Packard as an Aero Engine Builder

Packard Gas Turbines

by Robert J. Neal

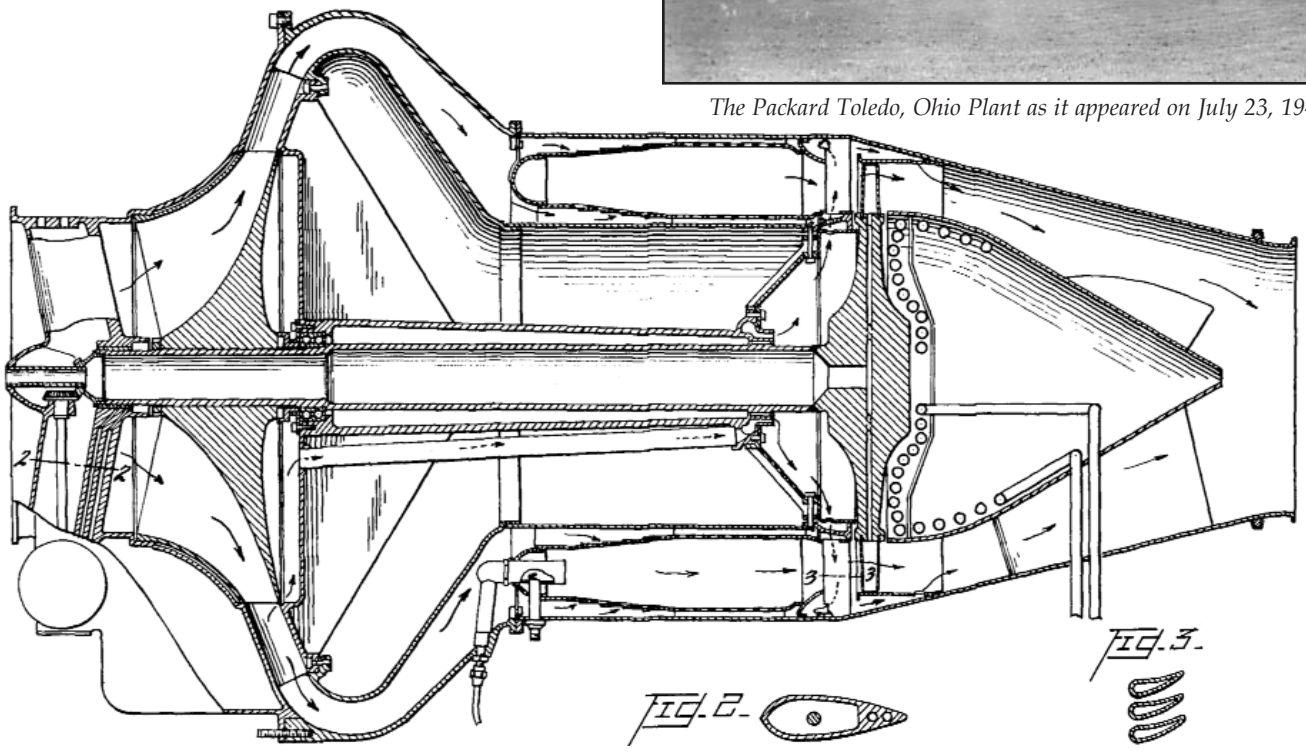
Earlier articles of this series, "Packard as an Aero Engine Builder 1919 - 1923", "Spark Ignition Engines: 1923-1939", "The Packard Diesel" and "The Packard Merlin" appeared in Vol. 1 No. 4 (Winter, 2002), Vol. 7, No. 3 (Summer, 2008), Vol. 7, No. 4 (Fall 2008) of *Torque Meter*, and on the AEHS web site. These articles are excerpted from *Master Motor Builders*, by Robert J. Neal. Unless otherwise noted, all illustrations are from the author's collection.

In the summer of 1943 Packard leased from the government the former plant of Aviation Corporation on the outskirts of Toledo, Ohio. Here they manufactured parts for the Merlin engine and referred to it as the Toledo Division. About a year later the Army Air Force Material Command contracted with Packard to carry out "advanced aircraft engine development" on both the Merlin and gas-turbine engines. The announcement for the latter was carried in a Packard news release dated July 12, 1944, titled "Packard Advanced Engine Division Formed" although the project had actually been initiated in April.

Gas-turbine work was in its early stages then and was, of course, highly classified. Packard's announcement stated: "Developmental activities will not necessarily be confined to the Rolls-Royce engine on which Packard has extensively collaborated with British and Army engineers in important design improvements."

In July of 1944 Packard had hired Robert M. Williams, formally an advanced design engineer at Allison Engineering, as chief design engineer at the Toledo facility. In January of 1945, Williams got a phone call from the head of the Power Plant Lab at Wright Field asking that he come to the field to discuss a project they wanted Packard to help them with. He did so and found they wanted Packard to help solve a heating problem with the tail cone assembly of the I-40 jet engine General Electric was working on. (The I-40 became the J33 and was taken over as a production engine by Allison.) They asked how fast he could set up a test stand for the engine and the reply was to have it shipped over to the plant and the stand would be ready when it got there. That was on a Monday. By Thursday a new stand with instrumentation was ready for an engine, but it was two days later before it arrived.

The Packard Toledo, Ohio Plant as it appeared on July 23, 1947.



Drawing derived from a patent covering the XJ41 design.
U.S. Patent 2,625,794 was applied for on February 25, 1946 and was issued to Robert M. Williams and Curtis N. Lawter on January 20, 1953.

When discussing the project in 1990, Williams said he thought the reason Packard was asked, since they had no prior jet design experience, was because they had always been so responsive to any engineering requests made of them in the past.

The solution did not turn out to be too difficult to arrive at and thus response was again rapid.

The Packard XJ41 and XJ49 Jet Engines

In early 1945 Williams was called back to Wright Field to see General Carroll, then chief of the Power Plant Lab. They wanted Packard to take on a research project to develop an expendable jet engine of 2,000 pounds thrust to weigh no more than 1,000 pounds. The engine was to be used to propel a missile. The requirements were shortly changed to 4,000 pounds thrust.

Packard took on the project under U.S.A.F. contract W33-038-ac-1850. Although potential production of the final product did not appear as a particularly lucrative endeavor, in light of its potentially limited use, Packard felt they wanted to be involved in this new aircraft engine of the future. Again it was Colonel Vincent who was the driving force in Packard taking on this new field. He was, of course, looking at the possibilities beyond this first engine.

Design work began on the engine in May of 1945. It was to eventually be assigned the military jet designation of J41 but since it never became a production engine it always carried the experimental number XJ41.

After studying available information on existing turbo-jet engines it was decided to take a long-range viewpoint of the problem and to design an engine which, when developed, would represent a marked advance over turbo-jet engines of conventional design, and present a good possibility of utilizing the knowledge gained in the design and production of future engines.

Low manufacturing cost was of prime consideration. Minimum use of strategic materials was also of great importance with emphasis on the necessity of designing a light-weight unit.

A mixed flow compressor was selected for its light weight, high efficiency and high pressure ratio. An annular combustion chamber was chosen for its light weight, low manufacturing cost and greater overall efficiencies. Hollow turbine blades, both rotor and stator, were used to allow the minimum use of high temperature alloying materials. The engine was completed and operating on a test stand on January 8, 1946.

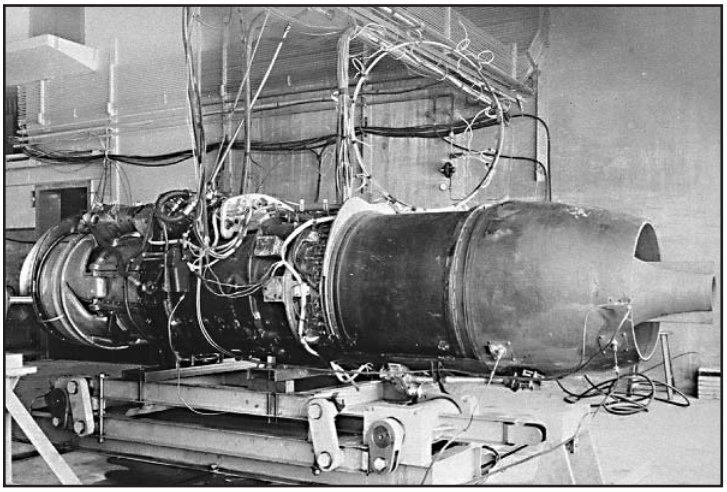
Perhaps the most outstanding design characteristic of the engine was the use of air inlet velocity relative to the impeller blades of Mach number one. This proved to allow the final engine to produce more thrust per pound of weight than designs using lower velocity inlet air. The XJ41 weighed 1,100 pounds and produced 4,000 pounds of thrust, whereas the GE J33 weighed 1,820 pounds and was rated at the same thrust.

By the end of 1946 the Toledo facility had been considerably upgraded with the installation of equipment for the fabrication and testing of turbo-jets and was valued at $10,000,000. In addition Packard had available for flight testing use shop and hanger facilities at Willow Run, Michigan valued at $1,000,000. By spring of 1947 $3,500,000 in additional laboratory and testing equipment was installed.

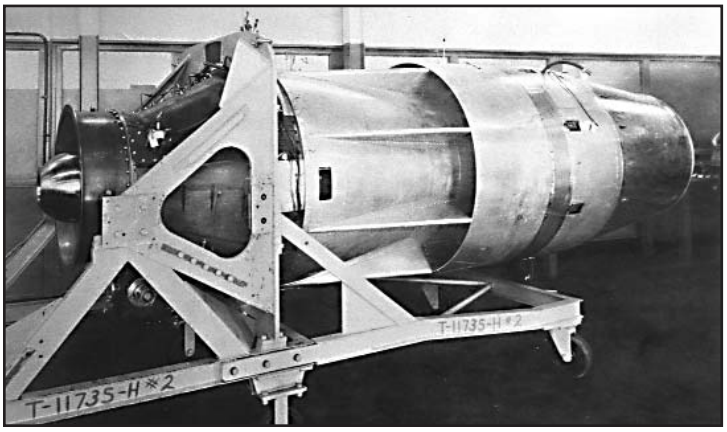
Development continued on this engine for another three years and two versions were built. Packard assigned their own model numbers of PT-103 and PT-104 to what were given military designations of XJ41-V-1 and XJ41-V-3. In February of 1947, a design study was also done on a version suitable for high acceleration (catapulted take-off) and assigned model number PT-106. It is not thought that any of this model were built but, by July of 1947, at least four of the combined PT-103 and PT-104 models had been built and production was scheduled to number seven. Serials were assigned beginning at V-500001.

Between September of 1947 and July of 1948 a XJ41 was flight-tested several times in a North American B-25J bomber.

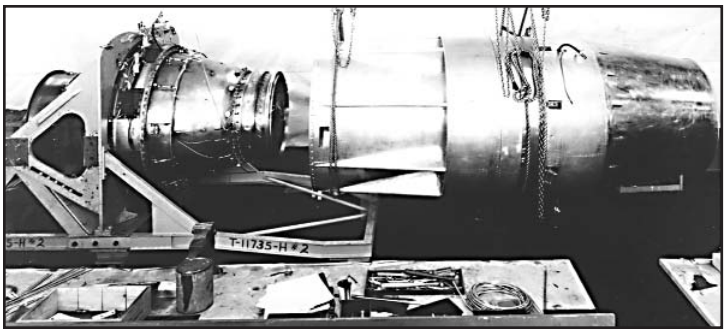
In October of 1946 Williams and one of the engineers working under him, Dr. George F. Wislicenus, got together and discussed ways of improving the propulsive efficiency of the turbojet engine. They came up with an idea which they called the "ducted fan," a design which was to eventually be called the turbo-fan. The design was presented to the appropriate person at the Air Force Power Lab at Wright Field (now commanded by Colonel Paul Nay), and in December resulted in an additional development request in their original contract.



Packard XJ41 on a Test Stand in the Toledo Plant



Packard XJ49 "Ducted Fan" Engine



Packard XJ49 is shown with the "ducted fan" section separated from the main engine section.

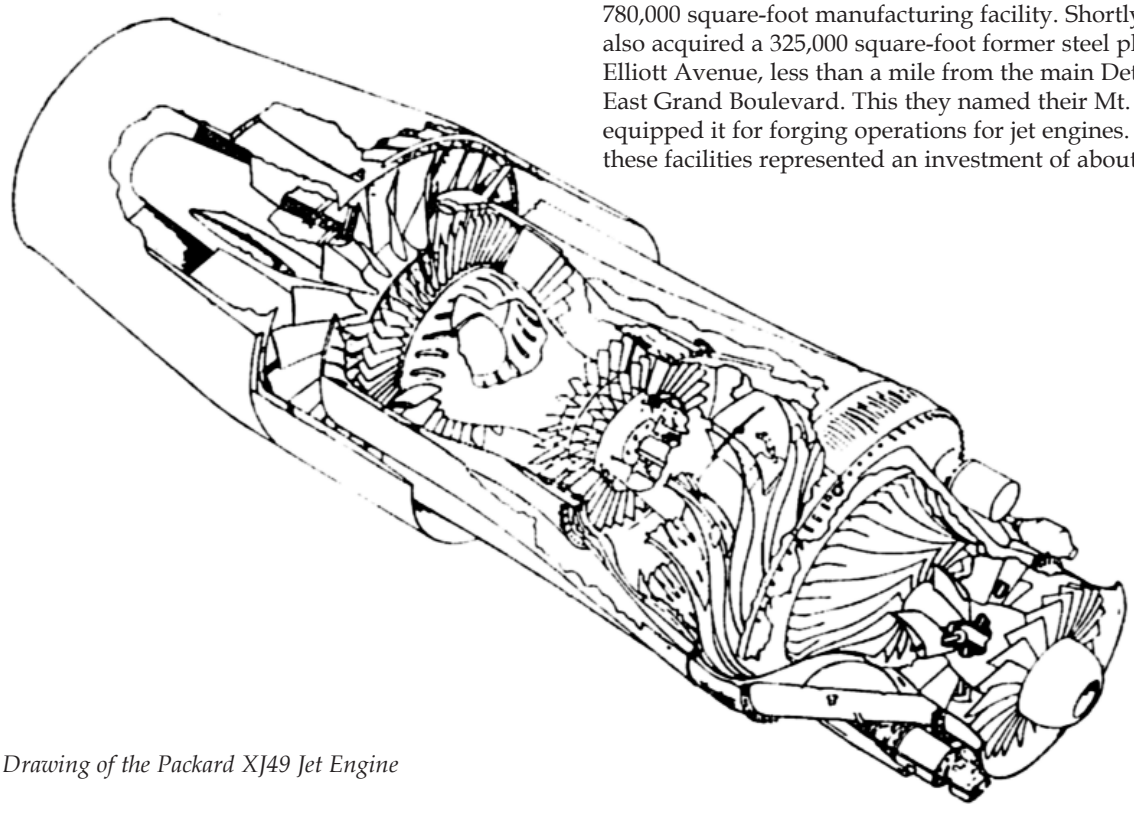
The resulting engine was the XJ49-V-1, the basic design of which is described as follows. This engine has a two-stage compressor made up of an axial-flow supersonic compressor followed by a mixed flow compressor to give an over-all compression ratio of 6:1. The compressors are driven by a two-stage turbine which gets its power from an annular combustion chamber. The discharge from the first turbine drives another two-stage turbine. The blades of the last stage of the second turbine are extended to form a supersonic fan to provide air for additional thrust and further combustion. Supplementary burning or reheat takes place between the two turbines and tailpipe burning can also be used.

This was Packard's model PT-205. In an unusually short period between basic design theory on paper and a completed engine ready to make its first test run on a stand, Packard ran the first (and only) XJ49 in November of 1948. Take-off thrust was 12,000 pounds, military rated thrust was 11,000 pounds, normal thrust was 10,000 pounds and cruising thrust at 35,000 ft was 2,560 pounds. At this time the XJ49 was the most powerful jet engine in operation.

As the end of 1948 approached, military budgets became more austere and the prospects of continued research and development money became dim. Williams had been informed by officials at Wright Field that the budget situation was getting so bad that they were not going to be able to continue to sustain as many engine builders, and Packard was likely to be among those to be dropped.

The prediction turned out to be true and on January 28, 1949, Packard was informed its development contract would be terminated. Packard immediately proceeded to shut down the Toledo facility and turn it over to the Air Force. The plant and most of the equipment (including some of the most modern available at the time) belonged to the government. Final research reports were written and filed with the Air Force in March of 1949.

The single XJ49 engine was turned over to the National Air Museum (now NASM) by the Air Force Museum on September 16, 1959, and is now in storage at their Silver Hills, Maryland facility.



Cutaway Drawing of the Packard XJ49 Jet Engine

The closing of the Toledo operation was followed closely by the closing of Packard's Aircraft Engine Division. Most of the engineering staff had been hired for that project and therefore they left the company. Dr. Arthur Nutt left Packard on April 1, 1949. He operated his own sales and engineering firm for two years and then and went to work for Lycoming as Chief Engineer of Piston Engine Production and Development and Director of Engineering in 1951. He retired on December 1, 1959 and turned 65 on February 6, 1960. He spent his summers at his home in Falmouth, Massachusetts, and winters at his home in Deerfield Beach, Florida. He passed away on April 22, 1983.

Packard Production of J47 Jet Engines

Packard had been out of the aircraft engine business but a little more than a year when they approached the Air Force in early 1950 with the idea of producing J47 turbojet engines. They felt they had the required experience and Air Force looked like it would have a requirement for additional production, and Packard needed the additional defense work. A feasibility study contract (GTL-7799) was awarded on June 5, 1950, just 20 days before North Korea invaded South Korea.

The United States immediately became the principal supplier of United Nations military forces involved in what became known as the Korean War. Air Force requirements for J47 engines were substantially increased and Packard was awarded contract AF-33 (038)20783 on February 9, 1951, for the production of 3,000 General Electric J47-PM-25 engines. The original contract price totaled $180,000,000. Although Packard would have to provide the building facilities in which production would take place, the Air Force paid $48,414,343 under contract AF-33(038)20783 for the machinery and equipment needed. On June 24, 1952, the production contract was amended to increase the quantity to 6,000, and the total contract price to $393,711,025.

Packard purchased 55 1/2 acres of land adjacent to the company's Utica proving grounds and construction started on a new 780,000 square-foot manufacturing facility. Shortly thereafter they also acquired a 325,000 square-foot former steel plant at 8500 Mt. Elliott Avenue, less than a mile from the main Detroit plant on East Grand Boulevard. This they named their Mt. Elliott plant and equipped it for forging operations for jet engines. Acquisition of these facilities represented an investment of about $15,000,000.

These engines were quite complex (8,854 parts in each as compared to the Merlin's 14,000 plus and the 4M-2500's 10,000 plus) and it took more than a year to get manufacturing facilities in place. The first engines were completed in July of 1952.

The initial contract called for a production rate of 500 per month. By the time Amendment Number 13 had been issued in March of 1952, the rate had been reduced to 300 per month. In January of 1953 it was further reduced to 250 per month. The total contract amount had remained the same (6,000) but the completion date had moved from December of 1953, with good prospects of further contracts, to March of 1955, and prospects dim.

All of this occurred before initial production began in the summer of 1952. July output was 5 engines, August 10, September 50, October 80, and November and December 120 each. Monthly output was 200 in January of 1953 and had reached the monthly plan of 250 by February.

In the mean time the Korean War had produced a year of intensive combat and two years of negotiations intermixed with relatively minor conflicts. On July 27, 1953, a permanent cease fire was signed. This series of events brought with it a drastic reduction in military requirements. By February of 1953 the Air Force had informed the three builders of the J47, General Electric, Studebaker and Packard, that overall production would have to be cut by 20%. The assignment of the reduction was somewhat disproportionate and Packard objected, but to no avail. Studebaker and Packard production was cut by 40% in March, only two months after reaching full scheduled production.

This resulted in a monthly production of about 150 engines which continued until October, at which time production was reduced to a pilot line of 25 per month. This rate was continued until the contract was terminated in June of 1955. A total of 1,275 engines were produced in 1952, 2,066 in 1953, 550 in 1954 and another 134 until the contract was terminated. Total production by Packard was thus 3,025 engines of an original contract for 6,000 with no prospects for further orders. Small contracts to furnish J47 and J57 parts and overhaul J47 engines were filled in 1955 and 1956, and that was the end of Packard's involvement in the jet engine business—one they had high hopes for and one which had provided much needed revenue at a time their automotive business was not doing well at all.

The new Utica plant was converted for use to manufacture their new V-8 engine, automatic transmissions and rear axle assemblies.

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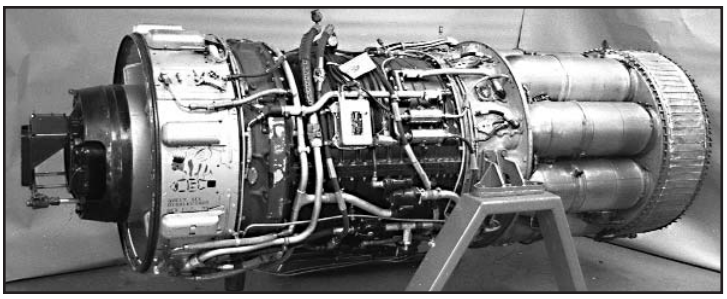
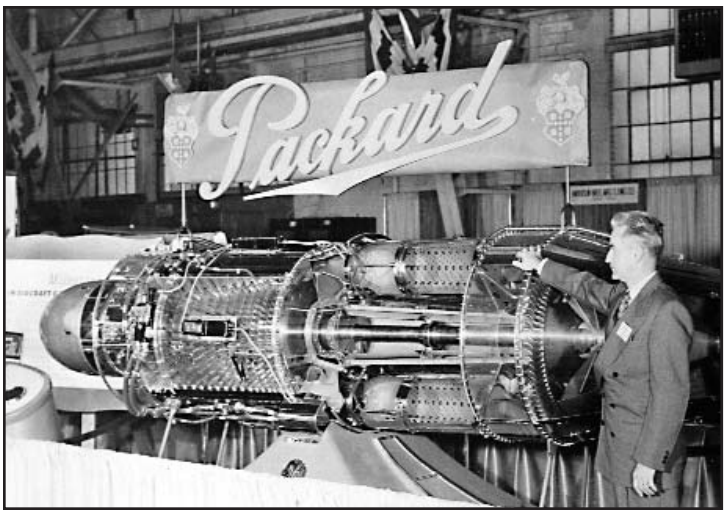
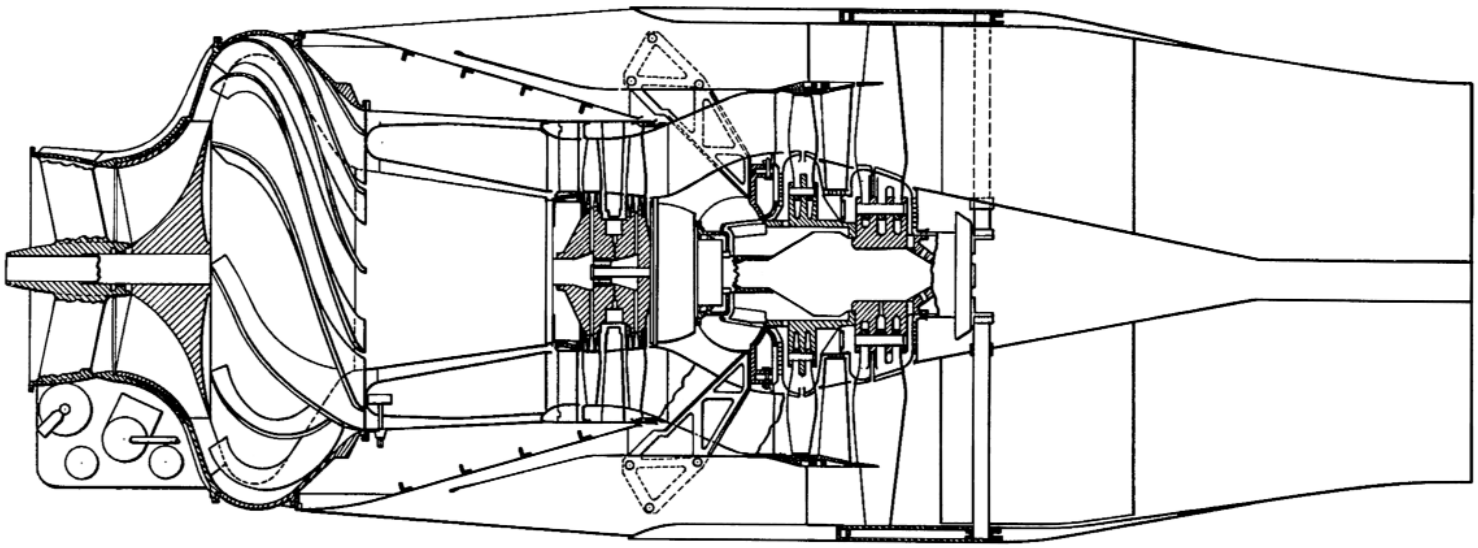


Packard-built J47. This engine is in the collection of Edward Mark (Courtesy of Edward Mark).



Packard motorized display showing a J47 with the outside housing made of Plexiglas. The J47 was a product they were proud of and one that produced much needed revenue.



Drawing derived from a patent covering the XJ49 design.
U.S. Patent 2,620,624 was applied for on September 27 1946 and was issued to George F. Wislicenus on December 9, 1952.