largest. By war's end they had delivered 6,863 *Liberty* engines. During the war Vincent had left Packard and been commissioned an officer in the Army. He entered service in the Signal Corps to head the aircraft engine design section as a Major and by the end of the war was a Lt. Colonel. After the war he was commissioned a full Colonel in the Army Air Service reserve corps. He was known by his friends and associates as "Colonel" Vincent until his death.

Packard enters commercial aircraft production

November 11, 1918, brought an end to the war and with it Packard's preparation to return to commercial production of automobiles and trucks and to enter into the commercial aero engine business. In the November 14, 1918, board minutes then company president Macauley expressed what he felt was the current condition of the company as regards to resuming every day business. Among those comments was the following:

"Organization. Our internal organization is, I believe, at maximum strength and ready to cope with nearly anything. The exception to this is the Engineering Department, which has been depleted by the loss of Mr. Vincent and Mr. Hunt, and many lesser lights under them; but we shall undoubtedly be able to get a good many of these men back, and they are, as a matter of fact, already beginning to apply for reinstatement. I think it is more than likely Mr. Hunt will return to the organization. Whether Colonel Vincent will do so depends upon his inclination and attitude."

O. E. Hunt had been Packard's Chief Engineer prior to the war and had left the company to work for the government's Bureau of Aircraft Production as Associate Engineer of the Detroit District of the airplane engine production section. The Detroit District controlled the production of the *Liberty* engine.

The December 23, 1918, board minutes reveal that both men elected to return, O. E. Hunt on December 1, 1918, as Chief Engineer of the Motor Carriage Department at $10,000 per year, and Col. Vincent as Vice-President of Engineering on January 1, 1919, at $30,000 per year.

The January 21 minutes note the hiring on January 1 of three engineers who would work for Packard for a number of years and make many contributions to the design of future aero, marine and other engines. Captain Lionel M. Woolson as Engineer in Charge of Tests at $5,000 per year, Marvin J. Steele as Engineer of Special Design at $3,600 per year and Alfred Moorhouse as Engineer of Special Design at $5,000 per year. Moorhouse had been Chief of the Engineering Records Department under Col. Vincent at McCook Field, and Woolson head of Engineering Tests. Moorhouse would become Packard's Chief Engineer after Hunt's resignation in 1920 to go with Hare's Motors, and Woolson would eventually become their Chief Aeronautical Engineer. Hare's Motors did not last long and Hunt then went to work for Kelly-Springfield, and by 1922 was Chief Engineer for Chevrolet. By 1942 he had risen through the ranks to Executive Vice-President of General Motors. Also hired on January 1 was Etienne Dormoy for aircraft design work. Dormoy had been one of the chief designers with the LePere French Mission and later became Chief Engineer of Buhl Aircraft Co.

On February 1, 1919, Charles H. Vincent, Col. Vincent's brother, was hired "for testing work, for the Engineering Department, at the rate of $166.66 semimonthly" ($4,000 per year). "C. H.", as most of his friends called him, had worked for Packard, left, and then returned twice prior to this time. He had first worked for the company as an assistant foreman in the early teens, then for Hudson until January 12, 1917, when he returned to Packard to work in the Experimental Department. Here he did some work on the 905 engine and a few months later left on a lengthy automotive test trip to the west coast from which he returned to help work on the *Liberty* engine during the war. He then left the company and went to work for the Bureau of Aircraft Production in the Detroit District until the end of the war and was re-hired on February 1, 1919. From this time he never left the employ of Packard until he retired on January 1, 1948, as a Consulting Engineer. He served Packard in a number of positions over those years, including Experimental Engineer, Quality Engineer, Chief Inspector, Proving Grounds Manager and Assistant Service Manager for the Rolls-Royce Merlin engine program.

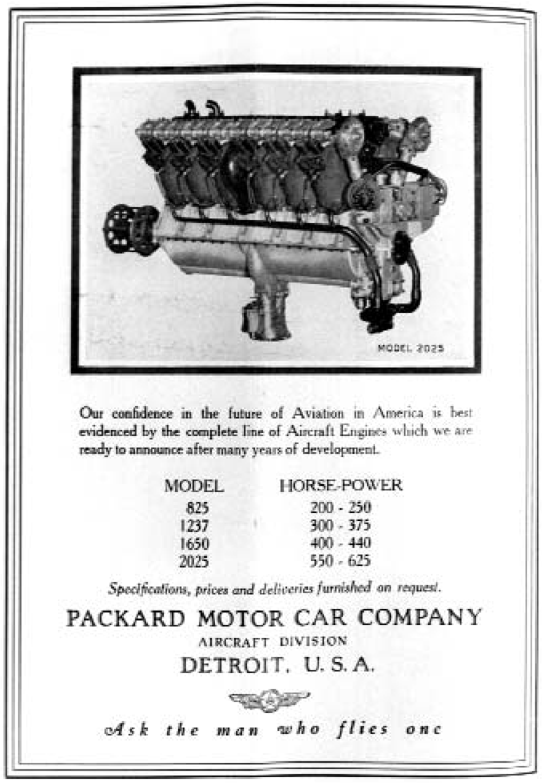
Also hired during this period was Walter E. Lees on March 24, 1919, for work in the Engineering Department at $3,000 per year. Lees had worked at McCook Field with Col. Vincent as a civilian test pilot for the Army. He would leave Packard in June and go to work for the Russell Aviation Co., followed by several other companies until he returned to Packard in April of 1925, and remained with them until they left the aircraft engine business in 1934. His principal work for Packard was as test pilot and test engineer.

As a matter of interest to the reader, the average rates being paid to production workers at this time was about $0.75 per hour ($1,560/year), inspectors $0.90 per hour ($1,872/year) and foreman $1.00 per hour ($2,080/year). One can easily see that people with specialized skills demanded considerably higher wages.

The Packard Airplane

Even though Col. Vincent did not officially go back to work for Packard until January 1, 1919, he without doubt had made the decision to do so a long time before. He had conceived designs for three new aero engines, a V-8 and two V-12s, and an airplane to be powered by the V-8. It was his intention that they be produced by Packard. On January 20 Packard announced their intention to market a two-passenger biplane which would sell for about $15,000. Several publications carried the announcement, including the January 23 issue of both *The Automobile* and *Motor World*. It was to appeal to the wealthy sportsman and thought to have an immediate market. They were followed on February 3 by a similar article in *Aerial Age Weekly*. The first airplane was to have been completed within 30 to 60 days and be available through Packard dealers. It was stated that both their Boston and Chicago dealers had already ordered one.

It is certainly evident that the airplane was completed ahead of schedule as photographs of it and its engine, the 1A-744, were released to the press in time to appear in the March 1, 1919 issue of *Aviation* magazine.



The first of Packard's regular series of aero ads. This ad ran in Aviation *magazine from February 20, 1922 through April 3, 1922. Note that it lists the 1A-1650 Packard* Liberty. *Availability of this engine on the government surplus market would soon cause Packard to drop it from their line of new engines. Author's collection.*

The actual airplane, an extra 1A-744 engine (serial No. 2), and 1A-1116 engine, (serial No. 1) were on display from March 1-15 at the New York Air show at Madison Square Garden.

The Packard airplane was designed to be powered by the 1A-744 engine. A well-done color brochure describing and picturing it and the 1A-744 engine and describing the 1A-1116 and a designed but-not-yet-produced 1A-2025 engine was made up and distributed at the air show and to Packard dealers. The brochure and two different photographs of the actual airplane completed and inside the Packard factory were used as the basis of illustrations in a number of articles on the airplane published during 1919.

The design of the Packard airplane was accomplished by Etienne Dormoy (a Spad employee with the French Mission during the war), Keith Rider, Ivar L. Shogran, Col. Vincent and a man named Galloway. Test flying was done by Fred Hoover, another McCook Field pilot hired after the war. The airplane was built in a section of the factory separate from the LePere airplanes, the last of which were not completed until February of 1919. Col. Vincent patented the design and layout of the fuselage in patent 1,496,397 (application filed Feb. 7, 1920) issued June 3, 1924.

Packard airplane pictured in February of 1919 still on the factory floor. Note the shape of the upper wing to fuselage struts. This shape has only been noted on Packard-built or rebuilt airplanes. Courtesy Peter Bowers.

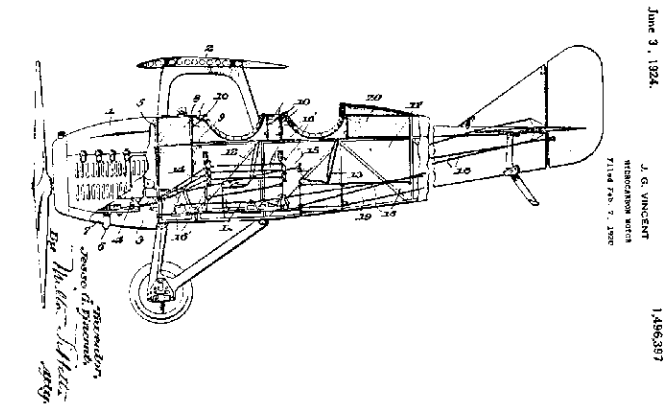
Potential orders never materialized and the board of directors killed the project over the objections of Col. Vincent. Thus only one airplane of this design was ever built. *Motor Age* carried the official announcement date lined July 13 in their July 15, 1920 issue. Designers Dormoy, Rider and Galloway left the company and went to work at McCook Field, and Shogran went to Los Angeles to work on the "Uni-Flow" engine designed by Vernon Balzer and Jack Ballou.

Ivar Shogran, in a 1979 letter to Robert Meyer, then curator of aero propulsion at the National Air and Space Museum, gave his impression of Col. Vincent and described the Experimental Department as it existed in 1919.

"Col. Vincent's operation was interesting. He had his personal office and conference room. Out of the office was a door leading to the design section. With a single aisle, there were eight to ten drafting tables on each side. Each individual at this table was a specialist on one or more related subjects: pistons, pins and rods, crankshaft and bearings, crank case, cylinders and valves, carburetion and manifolds, ignition, chassis etc. Our group, of course on airplanes."

"When Col. Vincent stepped through the door from his private office to our design section he had immediate access with the status of any desired subject, in detail, and could interject his opinions. While a very busy man, he was an excellent director but still a patient listener. Col. Vincent was what some called a

Packard airplane with cowl removed to show its 1A-744 engine. Courtesy Peter Bowers.



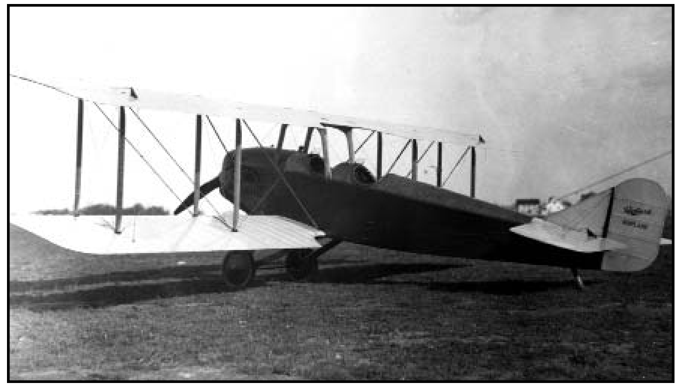
Col. Vincent's patent number 1,496,397 filed February 7, 1920 for the design features of the Packard airplane. Author's collection.

wonderful mechanical architect in his ability to visualize the total project and maintain harmony between all the details in their respective environments."

The Packard airplane was retained by the company as a test vehicle for as long as they were producing engines of an appropriate size to power it. Its 1A-744 engine (serial No. 1) was replaced with 1A-825 (serial No. 3) on July 29, 1921. In addition to its use for testing purposes, Col. Vincent frequently used it for transportation to Selfridge Field, Indianapolis, and McCook Field in Dayton, Ohio, as well as occasional flights just for pleasure.

It was sold in August of 1925 to Dr. Charles W. Adams of Detroit. When the Dept. of Commerce started issuing airplane licenses and identification numbers in

Ad Packard placed in several magazines in early 1919. The same illustration was used in their brochure for this airplane. Author's collection.



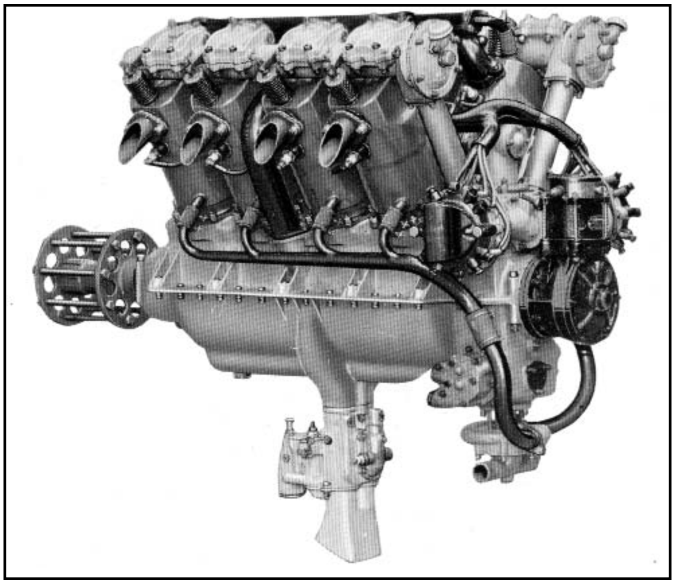
This Packard airplane at Packard Field at Rosendale Corners, Roseville, Michigan. Courtesy NAHC.

1927, the airplane was issued number 707. It underwent various modifications and rebuilds over the years and changed ownership several times. It was last registered in Mt. Clemens, Michigan to Howard F. Hatzenbuhler who purchased it on Sept. 20, 1935. Its license expired on Oct. 15, 1936 and was never renewed.

Packard Air Field

On May 22, 1919, the board authorized the purchase of land on Gratiot Avenue at Rosendale Corners, midway between Detroit and Mt. Clements, for use as an aircraft testing field. They had sold Joy Field (now Selfridge Field) to the government in 1917 and needed testing facilities to try out their new engines. Shortly thereafter a hanger was constructed and a Curtiss JN-4 training plane purchased. This became known as Packard Field and was used by the company for testing until the Proving Grounds were constructed at Utica in 1927-1928. When the property for the new proving grounds was purchased in December of 1926, Packard Field was sold to Truman H. Newberry, Packard Director from 1903 to 1933.

Col. Vincent (left) and Fred Hoover (Packard Test Pilot), and the Packard airplane. Courtesy of NAHC.

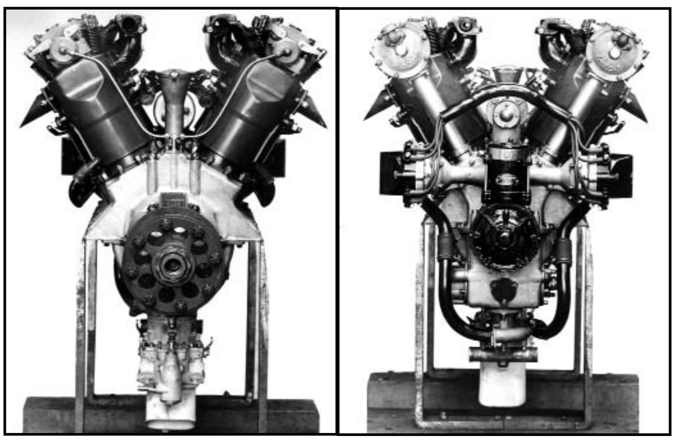


1A-744 serial No. 1 shown with starter attached to rear. Author's collection.

The 1A-744, 1A-1116 and 1A-2025 Aero Engines

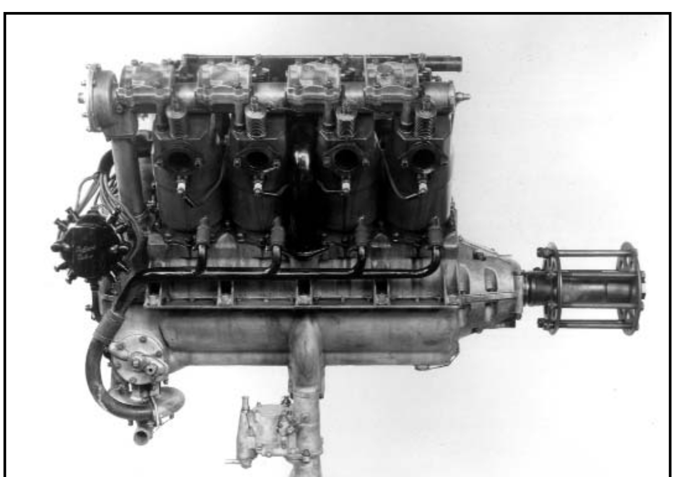
At the same time Packard was announcing to the press that they were entering the commercial airplane and airplane engine market, Col. Vincent was approaching the Air Service with the proposition that they contract a small quantity of the three types he was proposing, the 1A-744, 1A-1116 and 1A-2025. He met with Lt. Col. Clark (Lt. Col. V. E. Clark, Chief Aeronautical Engineer U. S. Army 1915 - 1920) on Feb. 9, 1919 and discussed the matter, and followed it with a confirming letter on Feb. 10. Col. Clark in turn proposed the matter to Lt. Col. Bane (who now held Col. Vincent's old position at McCook Field) and Maj. Hallett (Chief of the Power Plant Division at McCook Field) who readily accepted it and looked over the drawings of the engines. All this had occurred by March 1, the opening of the New York Air Show at which Packard had on display two 1A-744 and one 1A-1116 engine.

Col. Bane then tried to cover all angles of the matter and requested Maj. Hallett to see if he could also get the opinion of Charles F. Kettering (at that time president of Dayton Engineering Laboratory Co. - DELCO)

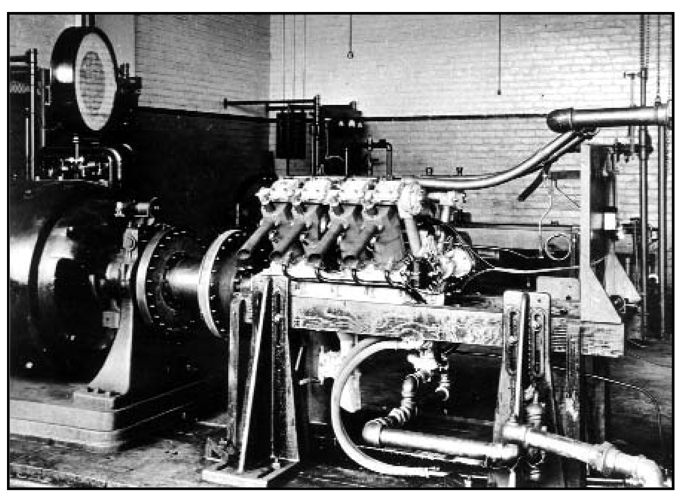


1A-744 serial No. 1, front and rear views. Author's collection.

Above Left: Delco 8-cylinder distributor head. Above Right: Delco ignition switch. Author's collection.



1A-744 right side. No starter is installed. Author's collection.



1A-744 serial No. 1 on a test dynamometer at Packard. Author's Collection.

and Henry M. Crane (vice president and chief engineer of the Wright-Martin Aircraft Corp.) regarding the design of these engines. On June 2, 1919, Col. Bane received a telegram from McCook Field stating that "Kettering's opinion is that the series of Packard engines is very sound and they should be built."

On June 10, authority was requested to contract for experimental engines from Packard, and on June 17 Col. Bane was advised that $190,000 was to be set aside for the contract.

On that basis work was begun, even though it was Nov. 4 before the formal contract was issued for the production of four 1A-744, two 1A-1116 and four 1A-2025 engines. The contract amount was $187,836.02. Some modifications were made to 1A-744 No. 2 (which had been displayed at the New York show) and it was delivered on Oct. 30, five days before the formal contract was issued. Deliveries of the remaining engines continued on a rather random basis until early September of 1920. 1A-1116 No. 1, which was also at the show, was delivered as part of the contract on Feb. 2, 1920.

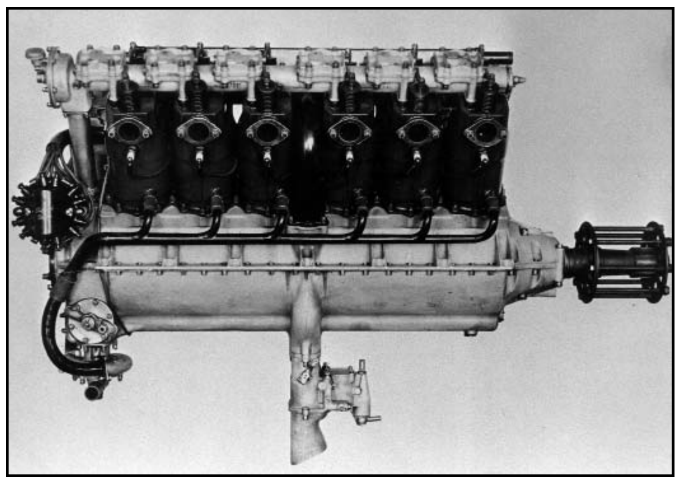
The engines of this contract were 1A-744 numbers 2, 3, 4 and 5; 1A-1116 numbers 1 and 2; and 1A-2025 numbers 1, 2, 3 and 4.

The 1A-744 engine, although following the basic mechanical design of the *Liberty*, deviated in many respects from it. The engine was a V-8 with an included angle of 60º. Bore was 4 ¾ inches and stroke 5 ¼ inches for a displacement of 744.24 cubic inches. Compression ratio was 5 to 1 and the engine weighed 560 pounds. Power rating was 180 HP @ 1600 RPM and 200 HP @ 2000 RPM. Ignition was dual using a 12-volt Delco battery-type with distributors mounted in the rear at about mid-engine for easy access, and two plugs per cylinder were used. A single duplex carburetor was mounted below the engine with intake passages formed one up each side within the two halves of the aluminum crankcase. The upper outlets of these two passages are connected to a water-jacketed aluminum manifold for each cylinder bank by flanged steel tubes. Thus the carburetor intake was from below the engine through a suitable hole in the cowling. This not only provided easy access to the carburetor but also resulted in any fuel leaks or flooding overflow draining directly outside the engine cowling and eliminated fire danger from these conditions. It also allowed gravity feed of fuel to the carburetor. The water and oil pumps were mounted on the bottom rear for easy access as was the optional Bijur starter. A 12V generator was mounted between the cylinder banks.

The engine passed its 50-hour government test at McCook Field on March 31, 1920, and became available on the commercial market at about the same time. Serial numbers 6 and 7 are believed to have been sold on the civilian market.

Several patents were issued to Col. Vincent covering the new features incorporated into this engine, and the several others to follow within this design family, notably the 1A-1116, 1A-2025, 1A-825 and 1A-1237. The first was applied for on February 7, 1920, and the last on May 22, 1920. Patent 1,415,067 covered an improved rocker shaft cover to prevent oil leakage; 1,409,073 covered the design of the below-engine carburetion system; 1,595,432 covered the design of the oil pump, oil pressure regulator and oil bypass system; and 1,476,781 covered the water pump drive.

The 1A-1116 engine was simply a V-12 version of the 1A-744. Displacement was 1116.36 cubic inches and rated power was 270 horsepower @ 1,600 RPM and maximum 300 horsepower @ 1,850 RPM. Weight was 733 pounds. All parts not required to be different by virtue of the increase to twelve cylinders were the same in both engines, including the water pump, oil pump and oil pressure regulating systems. Either Dixie magneto or Delco battery ignition was available. As was the case with the 1A-744, the 1A-1116 became available on the civilian market in March of 1920, but none are believed to have been sold there.



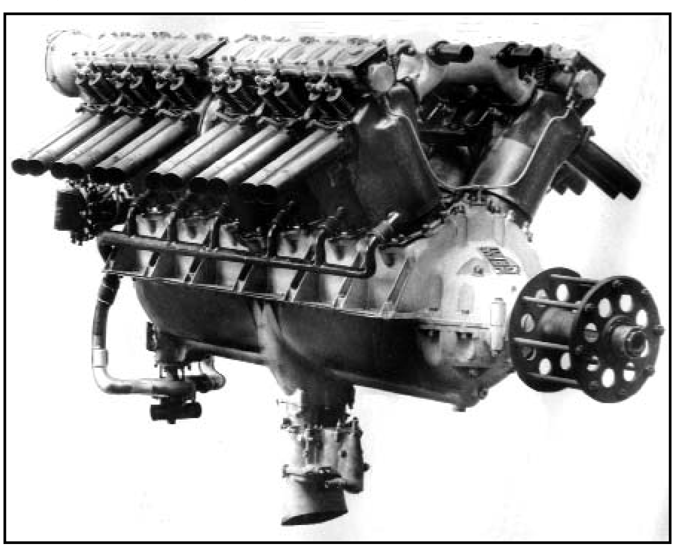
1A-1116. This engine was of the same design as the 1A-7444 but with additional cylinders. Front and rear views are the same as the 1A-744. Author's collection.

Delco 12-cylinder distributor head. Author's collection.

The 1A-2025 was quite similar to the 1A-1116 in design but considerably larger. Bore was 5 ¾ inches and stroke 6 ½ inches, giving a displacement of 2,025.42 cubic inches. Compression ratio was 5 to 1. Rated power was 550 horsepower @ 1,800 RPM and maximum was 600 @ 2,000 RPM. Dry weight was 1,142 pounds. Other than size, the only notable difference was the use of four valves per cylinder. Four valves give better breathing characteristics than do two, and Packard would eventually use this design almost exclusively on their non-automotive engines. It was evident that some were skeptical about the need for four valves as indicated by the comment made in listing the engine in *Janes All the Worlds Aircraft* in 1920: "The type 1A-2025, of 500 HP, is fitted with four valves per cylinder, the other types are content with usual allowance." As introduced, the engine had Delco battery ignition. In 1921 (after serial No. 4) the ignition was changed to Dixie magneto.

As on all Packard aero engines built up to this time, the valves were driven by a single overhead cam on each cylinder bank and roller-operated rocker arms. This was Packard's first four valve engine. The cylinder design and method of manufacture was covered by patent 1,695,676 applied for on February 6, 1920, by Col. Vincent. The prototype engine and three others were built under the 1919 contract. What were considered production engines started with serial No. 5 and were not contracted for until 1921.

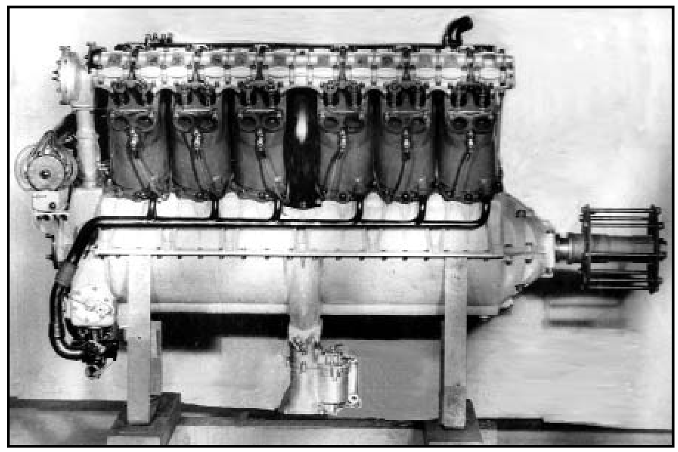
Engine No. 2 was installed in the Engineering Division's VCP-1 (Verville-Clark Pursuit; Clark was Lt. Col. V. E. Clark), originally powered by a Wright-Hispano, and its designation changed to VCP-R (racer). During testing the airplane crashed in an unfortunate collision with a timing car while landing at Wilbur Wright Field on Aug. 2, 1920. The plane was rebuilt



1A-2025 of the design used on serials 1-4. Delco battery ignition was used. Author's collection.

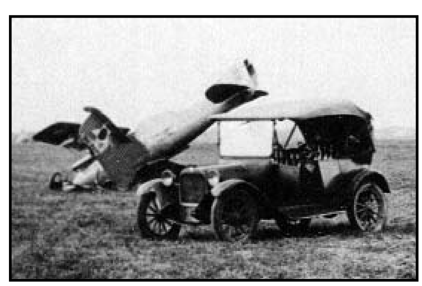
and engine No. 3 installed. The plane was then sent to France to compete in the Gordon-Bennett race on September 28 where, after completing only one lap, it was forced out with an over-heated engine caused by a combination of pre-ignition and too small a radiator. Interestingly, of the eleven planes entered in the race only two completed it.

Maj. Rudolph W. Schroeder, the Army's chief test pilot and current holder of the world's altitude record (set in a Packard LePere airplane powered by a supercharged *Liberty* engine), was scheduled to pilot the plane in both the Gordon-Bennett and Pulitzer races, which was scheduled to be flown on Thanksgiving Day. Lt. Corliss C. Moseley was his back-up pilot. A short time before the scheduled Gordon-Bennett race



1A-2025 late type with magneto ignition and redesigned cam housing. All engines serial 5 and beyond were of this design. Author's collection.

VCP-1 as modified to become VCP-R shown here with the upper engine cowl removed. Author's Collection.



The aftermath of the August 2, 1920 collision at Wilbur Wright Field. Both vehicles involved are shown. The pilot, Maj. Schroeder, was not injured. Courtesy of The Air Force Museum.

Maj. Schroeder was informed that due to a postwar cut back in military expenditures he would be reduced in rank to Capt. Furious, he submitted his resignation from the service. He was persuaded to delay his departure until after the completion of the Gordon-Bennett race.

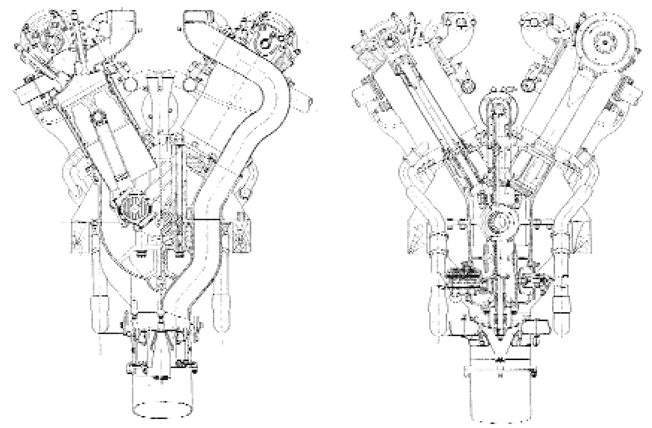
The plane was shipped home and prepared to compete in the Pulitzer race to be held on Long Island on Nov. 25. Lt. Moseley was the pilot and it won that race with a speed of 156.5 MPH. Later, it raised the American air speed record to 186 MPH. The Engineering Division of the Air Service was highly interested in the development of large size engines for bomber aircraft. The 1A-2025 was considered as a potential engine for this use as well as for high-speed pursuit planes.

By Sept. 4, 1920, four engines of the early type with Delco ignition had been delivered and were at McCook Field. Six more with magneto ignition were ordered on June 10, 1921 for a total of ten. An additional 1A-2025 was delivered in late 1922 or early 1923 and in tests produced 580 horsepower at 1,800 RPM, or about 30 horsepower more than the early models achieved at this speed. This accounts for a total of eleven engines delivered to the Air Service.

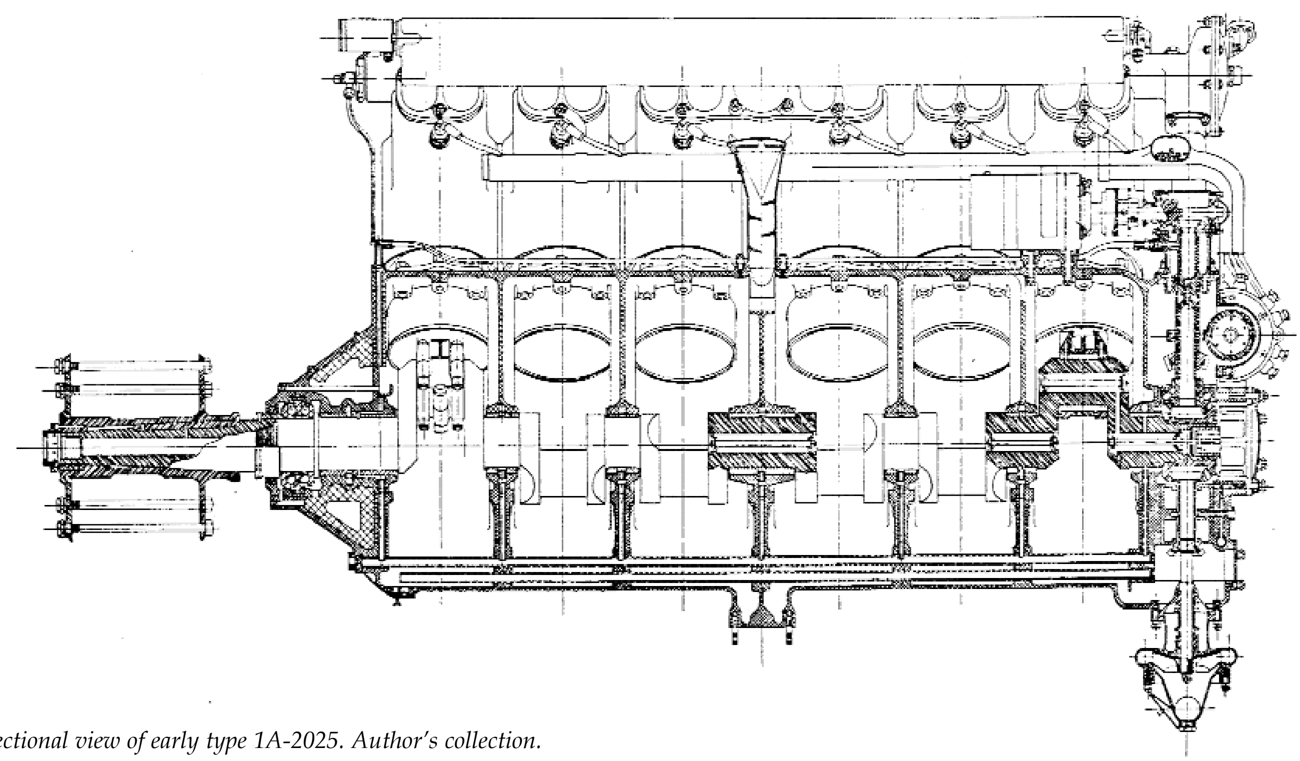
None are known to have been purchased by commercial companies although there was a proposal in late 1921 by the Airliner Engineering Corporation to install two in their 25-passenger RB-1, which was then powered by two Libertys.

Of the first four engines, No. 1 was the prototype and was not flown. Serial No. 2 and 3 were used in the Verville-Clark pursuit during its initial testing. Engine No. 3 was used in the 1920 Gordon-Bennett and Pulitzer races. We do not know that engine No. 4 was ever flown. Of the next six produced, five powered 1922 Pulitzer race planes and No. 10 acted as a spare. Engine No. 11 was used only for tests. Engine No. 5 served dual use in that is was used to power one of the 1922 Pulitzer race planes and was later used as the basis of the one 1A-2200 engine built.

Of these eleven engines, five are known to have survived. One is in the Museum of Aircraft and Aeronautics in Krakow, Poland; one (serial No. 10) is in the Air Force Museum at Wright-Patterson AFB, Ohio;



1A-2025 sectional views (left) through the cylinder and intake manifold and (right) through the timing and accessory gear drive, water and oil pumps. Author's collection.



Sectional view of early type 1A-2025. Author's collection.

one was purchased surplus by Gar Wood, eventually was owned by the author and is now owned by Walter Hill (serial No. 9); one converted to marine use and now owned by Kieth Canouse (serial No. 7) and one which was converted for marine use and now in a private collection in Florida. Two of the late type are known to have been converted for marine use and installed in the 85′ yacht Rosewill in 1927; the Florida engine might be one of them but serial No. 7 is not.

A total of nine 1A-744 engines are known to have been built. No. 1, 6 and 7 remained in the possession of Packard. All others were purchased by the Air Service. No. 1 was converted to 825 cu. in. as were No. 8 and 9. No. 1, 6 and 7 were no doubt eventually sold on the commercial market by Packard.

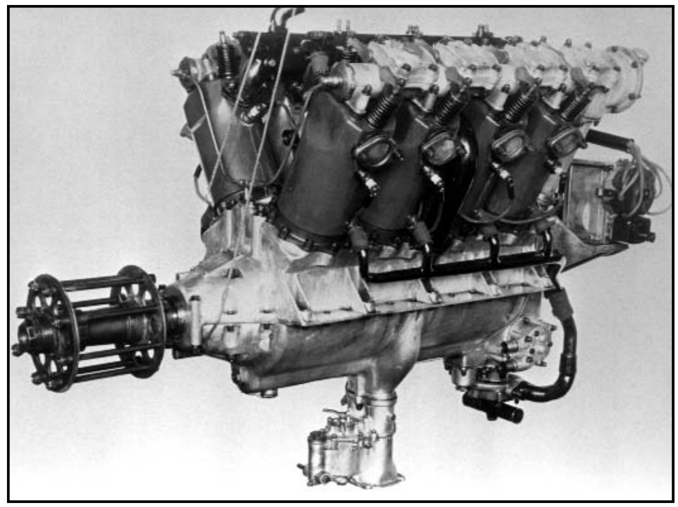
The Packard Fokker D VII Airplanes

In connection with these early post-war engines, Packard requested of the Air Service, and received, the loan of three Fokker D-VII airplanes to use for flight testing 1A-744, 1A-825, 1A-1116 and 1A-1237 engines at Packard Field. In late June of 1920, the Air Service loaned Packard Fokker D-VII airplane U.S. No. 8403 with which to flight test the 1A-1116 engine, and shipped them 1A-1116 No. 1 to be installed and tested. They test-flew the plane with the Mercedes engine with which it was supplied, and then removed it and installed the 1A-1116 and test flew it with the new engine on July 22, 1920. A second Fokker D-VII, No. 7790, was supplied along with 1A-1116 No. 3 for the same purpose and was first tested on November 1, 1920. A third Fokker D-VII, No. 4529, was also loaned in March of 1921. It was converted to a two-seater and a 1A-744 was installed in it for testing. In late April the first production 1A-825 (serial No. 1) was installed in it. These planes were retained for some time by Packard for testing engines ranging from the 1A-825 through the 1A-1237. Packard was contracted to do whatever modification was necessary to change engines in these airplanes and to convert 4529 to a two-seat configuration. Packard retained these airplanes until late 1922 and then returned them to the Air Service.

Fokker D-VII No. 8403 on loan to Packard by the Army Air Service for testing 1A-1116 engines in 1920. Packard test pilot Fred Hoover stands by the plane. Author's collection.

The 1A-825 and 1A-1237 Aero Engines

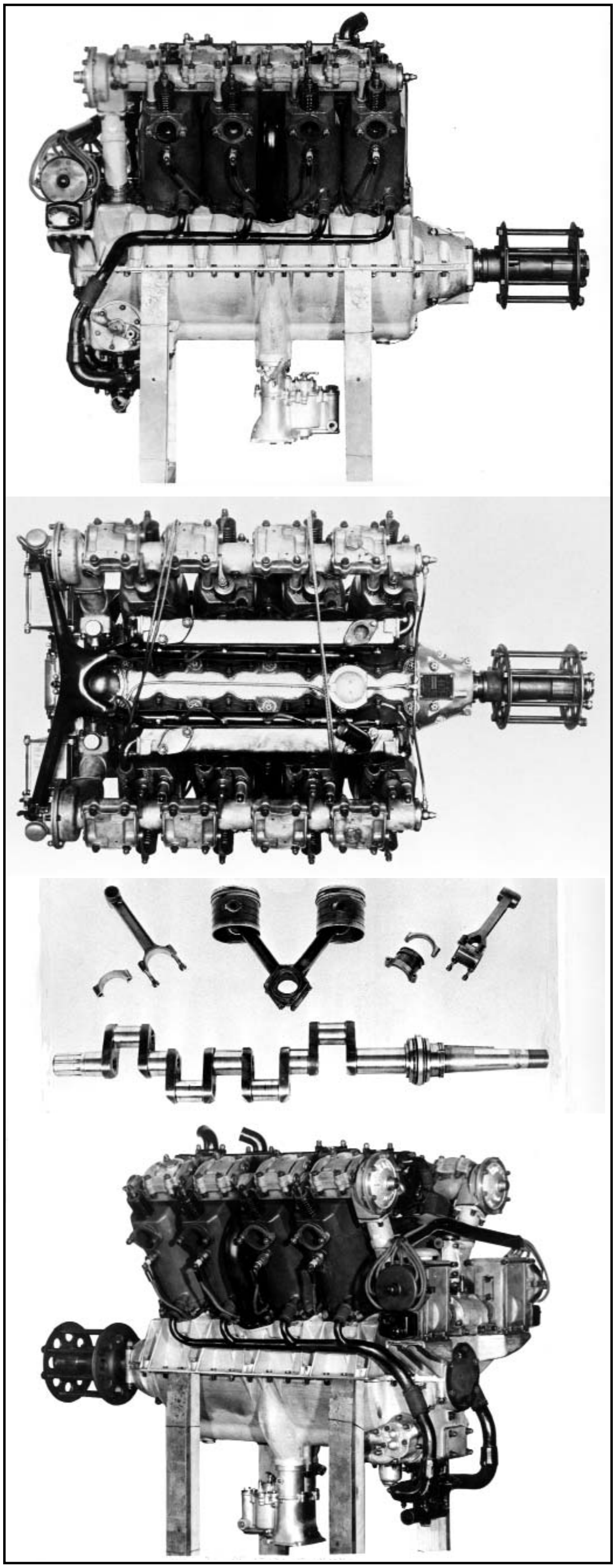
About the time the first mentioned contract was nearing completion, Col. Vincent decided the 1A-744 and 1A-1116 engines could be easily improved upon by increasing the bore from 4 ¾″ to 5″ with the remainder of the design of the two remaining little changed. This would increase the displacements of the two to 825 and 1,237 cu. in. respectively. At the same time the compression ratios would be increased from 5 to 1 to 6.5 to 1, with 5.5 to 1 being an option. The resulting engines would be the models 1A-825 and 1A-1237. The idea was to create "high altitude" engines.



1A-825 serial No. 2. Author's collection.

In order to get a better idea of what the designer was trying to accomplish and what obstacles he was trying to overcome, we must attempt some small amount of explanation. Engineers had long realized that engine efficiency rose significantly as compression ratios were increased. Raising the compression ratio of an engine always caused, at some point along the scale, detonation. A very simplified explanation of the phenomenon of detonation is to say that the usual burning of fuel in the cylinder is replaced by exploding. This raises peak cylinder temperatures and pressures significantly, and if excessive or long term, detonation can

Fokker D-VII No. 4529 loaned to Packard by the Army Air Service for testing. The plane was converted to two-seat configuration by Packard and used for testing 1A-744 and 1A-825 engines. Author's collection.



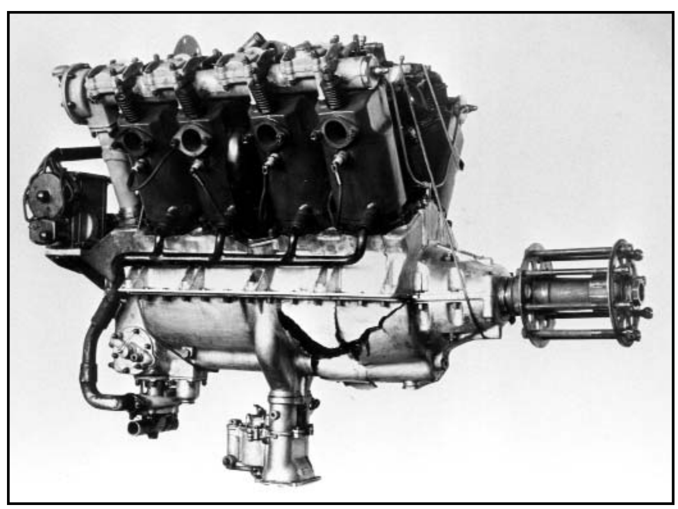
Above: *1A-825 side and top views. with crankshaft and a set of pistons and rods shown below the top view Author's collection.*

cause engine damage or even failure. Detonation can be controlled to some degree by reducing engine throttle, but the most controlling factor at that time was the quality of fuels available. Progress was being made with improving fuels by what was called "doping" the fuel with various additives whose purpose was to reduce detonation. Progress on the improvement of fuels was very slow, however.

One of the penalties of flying airplanes to high altitudes is that a piston engine looses power because of the thinner air. A phenomenon discovered at the time was that the higher you went the higher the compression ratio had to be in order to experience detonation. Thus you could take advantage of the better efficiency of higher compression ratios when the engine was used at high altitude if you were satisfied to keep the engine throttled back at low altitudes.

This was the idea behind this increase in engine size and compression ratio. Use a larger engine with higher compression ratio which will give about the same power as the smaller one it replaced when operated at low altitudes with reduced throttle, but which will give more power at high altitudes (because of both its larger displacement and higher efficiency) where it can be operated with wide open throttle. They called these "over compressed, over dimensioned" engines.

The first engine made up in this configuration was 1A-1116 No. 4, which the Air Service had furnished for testing purposes. This engine was modified by replacing the 4 ¾" pistons and cylinders with 5" size which required boring out the crankcase to receive the larger cylinders. The Delco battery ignition was replaced by two Dixie type 1200 magnetos, and newly designed exhaust heated intake manifold elbows replaced the old type. A new crankshaft with a revised design oil distribution for connecting rod bearings was also



1A-825 serial No. 2 after its crankshaft broke 48 hours and 45 minutes into a 50-hour Air Service endurance test. Note the fractured crankcase and off-angle propeller hub. Author's collection.

installed. Compression ratio was raised to 6.5 to 1 from the 1A-1116 standard of 5 to 1.

This engine was dynamometer tested on December 7 to 9, 1920 with very favorable results. A power curve was run up to 2,300 RPM at which point it produced 392 horsepower and had still not peaked out.

The Air Service liked the idea and ordered 1A-744 No. 8 and 9 delivered in 825 cu. in. size. At the same time they ordered 1A-1116 No. 5 and 6 (also as yet undelivered) finished as 1,237 cu. in. engines.

Since the Air Service had two of the five 1A-744 engines they purchased converted to 1A-825 models, they purchased only two additional 1A-825 engines, No. 1 and 2. Sometime prior to 1925 Packard replaced the 1A-744 No. 1 in the 1919 Packard plane with 1A-825 No. 3. Packard replaced the 1A-744 model with the 1A-825 and continued to advertise this engine on the commercial market until 1924. It is estimated they may have sold an additional nine for a total of twelve.

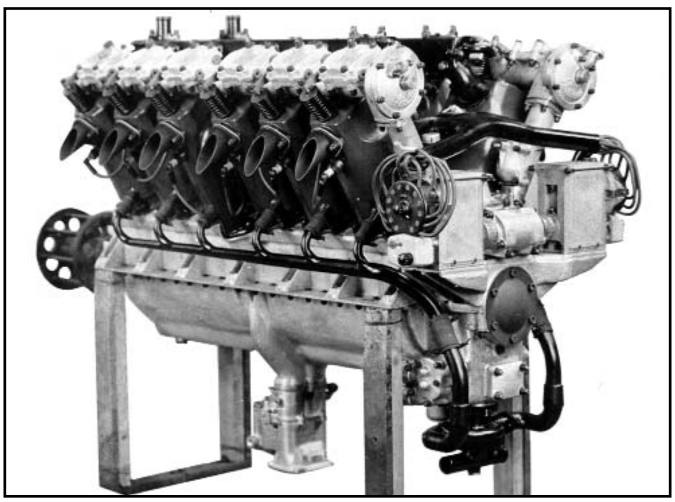
Production of the 1A-1116 was limited to six, all of which were purchased by the Air Service. The model was then replaced by the 1A-1237.

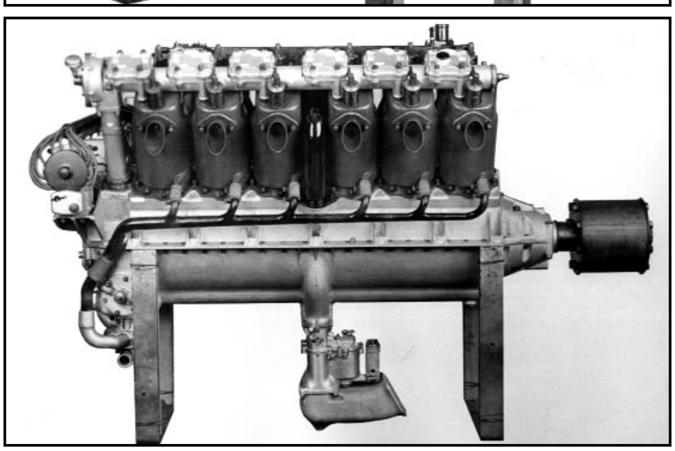
The Army, and eventually the Navy as well, had their real interest in the 1,237 cu. in. size because these would be useful in observation and fighter planes. The 1A-825, because of its power rating, was pretty much limited to use in training planes and they had an ample supply of surplus Hispano-Suiza engines on hand for that purpose .

In addition to Col. Bane and Maj. Hallett mentioned above, a good deal of the correspondence between Packard and the Air Service in connection with these contracts took place with Maj. Reuben H. Fleet, contracting officer for the Air Service from 1919 to 1922. On about June 1, 1920, all these officers were reduced in grade (but not in work position or responsibility) as was Maj. Schroeder. Bane became a Major and Hallett and Fleet became Captains. Schroeder left the service 9/31/20, Fleet on 12/1/22 and Bane on 12/15/22. Hallett also left the service in the early 1920s.

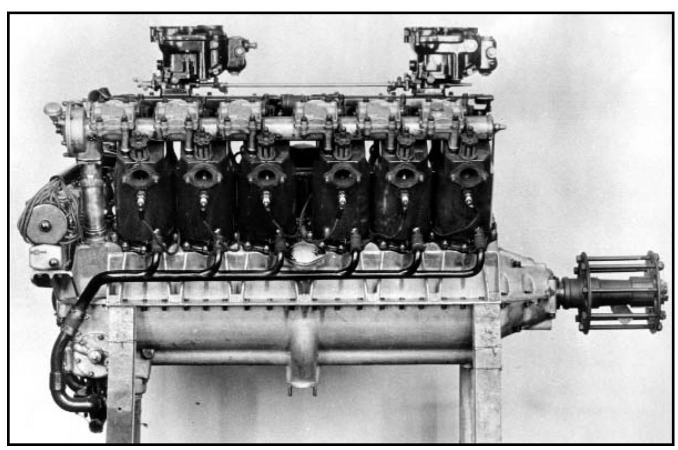
Negotiations for a production contract for 1A-1237 engines started in December of 1920 and a contract for 25 was issued on Jan. 11, 1921. Delivery was completed on Aug. 27, 1921. A contract for an additional 15 engines was signed late in 1921 and delivery completed in early 1922. The Navy also installed this engine in several aircraft and are believed to have ordered about 10. In addition, an estimated 5 were sold to civilian users for a total production of 55 engines.

This engine was fairly close to what we call today a “square” design. The bore was 5 inches and the stroke 5 ¼ inches, giving a displacement of 1,237.005 cubic inches. It was a 60º V-12 with single overhead cams on each bank driving two valves per cylinder. Dual ignition was provided by a pair of Dixie magnetos mounted at the center rear of the engine for easy access. A single duplex Packard Zenith carburetor was mounted below the engine in the same manner as their other postwar designs. The engine weighed 735 pounds dry and was rated at 300 horsepower @ 1600 RPM.





Above: 1A-1237 left and right side views. Author’s collection.



1A-1237 serial No. 35 modified to use two Stromberg NA-L5 carburetors. Notice lack of the usual bottom-mounted carburetor, missing right manifold tube between the center cylinders and use of multi-spring valve springs. Author’s collection.

The Army design requirements were that it produce a minimum of 300 horsepower at rated RPM. It actually exceeded those requirements by a considerable margin, producing 316 HP @ 1,600 RPM and 400 HP @ 2,300 RPM. Compression ratio was 6 ½ for high altitude use and 5 ½ for low altitude.

Of the original contract for 25 engines, No. 1 engine completed its tests on March 30, 1921, and was shortly thereafter installed in one of Packard's Fokker test planes. No. 2 engine completed its tests the following day and was boxed and shipped to McCook Field on April 2 to begin its 50-hour test run, which it completed successfully on April 14. Col. Vincent OK'd the engine to go into production on April 18, 1921.

The de Havilland DH-4C

In May of 1921 the Air Service furnished Packard with a de Havilland DH-4B airplane with which to test 1A-1237 engines. The plane was modified by Packard to accommodate the engine and to provide dual cockpits. When the wing position was shifted to accommodate the balance change, Packard installed new upper wing-to-fuselage struts designed and manufactured by themselves. This change, combined with the new cowling and radiator shell, which were also of their design, resulted in a plane which resembled their own 1919 airplane. They then painted the tail with the same "Packard Airplane" markings used on their plane. The designation of the plane was changed to DH-4C. The painting of their logo on the tail would seem to indicate Packard ownership rather than loan. The loaned Fokkers retained their military markings while in Packard use and this airplane carried no Air Service number. The Air Service had an abundance of these airplanes as World War I surplus and most likely would have sold one to Packard had they requested it.

Colonel Vincent noted in his June 1, 1921, diary entry "During afternoon went out to Aviation Field with Captain Woolson and Captain Rickenbacker. Tested out DH4C." On June 15 we find: "Inspected new Fokker plane equipped with 1237 and passed it for delivery to the Field. This is the best workout that we have so far constructed.—Went out to Field about 3:30 and gave Mrs. Lewis and Barton an airplane ride. Mr. Hoover (Packard test pilot) flew the DH-4C and obtained a speed of better than 115 miles per hour." This Fokker would appear to be the fourth one loaned to Packard for testing.

Packard's de Havilland DH-4C. Note the characteristic "Packard" upper wing-to-fuselage struts. The plane had a 1A-1237 engine installed and the tail marked "Packard Airplane" in the same manner as they marked their 1919 airplane. Courtesy NAHC collection.

The 2A-1237 Aero Engine

The last significant design activity on this engine involved a new carburetion system. As one might suspect, although the bottom mounted carburetors of the early post WW I aero engines did have some advantages, good unrestricted manifolding was not one of them. Packard supplied some engines to the Navy as well as the Air Service, and in connection with a development program being undertaken by Packard to improve the 1A-1237 engine and upgrade it to what was to become the 2A-1237, the Navy Bureau of Aeronautics contracted Packard to build an engine with dual carburetors mounted in the vee to replace the original design.

The object was to increase rated power to 350 horsepower @ 1,800 RPM with a 5.5:1 compression ratio and improve reliability. 1A-1237 No. 35 was modified to use two Stromberg NA-L5 duplex carburetors on a new intake manifold. New improved connecting rod bearings, Silchrome steel valves, marine engine-type multiple valve springs and a heavier design crankcase were installed.

Tests were conducted between December 28, 1922 and January 3, 1923, and showed that an improvement of about 7.5% was obtained throughout the power range. A 50-hour endurance run was made starting on March 15, 1923. In the results of the 50-hour test Packard made the following statement: "Although the Model 1A-1237 engine, as modified for the purposes of this test, gave an excellent account of itself, it is believed that any additional engines of this type to be constructed should be constructed in accordance with the specifications for the Model 2A-1237 engine as submitted to the Bureau of Aeronautics on November 16, 1922. These specifications did not differ materially from those of the engine tested except in relation to the crankshaft design. It was contemplated increasing the diameter of the crankshaft main journals from 2 3/8" to 3" and the diameter of the crankpins from 2 1/8" to 2 ½"."

The 2A-1237 engine was never put in production but the soon-to-follow 1A-1300 was similar in many respects, having the 2 ½" and 3" bearing sizes mentioned above and dual carburetors mounted in the vee. It also had the same 5 ¼" stroke as the 1237 engines but increased the bore 1/8" to 5 1/8". The major improvement was in the new four valve design of the 1A-1300.

Delivery of the initial order of 25 was nearing completion when on December 12, 1921, Col. Vincent made the following diary entry:

"Went to McCook early and agreed on details of contract for fifteen additional 1237 engines. Saw Captains Fleet and Hallett, also Major Bane, and others. Went from McCook Field to General Motors Laboratories and had a good chat with Mr. Kettering. Drove his new 6-cylinder air-cooled car. Lunch with Mr. Kettering at Laboratories. Left at 1:30 via General Motors Airplane for Indianapolis. After landing in Speedway, went direct to Nordyke & Marmon plant where I met Mr. Howard Marmon & Mr. Moskovics. Attended S.A.E. meeting during evening. Spent night with Mr. Moskovics at his home."

This was a typical day for Colonel Vincent. The Colonel was a very active man and accomplished a great deal in a short period of time. He was President of the Society of Automotive Engineers in 1920, an honor bestowed only upon the most respected in the field and a most unusual honor for one whose formal education ended with grammar school.

Col. Vincent enjoyed flying and often took one of the Air Service Fokkers or company planes on a pleasure-oriented test trip. On March 23, 1921, for example he noted:

"Flew the two-seater Fokker to McCook Field during the afternoon. Left at one o'clock, made trip in two hours and averaged ten miles to the gallon of gasoline. Dinner with Mr. and Mrs. Kettering at their home."

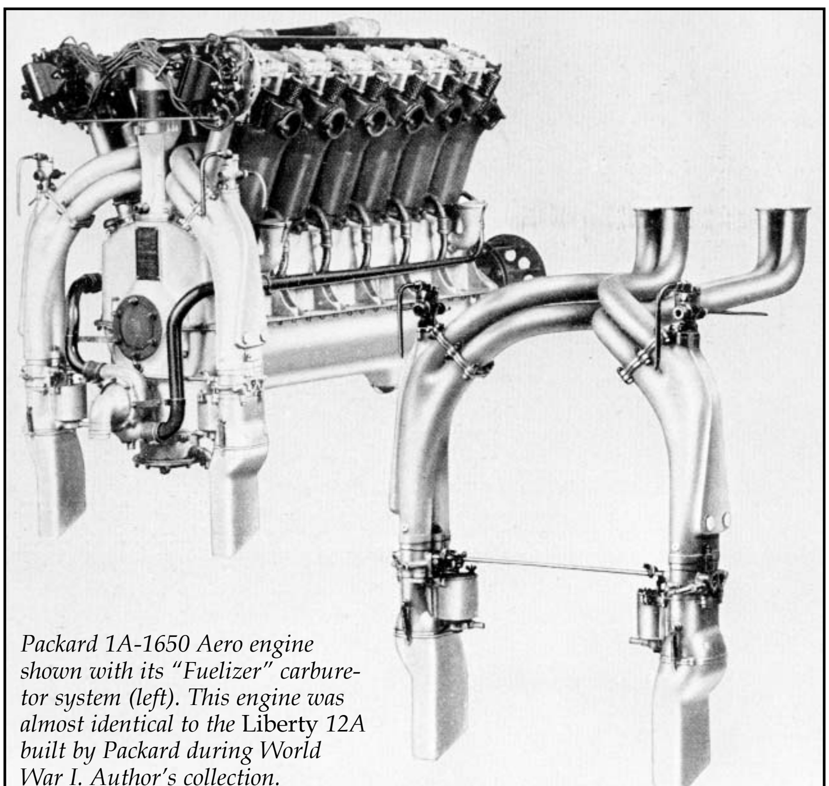
The Packard Model 1A-1650

As one might expect, Packard put on the postwar aero engine market in late 1919 a slightly redesigned *Liberty* twelve. This new commercial *Liberty* became Packard's model 1A-1650. An advertisement of October 1919 noted "For the first time Packard offers this noteworthy engine on a commercial basis." "Only a few of the first-run of these motors remain unsold. Telegraph orders advised."

Displacement was 1,649.5 cubic inches with a bore and stroke of 5 x 7 inches. Rated horsepower was 420 @ 1,750 RPM, and weight was 860 pounds. Mechanically it was almost a duplicate of the *Liberty* and was most likely made up by using parts remaining from military contracts. Some, if not most, of these parts came from Nordyke and Marmon Co. of Indianapolis whose military order for 3,000 L-12A engines had been reduced to 1,000 at the end of the war. In the minutes of the Packard board of May 5, 1919 is found the following entry:

"Management was authorized to purchase from Nordyke and Marmon Co. of Indianapolis, for $100,000.00, their stock of finished and semi-finished *Liberty* engine parts, together with jigs, fixtures and gauges necessary to complete the semi-finished stock, this material to be used by the Engineering Department in the construction of special motors."

Considering the pending surplus status of the *Liberty* engine, it is not likely another production run was ever made although the engine continued to be listed as available until 1922. Estimated production is 70 to 90 engines.



Packard 1A-1650 Aero engine shown with its "Fuelizer" carburetor system (left). This engine was almost identical to the Liberty 12A *built by Packard during World War I. Author's collection.*

The Packard Fuelizer

A novel invention never available on any other aero engine was offered on the 1A-1650, the Packard "Fuelizer." This was a preheating device for the fuel mixture which was invented by Capt. Woolson. It was covered by patent 1,550,136 issued on August 18, 1925. Application for it was filed on December 23, 1920. Packard used a version of this "Fuelizer" in their automobiles with success, notably in the 3-35 Twin Sixes and later in their Single Six cars.

Essentially this device took advantage of the pressure difference on either side of the carburetor throttle to shunt some of the mixture into a heating chamber and igniting it with a separate spark plug. The resulting hot gases were routed back into the intake manifold along with the unshunted mixture, and thus heated it. The more open the throttle the lower the pressure differential and thus less shunting and less preheating took place.

The Fuelizer feature did not become available until about January 1920. Price of the engine was $4,500 without Fuelizer, and $4,800 with Fuelizer.

It is doubtful that many Fuelizers were produced and sold. The Air Service purchased one and installed it on a *Liberty* engine and mounted the engine in DH-4 "P-135." This combination was tested between June 7 and July 1, 1920. Results of those tests were not particularly good and in many cases the engine operated better without the device than with it. Air Service engineers came to the conclusion that much of the trouble was caused by the cooling effect on the intake mixture as it traveled up the long pipes between the Fuelizer and the intake manifold. Their opinion was that the theory was good and if it worked as designed they would like it very much. However, their conclusions as stated in their test report Volume II No. 134 dated November 20, 1920, was: "It is concluded that in its present form the Packard Fuelizer applied to the *Liberty* engines is unsatisfactory for service use."

This engine equipped with Fuelizer was also tested on Packard LePere 42148 but nothing further came of the design so far as aircraft were concerned.

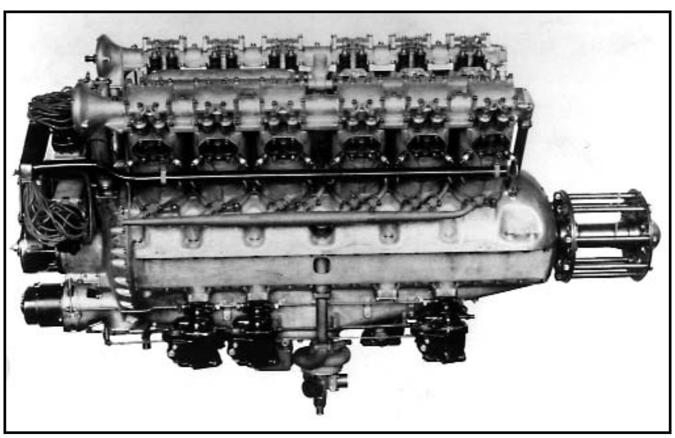
The Engineering Division "W" Engines

The Air Service was interested in even larger engines and designed their own "W" configuration engine having three rows of six cylinders with a bore of 5 ½" and a stroke of 6 ½" producing a total calculated displacement of 2,779.8 cubic inches. Because the engine used articulated rods on the two outside banks of cylinders, the stroke of those cylinders was slightly increased and the actual resulting displacement was 2,832 cu. in.

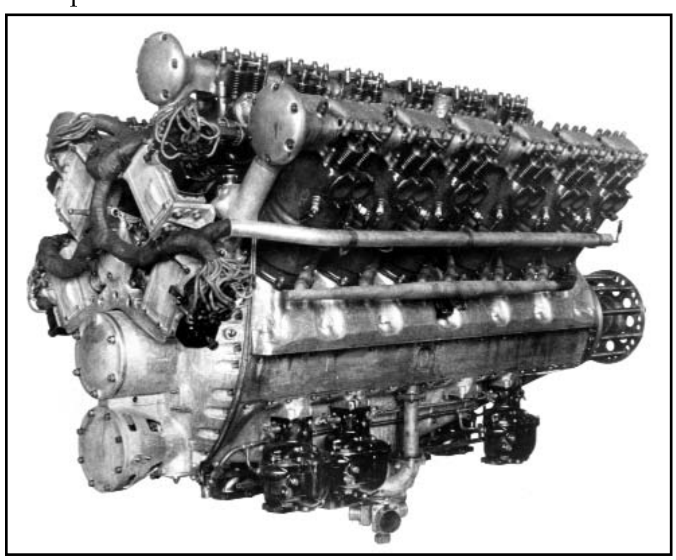
Six single-barrel Stromberg updraft carburetors were mounted below the lower crankcase with passages carrying the fuel mixture from each running up through the crankcase to a manifold which fed three cylinders. A four-valve-per-cylinder design similar to that of the 1A-2025 was used. Both battery and magneto ignition systems were used to drive the four plugs per cylinder during various testing phases. Rated horsepower was 700 @ 1,700 RPM, and weight was 1,720 pounds. It would produce a maximum of 800 horsepower at 1,900 RPM. The engine was designed after the 1A-2025 and was similar in many respects. Designated by the Air Service as the W-1, manufacture of its parts were contracted to Packard and the engine assembled at McCook Field. This engine was first tested in April of 1921. At least three other W-1's were built and tested to finalize the engine design. Following these tests, patterns and drawings were updated to reflect all proposed changes, and then Packard was contracted to produce 10 model W-1-A engines.

By early 1923 the first production W-1-A had been received from Packard and passed acceptance tests. After testing this engine further the Air Service made other changes and incorporated them in the last five engines of the contract which were then designated W-1-B models. Thus production was four W-1's, five W-1-A's and five W-1-B's.

A W-2 engine of similar design was proposed by the Air Service. Parts to assemble two were contracted with Packard and had been received by early 1923. Although no further information on this engine has so far come to light, it is assumed they were assembled but no more were contracted as more up-to-date designs were shortly forthcoming from a number of outside engine manufacturers. This engine had a bore of 6 ½" and a stroke of 7 ½" giving a total displacement for its 18 cylinders of 4,479.66 cu. in. (discounting its slightly increased displacement caused by the use of articulated rods on the outside banks). Output was to be 1,000 horsepower.



Packard-built Engineering Division W-1A. Author's collection.



Packard-built Engineering Division W-1B. Author's collection.

The Air Service did not have facilities to manufacture an engine thus the contracting of Packard to build it. Packard stated several times in later years that they had built a "W" type engine, along with many other types. These statements pointed out their ability to produce almost any kind of engine one might desire. Although Packard without doubt designed its own "W" type engine, there is no evidence they built any but the ones for the Engineering Division.

The following statement in Packard's 1928 booklet *Packard Master Motor Builders* led the author on a two-year search before he finally uncovered the "W" engine referred to.

"Packard has no prejudices about motors. With its experience, Packard is not tied down to any one type of motor. For the small racing boat, with its slim lines, it builds a six-cylinder in-line motor. Because of the requirements for airplanes, it builds a 12-cylinder V-type motor, an 18-cylinder W-type, or a 24-cylinder X-motor. A great steel fighting tank for the U. S. Army presents still other limitations and needs, and here Packard installs a V-type eight-cylinder motor."

"Packard's application of a motor to an individual task is born of exact knowledge that could be gained only through widest creative versatility and more than a generation of experience. It has built practically every known type of internal combustion motor, and, of these, it has originated many."

In the October 20, 1922, entry of his diary Col. Vincent noted that he had a conference with Capt. Woolson and Mr. Brodie in regard to the possibility of reducing the weight of the 1A-2025 to 1100 pounds and increasing its output to 700 horsepower. He also "talked to Major Bane (at McCook Field) about this matter and the possibility of our building some two-seater observation pursuit machines around this engine." No records have been uncovered to indicate such an engine nor the observation pursuit planes were ever built. The discussion with Major Bane was probably what started the Air Service's interest in the design that resulted in the 1A-2200. One can also see from this entry that Packard still had some interest in building airplanes if the opportunity arose.

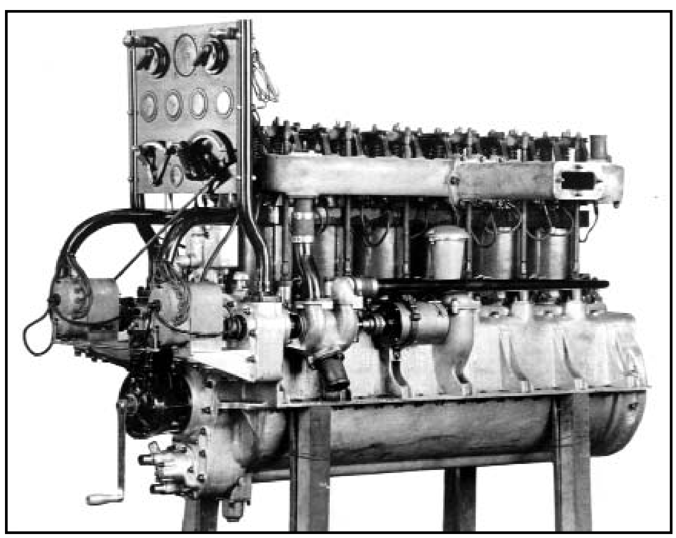
The 1A-744, 1A-1116 and the 1A-2025 were Packard designs which the Engineering Division underwrote the development cost of by purchasing almost all production. Because of this development expense, early engines were much more costly than later ones. For example, the first 1A-744 engines cost $14,658 each, the 1A-1116 was $18,625 and the 1A-2025 was $20,538. The next batch of orders produced prices of $10,700 for the 1A-744 and 1A-825 and $14,000 for the 1A-1116. (I have no information on later 1A-2025 engines but they certainly went down in price.) The last 1A-1116 engines cost $12,000 each. The first production run of 25 1A-1237 engines were priced at $8,986 each, a considerable drop from the initial price for its predecessor, the 1A-1116 of $18,625. This certainly shows that the Army was interested in new engine design, even though the *Liberty* continued to be their "workhorse" engine for a number of years. And, speaking of the *Liberty*, it is interesting to recall in connection with the above prices that Packard offered the 1A-1650 at $4,500 each, about half the price of the more modern 1A-1237. By about 1924 a new still-in-the-crate *Liberty* 12 could be obtained surplus for about $1,500.

The 1A-1551 Aero Engine

Early in 1921 the Navy contracted with Packard to design and build an airship engine which was to be used in their proposed ZR-1 rigid lighter-than-air craft which would eventually be know as the *Shenandoah*. This was to be a high reliability engine producing about 300 horsepower and being highly fuel efficient so as to reduce the amount of fuel required to be carried on long flights. It was intended that the aircraft be flown over the North Pole, although it was never actually attempted. Design progress was rapid and the first engine was completed on April 14, 1921. The principal designer was Col. Vincent and applications for patents on features new with this engine began to be filed on September 28, 1921, and ended on November 19, 1923.

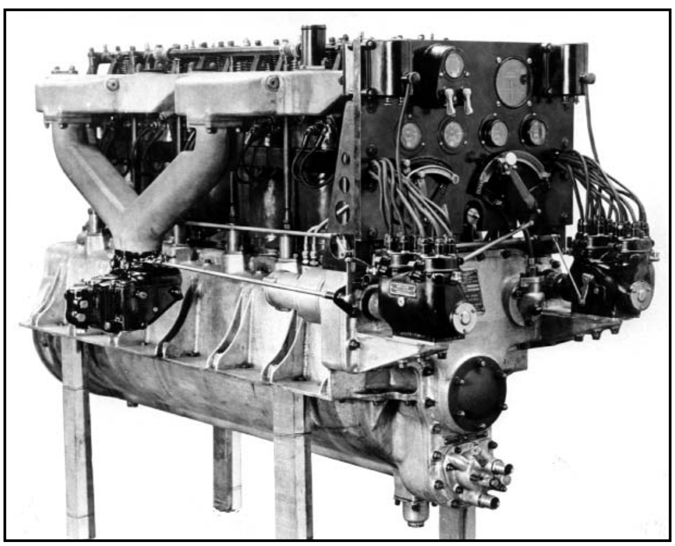
This in-line six-cylinder engine had a bore of 6 5/8" and a stroke of 7" resulting in a displacement of 1,551.24 cubic inches. Designation was 1A-1551.

The first engine was close to completion on March 14, 1921, when the Purdys of the Purdy Boat Co. of Trenton, Michigan, came by to look it over. It seems that close friend and fellow boating enthusiasts Carl G. Fisher had heard of Vincent's new engine and was



1A-1551 in early configuration with magneto ignition, early design exhaust manifold, control panel and hand/electric starter. Author's collection interested in the possibility of using a marine version of it in his boat, *Miss Miami*, which was currently being rebuilt by the Purdy Boat Co. Carl Fisher had homes in Port Washington, Long Island, and Miami, and had been a partner with James A. Allison in starting the Indianapolis Speedway Team Co. (which eventually became the Allison Engineering Company in Indianapolis and had done some design and manufacture work on reduction gears for *Liberty* engines during WW I and similar work for Packard) and building the Indianapolis Motor Speedway. Allison Engineering Co. was also building the reduction gear-clutch assembly for the 1A-1551.

The first engine was completed on April 15, 1921. It was a six-cylinder, over-head valve design with four valves per cylinder. A separate cam was provided on each side of the engine to drive vertical pushrods activating intake valves on one side and exhaust valves on the other by rocker arms, one pair per pushrod. The individual cylinders were built up of steel cylinders with welded on water jackets in the same manner as Packard's current aero engines. Intake and exhaust valves were the same size and the cylinder assemblies were reversible in respect to intake and exhaust side. Individual cylinder assemblies could be easily removed for repair or replacement. (This feat was proven when two Packard mechanics replaced a piston in one cylinder of a test engine. The elapsed time between engine shutdown and restart with repairs made was one and one-half hours.) They were held to the crankcase by four crabs, which in turn were held by four cap screws which screwed onto the heads on the main bearing bolts. The crankshaft was supported by seven main bearings held between the center-split aluminum crankcase by main bearing bolts which went through the bottom and top halves, and were used as hold-down bolts for the cylinder crabs.

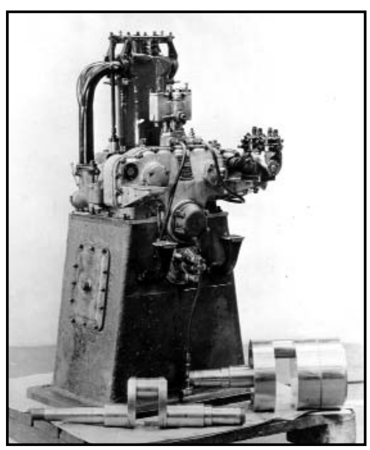


1A-1551 in final configuration with Delco ignition. Author's collection.

The engine was designed to be easily made up as either left or right hand rotation, depending upon which side of the aircraft they were to be mounted. The engine was supplied with double dual ignition, four coils and four plugs per cylinder and was their only production aero engine to be so designed. The first engine had magneto ignition, but that system was soon replaced with Delco battery type. Rated horsepower was 300 @ 1,400 RPM and maximum was 350 @ 1,400 RPM if a heavier pitch prop were used. Dry weight was 1,100 pounds with instrument board and hand starter.

Use of hand starters on engines for lighter-than-air craft was the accepted practice of the day because of the considerable added weight required to provide a large battery and starter. When the engine was large, as in this case, it was impossible to turn the engine fast enough in cold weather to draw in a fuel mixture through regular carburetion adequate for starting. This problem was circumvented by use of an acetylene primer invented by Capt. Woolson. Patent 1,659,621 covering this device was applied for on November 19, 1923. It was claimed in the patent that an adequate starter for this engine would weigh at least 50 pounds and the battery to drive it 75 pounds, thus adding 125 pounds to the weight of each engine and resulting in a total extra weight of 750 pounds for the six engines which drove the aircraft.

Two designs of hand cranks were used. In the first type the handle was provided at the control end of the engine and parallel to the crankshaft. (This type was also used on the 1M-1551.) The second design had right angle gearing and the handle could be placed on either side of the engine, depending on whether it was a right or left rotation engine. Both were geared 10 to 1. It is interesting to note that the photograph always used by Packard to illustrate this engine in their advertisements and brochure has no hand crank mounted on it.



1A-258 single-cylinder test engine used for 1A-1551 design work. Author's collection.

Another interesting device used on this engine was an automatic shut-down system also designed by Capt. Woolson and covered by patent 1,627,761 applied for on August 16, 1922. The system was required for engine safety because there was not always an engineer in attendance at each engine to manually reduce the throttle setting in case of emergency. This control would reduce throttle to idle any time the engine oil pressure dropped to 25 pounds or less. Such an event could be caused by burning out a bearing, breaking an oil line or running out of oil. An over-speed sensor was also provided which would cut off the oil supply to the pressure sensor if engine speed exceeded 1,500 RPM. This prevented engine runaway in case of a lost propeller, slipping clutch, or similar malfunction.

The first engine started its 50-hour test on May 19, 1921, and completed it shortly thereafter. All remaining tests were completed by June 22. Navy inspector Lt. Noville approved the engine and notified the Bureau of Engineering requesting shipping instructions.

This first engine was the prototype and development work to iron out minor problems continued for some time after its completion. To that end, Col. Vincent had requested the Navy allow them to build a single-cylinder test engine in December of 1921. Permission was granted and one was built in 1922. Packard called it the 1A-258 even though the identification plate placed on it was a 1A-1551 plate.

After receipt of the prototype 1A-1551 engine the Navy began a 300 hour test designed to prove the two principal requirements they had placed on the design: high reliability and fuel economy. The test was completed on August 3, 1922. Results were excellent with a new world record for fuel economy of 0.45 pounds of fuel used per horsepower hour. The test was made up of a series of runs ranging from 8 to 40 hours in length at rated horsepower (300 @ 1,400 RPM). The engine was torn down at 100 hours to check for wear, reassembled and run for another 200 hours. At the completion of the test Navy inspectors said the engine was in excellent condition and could have successfully completed the same test again without fear of breakdown. Packard made full use of these reports in their advertising for some time to come.

History of the *Shenandoah*

The ZR-1 airship was still under construction in the Navy's new hanger at Lakehurst, New Jersey, and would not be completed until August of 1923. Inflation was begun on August 13 and it was first airborne on August 20. The first flight was made on September 4, 1923. The ship was 680 feet long, 78.8 feet in diameter, weighed 124,500 pounds loaded, and carried 2,300,000 cubic feet of helium gas. Top speed was in excess of 75 MPH. Six engines propelled the craft, two on each side, one in the center rear mounted in suspended cars, and one in the rear of the control car which was under the forward quarter in the center of the ship. Propellers of the front and rear center cars and the rear pair of side cars were 16 feet in diameter and gear driven. The front pair of side car propellers were 12 feet in diameter and direct driven. All could be disengaged by clutches.

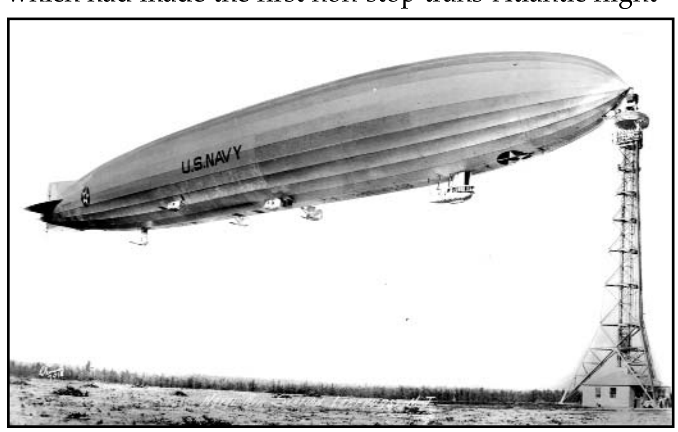
As part of the testing sequence, each engine was installed in its respective power car and that car suspended inside one of the large navy seaplane hangers at the Philadelphia Navy Yard. In front of the power car was mounted a Liberty engine with its propeller directing its air blast over the radiator and forward end of the power car thus presenting the equivalent conditions of the car traveling forward at 40 MPH. The 1A-1551 was then started and both engines operated continuously for 24 hours. In this manner both the engines and complete power car were subjected to a 24-hour test.

The many hundreds of hours of running accumulated by the boats *Miss Packard* and *Miss Miami*, powered by marine versions of this same engine, were considered by the navy as further testing to prove the design of the type.

After completion of the prototype engine, Packard was contracted to produce 12 production engines - six for use and six for spares. All were delivered by mid 1923. The price of the engines was $16,000 each. The reduction-reverse gears and disengaging clutch assemblies were supplied by Allison Engineering of Indianapolis, Indiana and cost another $19,000 each ($3,000 more than the engine).

Although Packard listed this engine as available for some time after 1923, it is believed that no others were built. Total production was therefore one prototype and 12 production engines. Of these at least four survive, one in the Smithsonian, one in Seattle, Washington at the Museum of Flight, one in Chicago, Illinois at the Museum of Science and Industry and one in the New England Air Museum at Windsor Locks, Connecticut.

Construction of the U.S.S. *Shenandoah* (ZR-1) began in 1921 and took about two years to complete. Selected as her captain would eventually be Lt. Comdr. Zachary Lansdowne, a 1909 graduate of the Naval Academy and an officer destined for great accomplishments. Lansdowne had been on board the British airship R-34 which had made the first non-stop trans-Atlantic flight



Shenandoah *moored at her mast at the Lakehurst, New Jersey Naval Air Station. Author's collection.*

from East Fortune, Scotland to Mineola, L.I., New York in July of 1919. He thus became the first American to fly non-stop across the Atlantic.

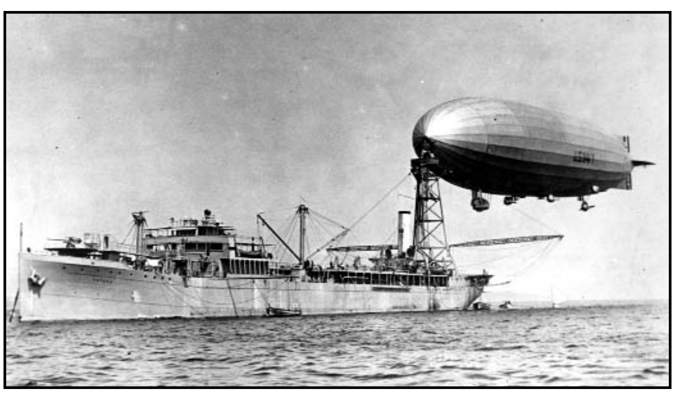
He later was Commanding Officer of the Naval Air Station at Akron, Ohio, and commanded the Naval airship C-7 in December of 1921 during the first airship flights ever made using helium as a lifting medium.

The *Shenandoah* was assembled in the new specially built hanger at the Lakehurst Naval Air Station in New Jersey. The base commander, Captain Frank McCrary, was her first captain and it was he who took her out on her initial flight on Sep-tember 4, 1923. Within the next twenty days the ship was flown over New York, Philadelphia and Washington, D.C.

Her first major cross-country flight was to the International Pulitzer Air Races at St. Louis, a 1,718-mile round-trip which began on October 2, 1923, with Capt. McCrary commanding. Upon arriving at the races the ZR-1 was the prime attraction of the show. Orville Wright was there and Lt. Al Williams (who would in later years pilot a Packard-powered racer to an unofficial world speed record) set a speed record of 243 miles per hour in the Curtiss R2C-1 biplane.

After returning to Lakehurst her official commissioning was scheduled to take place on October 10, 1923. Mrs. Edwin Denby, wife of the Secretary of the Navy, christened her *Shenandoah*, an Indian name meaning "Daughter of the Stars."

In November of 1923 President Calvin Coolidge signed a bill authorizing the Navy's proposal of an exploration flight by the *Shenandoah* over the North Pole. Shortly thereafter Lt. Comdr. Lansdowne was chosen to be her Captain. Although her scheduled flight was not to occur for some time, Lansdowne was put in immediate command and reported to Lakehurst on February 16, 1924. His first job was to oversee the extensive repairs necessitated by her being torn loose from her mooring mast during a bad wind storm on January 16. It was the repercussions of that disaster which caused an earlier-than-planned change of command.



Shenandoah *moored to her "sea mast" on the U.S.S* Potaka. *Courtesy of the Naval Historical Foundation.*

After repairs were affected, the ship was taken on a shakedown cruise to Albany and Buffalo.

One of the prime requirements of a flight to the North Pole would be the ability to refuel at sea, and to that end the Navy converted the fuel tanker U.S.S. *Patoka* to a special lighter-than-air refueler. The ship was equipped with a mooring mast of the same design as the one at Lakehurst. On August 8, 1924, with long-awaited good weather conditions off Newport, Rhode Island, the first test of the new sea mooring system was made. The *Patoka* served the Navy in this capacity for the *Shenandoah* and other lighter-than-air ships for another dozen years.

The next major flight for the *Shenandoah* was to be a transcontinental tour of some 8,100 miles, 1,000 miles further than she had traveled in total up to this time. Prior to leaving on this trip the engine located in the rear of the control car was removed. This saved weight, reduced noise in the control car and allowed the addition of a large radio installation in its place, the tradeoff being a small loss in top speed. The remaining five engines now had some 700 hours of running time and were replaced with new engines from the spare stock in preparation for the long trip. The normal rebuild time would be 1,000 hours and that point would be reached while on the trip.

On October 4, 1924, she left Lakehurst and headed southwest down the east coast on a trip which would carry her across Virginia, North Carolina and South Carolina. She then turned more westward and proceeded across the top of Georgia, Alabama, Mississippi and Louisiana and on to Fort Worth where she stopped at a special mooring mast set up at a helium plant there. Here she took on helium, fuel, oil, water and supplies. From there she proceeded on the next leg across the remainder of Texas to El Paso, then across southern New Mexico and Arizona and on to San Diego, where a mooring mast had also been constructed.

After a brief stay to affect repairs required by a bad landing caused by inexperienced ground handlers, the *Shenandoah* proceeded up the Pacific coast headed for Camp Lewis (now Fort Lewis) just outside Tacoma, Washington. She arrived there without mishap on Saturday October 17. There she refueled and took on supplies at the new mooring mast recently built for her trip.

Departing at noon the next day the ship circled over Seattle, proceeded across Puget Sound to the Bremerton Navy yard and headed back down the coast toward San Diego once more.

LT. Comdr. Lansdowne docked the *Shenandoah* once again at the San Diego mast at 11:40 A.M. on Tuesday October 21, 1924. She left the next day heading east across Arizona, New Mexico and north Texas. On the return trip the Captain swung her more to the north and flew across Arkansas, the tips of Missouri and Illinois and on across Indiana to Dayton, Ohio, in order to fly over the Army air field there. From there she went almost due east to her home base at Lakehurst on October 25, 1924.

After returning from this flight she was brought into the huge hanger and put "in dry dock" for an eight-month period of overhaul. This was a normal routine for such a craft—she had finished the record trip across the continent in good shape.

In June of 1925 President Coolidge officially called off the proposed North Pole trip, much to the chagrin of Lansdowne and all other Navy personnel who had hoped and planned for so long.

She made her first flight after overhaul in June of 1925, a cruise to New York City. Shortly thereafter she was flown to Bar Harbor, Maine, to be shown off to the attendees of the Governors' Conference there on July 4th.

A late summer "publicity" trip was scheduled to the Midwest for the ship to overfly as many county fairs as possible. Originally her sister ship, the *Los Angeles*, had been chosen to make the trip but orders were changed and the *Shenandoah* took her place.

Weather had always been found to be the most serious problem an airship was likely to encounter, even including the enemy in time of war. The first large-scale use of rigid airships was by Germany during World War I. 61 were in use by the German Navy, only 10 of which remained at Armistice. Of the 51 losses, 40% were due to weather and 28% were destroyed by the Allies.

Thunderstorms are particularly bad because of the rapid vertical air currents often encountered. These currents can raise or lower the altitude of an airship far faster than its ability to counteract the change by valving gas or dropping ballast. Too much altitude can burst gas cells and too little results in a crash landing. In addition to either of these dangers is added the terrific structural stress on the ship. Such a whipping motion as can be imparted upon a ship 680 feet long and weighing 124,000 pounds can break it apart.

Lansdowne was well aware of these facts, of course, and the scheduling of the trip worried him because of the frequent thunderstorms occurring in the area at that time of year. He requested the schedule be delayed until well into September in order to reduce that danger as much as possible. The final schedule was a compromise and the ship was to leave Lakehurst on Wednesday, September 2, 1925, which she did at 2:52 P.M.

She headed west and passed over Philadelphia at 4:18 P.M. and then continued her flight passing over Wheeling, West Virginia at 1:50 A.M. making 36 knots (41 MPH) air-speed with her five engines turning 1,000 RPM. Thunderstorms had now been reported to the north but it did not appear that they would come south far enough to give any trouble.

An hour west of Wheeling the ship ran into strong headwinds and made little progress for some time while a thunderstorm came south and crossed her stern, giving the crew uneasy feelings as they were unable to put more distance between themselves and the storm.

More thunderstorms to the north forced the Captain to take the ship further south while strong southwesterly winds tried to drive them into the storms. They crossed the time zone between Cambridge and Bayesville, Ohio, at about 4:00 A.M. EST, 3:00 A.M. CST. Headwinds were so strong that the ship was blown north while traveling south at an air-speed in excess of 40 MPH, thus passing Cambridge twice.

At 4:25 A.M. the ship hit a rapid updraft and began to climb at the rate of a meter a second from an altitude of 1,800 feet. The Captain ordered full speed and down rudder. In seven minutes, with the nose at a down angle of 18º, the ship climbed to 3,500 feet. It then leveled and descended to about 3,000 feet before again climbing at an even faster rate until it reached an altitude of 6,000 feet.

The ship then descended rapidly to 3,000 feet and broke into two pieces, about 220 feet behind the bow. The rear section fell rapidly and immediately broke into two parts. The control car broke away and fell free to the ground, killing all aboard. The forward section floated fairly slowly to the ground twelve miles away near Sharon, Ohio. The time - about 4:50 A.M. CST September 3, 1925. The location was three miles from Caldwell, Ohio.

Of the total of 42 people on board, 14 perished, among them Lt. Comdr. Lansdowne. As would be expected, there was a Board of Inquiry to determine the cause of the crash. The determination was that the severe and rapid movement of the ship caused by the air currents of the thunderstorm was more than the ship's structure could withstand.

Although only thirteen 1A-1551 *Shenandoah* engines were built, Packard used them for publicity purposes for a number of years. After the crash of the *Shenandoah*, their reference to the engines would often include the statement: "The last sentence in the log of the ill-fated *Shenandoah* said, 'All engines operating perfectly.'"

The first series of Packard's post WW I aero engine designs covered a span of a little less than five years. These designs were intended primarily for the armed services and were purchased almost entirely by them. As a refresher for the reader, I will list all the models and give their production figures as best as I can determine them at this time. Some are exact figures and some approximations believed to be quite accurate.

Model	Production Years	Number Produced
1A-744	1919-21	9
1A-1116	1919-21	6
1A-825	1921-23	12 *
1A-1237	1921-23	55 *
1A-2025	1920-23	11
1A-1551	1921-23	13
1A-1650	1919-22	80 **
	Total	186

*Approximate figures considered accurate within 10%.
**Approximate figure-estimate is between 70 and 90.

This amounts to a total of 106 engines of postwar design and 80 *Liberty* types. It is the best I have been able to come up with in the way of production figures as virtually no Packard records of production of these early engines survive. The only reason I can come up with what I believe to be very accurate figures is the fact that almost all the new design engines of this period were purchased under military contracts and I have been fortunate enough to find records of most of these contracts. In addition to this I have a verification of sorts in a statement made in a 1924 paper written by Col. Vincent about the reasons behind the design of the 1500 and 2500 engines which followed them. He said Packard produced "about 100 engines" of new postwar designs prior to introducing the 1500/2500 series. This certainly indicates 106 is reasonably accurate.

Thus ends the era of Packard's first commercial production and sales of aero engines, 1919 – 1923. These engines were, for the most part, based on the design of the World War I *Liberty* with various changes and improvements. Perhaps the feature we may find most controversial was the use of a carburetor mounted extremely low on the engine with the fuel/air mixture having to travel up those long and restrictive intake manifolds. In spite of the fact that the *Liberty* used what we may consider a more conventional system, as we now know it, many aero engines of that period used variations of the low carburetor design. Such designs included the Curtiss OX-5, V-2 and V-3, the Lorraine-Dietrich 220 H.P. V-8 and its companion type 12E V-12 as well as most other of this company's engines up to 1920, the Rolls-Royce *Condor*, the Sturtevant 5A-4 ½ and all of the Engineering Division "W" engines. And these only represent the extremes. Most water-cooled aero engines of the 1914 to 1924 period had their carburetors mounted close to the center-line of the crankcase.

Packard continued in the airplane engine business for another ten years and became a significant American builder. To Packard, the sale of aircraft engines was a small part of their overall business. The automobile was their prime product and the coming of the depression severely reduced sales of both automobiles and aircraft engines. Packard decided to concentrate on automobiles and left the aircraft engine business in 1934. They reentered it in 1940 when they contracted to build the Rolls-Royce *Merlin* under license for both British and U. S. use during World War II.

Robert J. Neal excerpts the above article from the book *Master Motor Builders*. The book tells the complete story of the design and production of all of Packard's non-automotive engines, aero, marine and industrial. Packard built its first aero engine in 1915 and continued as an active designer and builder until 1934. They reentered the market in 1940 and built Rolls-Royce *Merlins* during WW II. Following the war they designed and built a small number of experimental jet engines for the Air Force and then built the GE J-47 under license. This book is the only one ever published that documents these engines and is available for $65.00 plus $5.00 shipping from Aero-Marine History Publishing Co., P. O. Box 5582, Kent, WA 98064. Phone 253-631-2912.

Robert J. Neal also published a sequel to this book titled *Packards At Speed* which documents the uses of all of the non-automotive engines of Packard in performances of all types, from racing to record setting to just plain unusual feats. This book is also available from the above publisher at the same $65.00 plus $5.00 shipping.

Currently Neal is working on *The History of the Liberty Aircraft Engine* of World War I fame. This will be an in depth history of the inception, design, production and uses of this famous and long-lived engine. The uses to which this engine was put are indeed amazing and its active military use spans a period of years from 1917 to 1945. It was built in the United States, England and Russia and used militarily in aircraft, tanks and boats. It saw civilian use in even more areas. Watch for it between late 2002 and mid 2003.