Menasco Aircraft Engines and Their Air Racing Heritage

Part 1

by Larry M. Rinek

Introduction

Albert (Al) S. Menasco, California native and distinguished aircraft engine designer active in the 1920s and 1930s, produced a series of inverted, inline, four- and six-cylinder, air-cooled engines that achieved great success in many US air races before World War (WW) II. This article explores the technical development of Menasco's relatively light aircraft engines and their air racing success in the hands of "golden age" pilots. Menasco furnished special superchargers, cams, pistons, and other parts to achieve extra speed with available racing fuels. His engines had a reputation for being temperamental screamers[1] (and prone to overheating with improper air flow), but they could survive for a race in the right hands and lasted well in civil use.

The Menasco C4 Pirate was probably Menasco's best-selling engine. (Smithsonian Institution 96-15877)

Because a member of my own family (C. Norvin Rinek) was in the aircraft engine business from 1909 to 1911, I approached this subject with special interest.[2,3,4,5] The Menasco aircraft engine story is also of personal interest to me because I was employed briefly in Menasco's plant in Burbank, California (1968, Manufacturing Engineering), where the last of the company's aeropropulsion work was done (1940-1947).

Long-term readers of *Skyways* may remember Kenn Rust's prior article on Menasco[6]. This article, based on my SAE technical paper concerning Menasco, will provide an in-depth history from an engineering perspective, with additional emphasis on air racing aspects. You will see the culmination of two years of research across the United States.

I found that Menasco made historically significant contributions to the development of aircraft piston engines, along the way earning a legendary reputation for these engines in air racing during the 1930s. Like many other notable American aircraft engine developers (e.g., the Wright Brothers, Glenn Curtiss, Balzer), Menasco had neither advanced training nor college-level engineering education on which to base his accomplishments with engines. Instead, he leveraged his exceptional skills as a mechanic and technician to design his outstanding engine series. We shall see how Menasco overcame great adversity early in life, developed a youthful taste for speed, entered the aircraft engine business by accident, and then excelled in US air racing.

The Formative Years: Developing Mechanical Skills

Al Menasco was born on March 17, 1897, in Los Angeles, California. During a troubled boyhood, he aspired to be a free spirit and enjoyed resisting authority. He suffered an accidental gunshot wound in the stomach in early childhood.[8,9] After his mother died in 1902, when Al was only five years old, his father sent him to an orphanage for a few years. He was frequently truant from grammar school. After he ran away from home in 1908, at age 11, he spent some time at Juvenile Hall in Los Angeles.

It was not until 1910 that Menasco began to turn toward more constructive pursuits. At the urging of his older brother Milton (who had taken in Al to live with his family in 1909), Menasco attended the Manual Arts High School in Los Angeles (1910-1912). During the same period he caught the aviation "bug" and attended the great local air meets in Dominguez (in 1910, 1911, and 1912), serving as a mechanic and helper for various participants.[10] In 1912 and 1913 he worked as a machinist and motor tester for Los Angeles truck builder F. L. Moore, while he finished his education by taking night courses in machine shop and engines at Polytechnic High School. His lifelong interest in engines was generated and nurtured by these early experiences. He later bought his own auto repair shop, and auto repairing and racing dominated his life through 1915.

Menasco's interest in aviation was intensified when he met stunt pilot Art Smith in San Francisco at the 1915 World's Fair (where Menasco raced cars). Menasco and Smith embarked on an ambitious tour of Asia in 1916-1917. Menasco served as chief mechanic/machinist of the team, but he received a few hours of flight instruction (including solo flight) on the side.

US involvement in WW I, starting in 1917, eventually drew Menasco more strongly into the aviation world. Menasco not only continued to love aircraft engines, but also aspired to become a military pilot.

By the spring of 1918 the Canadian Royal Flying Corps, the US Navy, and the US Army Signal Corps had all rejected him as medically unfit for military flight duty because of a hearing problem (perforated left ear drum).[11] Menasco instead found employment as a civilian aeronautical engineer for the US Army at Langley Field (Hampton, Virginia), where he tested various aircraft engines and instructed troops in their maintenance. By July, 1918, Menasco had gone to work for a government contractor, Wright-Martin in New Brunswick, New Jersey, that was noted for licensed production of Hispano-Suiza aluminum monobloc V-8 aircraft engines. Menasco was first an inspector and later a field representative attached to Curtiss aircraft plants in Buffalo and Mineola (Hazelhurst Field), New York.

Al Menasco's Flight Training in Riverside California, circa Late 1917 (San Diego Aerospace Museum)

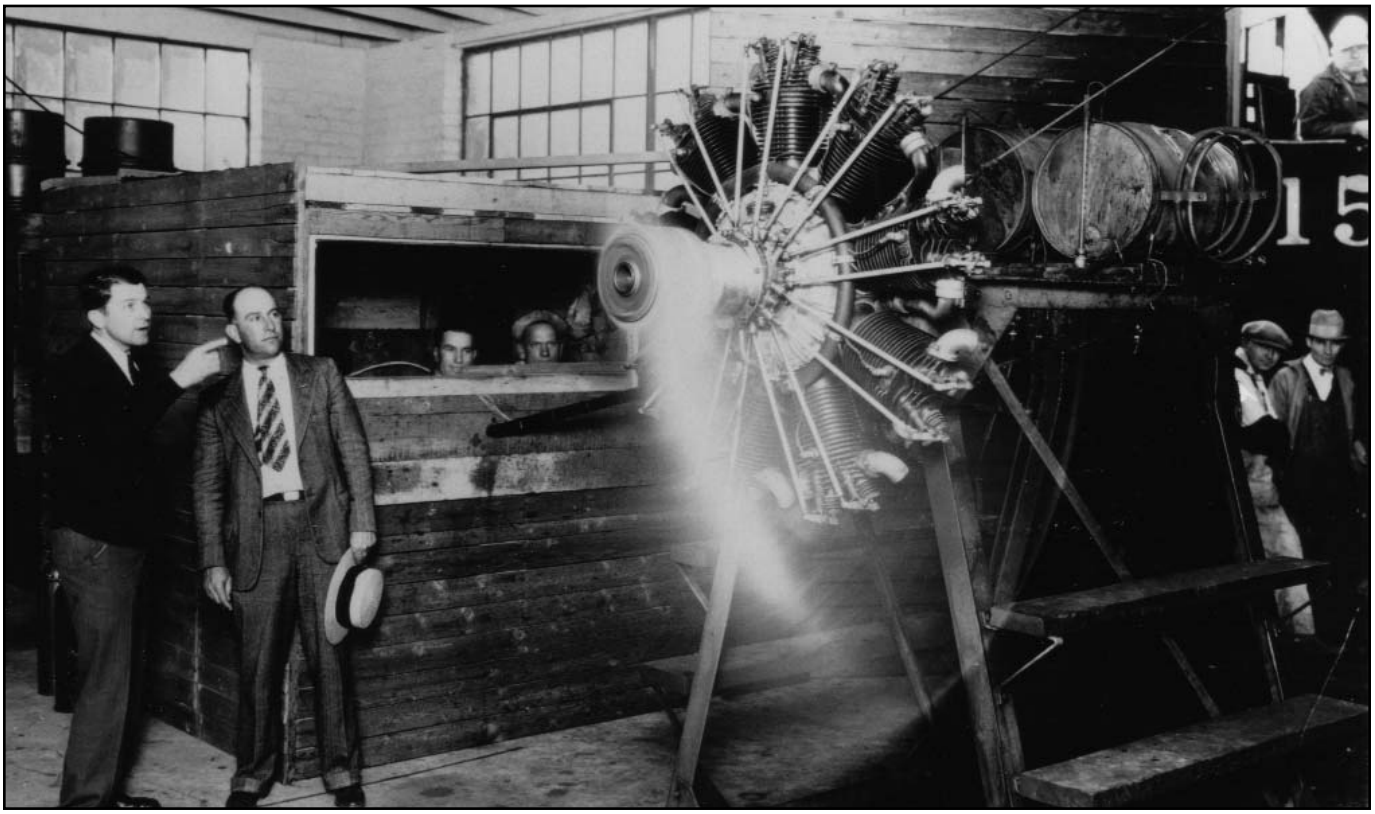
After the end of WW I, Menasco returned to California and drifted through a series of jobs. He was a retail automobile dealer in El Centro, a machinist in Los Angeles, a machine tool salesman, a builder of air compressors, and, finally, chief engineer for the Weber Showcase and Fixture Company (automobile glass grinding machinery).[12] The untimely death of his friend Art Smith in 1926 (in an air mail crash in Ohio caused by bad weather) led Menasco into the aircraft engine business, largely by chance.

Venturing Into Aircraft Engines

Menasco was propelled into the aircraft engine business in 1926 when he agreed to sell the Art Smith estate's principal assets, consisting of a warehouse full of 250 WW I surplus Salmson Z-9 water-cooled 230 hp (172 kW) radial engines made in France. When he was unable to sell them, Menasco decided to apply his engineering skills to upgrade the engines, which he shipped to Los Angeles. Menasco Motors Corporation was formed as a partnership with Karl Weber, and his new shop's first effort was the Menasco-Salmson B2, 9-cylinder, radial engine rated at 250 hp (186 kW) @ 1,500 RPM with a weight of 542 lbs (246 kg).[13]

Menasco's principal changes included conversion to air-cooled cylinders (cast aluminum shrunk and screwed to steel liner), new enclosed valve gear, intake system upgrades, and a new crankshaft. A sizable number were converted (about 50),[14] and these attracted some satisfied aircraft customers. By 1928, however, a new US law (prompted by safety concerns) changed the rules for engine builders. The US Department of Commerce (National Bureau of Standards) was required to conduct full-power durability tests for 50 hours; engines that passed the tests received an approved type certificate (ATC) that was mandatory for sale to civilian customers. Unfortunately, after five attempts the B2 failed to pass the 50-hour test (the fifth lasted about 49.5 hours before crankcase failure), and thus was withdrawn from the market. [15]

Menasco vowed to start over with an engine of his own design that would comfortably exceed test requirements for the ATC. Thus, in 1928-1929, Menasco Motors developed the first of a series of inverted, inline, air-cooled engines, a configuration that was a bit unusual in the United States but became Menasco's hallmark. The inverted engine was more common in Europe, and other US versions were also produced by Allison (an inverted, air-cooled Liberty V-12) and, among others, Fairchild's subsidiary, Ranger (Menasco's only serious US competitor in inverted engines). Ranger produced a much larger number of engine units than Menasco, primarily for Fairchild airframes. Menasco was urged to enter the inverted engine business by industry legend John K. (Jack) Northrop, who needed engines of that type for his new experimental 1929 Avion EX-1, the



Menasco-Salmson B2 on Test Stand (Menasco Aerosystems)

first of many Northrop flying wings. [16,17] The inverted inline engine offered many advantages for pilots and aircraft builders, including:

- Streamlined/low-drag installation
- A high prop centerline (which allowed the swing of a large prop with shorter landing gear)
- Improved visibility for the pilot
- Exhaust fumes directed down and away from the pilot
- A low center of gravity
- Ease of accessibility to the engine.[18]

The first inline Menasco engine, the four-cylinder A4 pirate (326 cu in/5.3 l, 90 hp/67 kW), was certified (ATC 50) in May, 1930. It was the first in a series of seven consecutive successful ATC applications, a record not matched by rival engine producers.

To ensure that it would receive the ATC, Menasco would reportedly not release a design for government testing until it demonstrated 125 percent of rated power for 100 hours at the factory. Such conservative overdesign of the engines served the air racing community well, as later events proved.

The A4 was underpowered and did not achieve commercial success (only five were built); the short-lived A6 derivative was equally unsuccessful (only three were built).[19] Menasco's next effort, the 95 hp (71 kW) B4 Pirate (with the same displacement as the A4), followed in 1930 and included carburetion improvements. The famous Ryan ST open-cockpit light plane was one of the aircraft that used the B4 as standard equipment, but most Ryan customers selected the more powerful (125 hp/93 kW) and larger (363 cu in/5.9 l) C4 Pirate (for Ryan model ST-A), which was probably Menasco's best-selling engine model.

T. Claude Ryan also became Menasco's best engine customer, buying more than 300 (for the ST and various military derivatives, such as the PT-16, PT-20, and STM) between 1934 and 1941.[20] Ryan summed up his early warm feelings for Menasco engines as follows in a letter to Menasco:

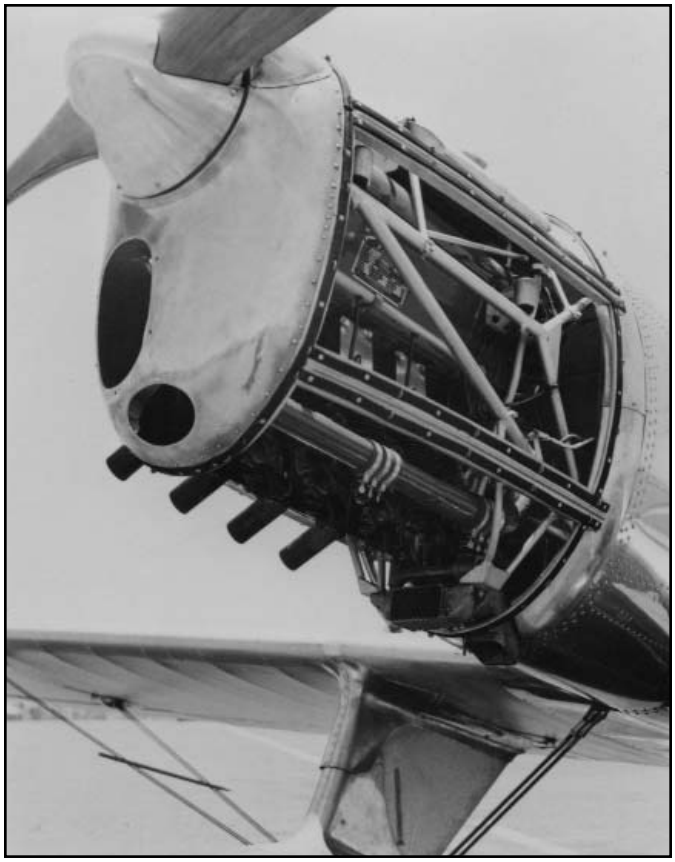
"We are greatly pleased with the excellent experience that we have had in the use of all models of Menasco motors and [attribute] much of the success and enthusiastic response that our new Ryan plane has met since it was introduced to the industry a few months ago, to the use of your motors". [21]

Unfortunately, circumstances years later forced Ryan to switch to competing radial engines (e.g., Kinner, Warner), mainly to improve cooling performance.

By early 1931, Menasco's 489 cu in (8.0 l), 160 hp (119 kW) B6 Buccaneer was approved (ATC 68) for production. A larger model, the 544 cu in (8.9 1) C6, was also in development, but it was dropped after an order was canceled. A major milestone was reached with the introduction in 1931-1932 of three supercharged Menasco engines: the 125 hp (93 kW) C4S, the 200 hp (149 kW) B6S, and the 250 hp (186 kW) C6S. Primarily for racing, these models did not receive civil ATC ratings until later (1934 for C4S and B6S, 1938 for C6S-4).

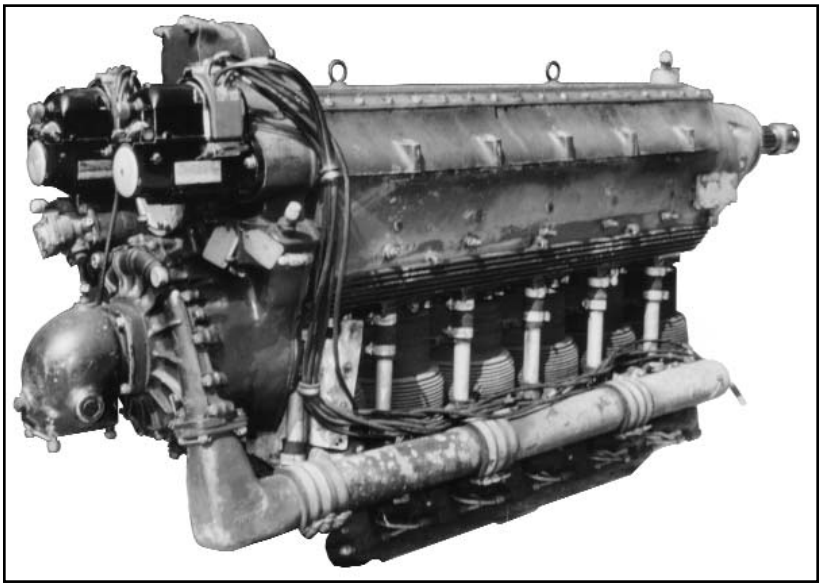
For the centrifugal supercharger blower, Menasco used a rubber-cushion coupling with a friction torsional damper driven by gears off the crankshaft at typical drive ratios of between 9:1 and 11:1. Impellers were precision cut on manual milling machines from solid forgings of "Dowmetal" magnesium.[22] Manifold absolute pressures (MAPs) on production engines (maximum of about 40-45 in Hg) were reportedly twice the boost of comparable engines at the time. Cast scroll housings were finned to release some heat. Supercharger efficiency was fairly high, but intercooling was not used (the long log intake manifolds rejected some heat).

Menasco 's supercharger installations were reasonably sophisticated for engines in that size/power class at the time. They were soon outclassed, however, by the military aircraft piston engines of the early 1940s, some of which included two-stage, two-speed, intercooled installations with water/methanol injection and very high MAPs (e.g., 75 in Hg for the P&W R-2800C [23] to 90 in Hg for the Rolls-Royce Merlin [24]).

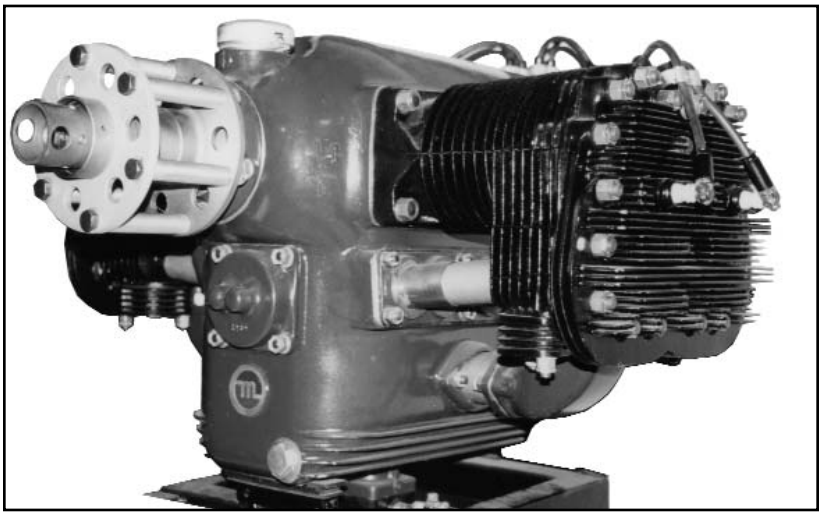


150 hp Menasco C4S in Ryan ST-A Special
(Teledyne Ryan Aeronautical via Ev Cassagneres)

Menasco's greatest engine development achievement in the 1930s, in my view, was the famous C6S-4 Super Buccaneer model. It was ATC rated in 1938 at 260 hp (194 kW), with 290 hp (216 kW) available for takeoff. The C6S-4 was a fine platform for racing, and Menasco also sold several for prototype aircraft applications in the late 1930s. Developed in 1935-1936 on the basis of the old C6S platform, the practically all-new C6S-4 debuted in 1937 with several beneficial changes: a rerouted intake and exhaust system, fully enclosed valve gear [25] dual camshafts, con rods forged from stronger steel instead of aluminum alloy, cylinder head upgrades, new forged and turned alloy steel cylinders, and so forth. In reference to the C6S-4, one air racing historian wrote: "In the second half of the 1930s, it gained a reputation for being the foremost small displacement racing engine on the American scene, and possibly worldwide. It was a true giant killer, and there is no doubt that the small Menascos would have gained much greater fame but for the approach of World War II."[26]



C6S-4, Intake Side, S/N 6127, now at Crawford Museum in "Goon" (William R. Lewis Collection)



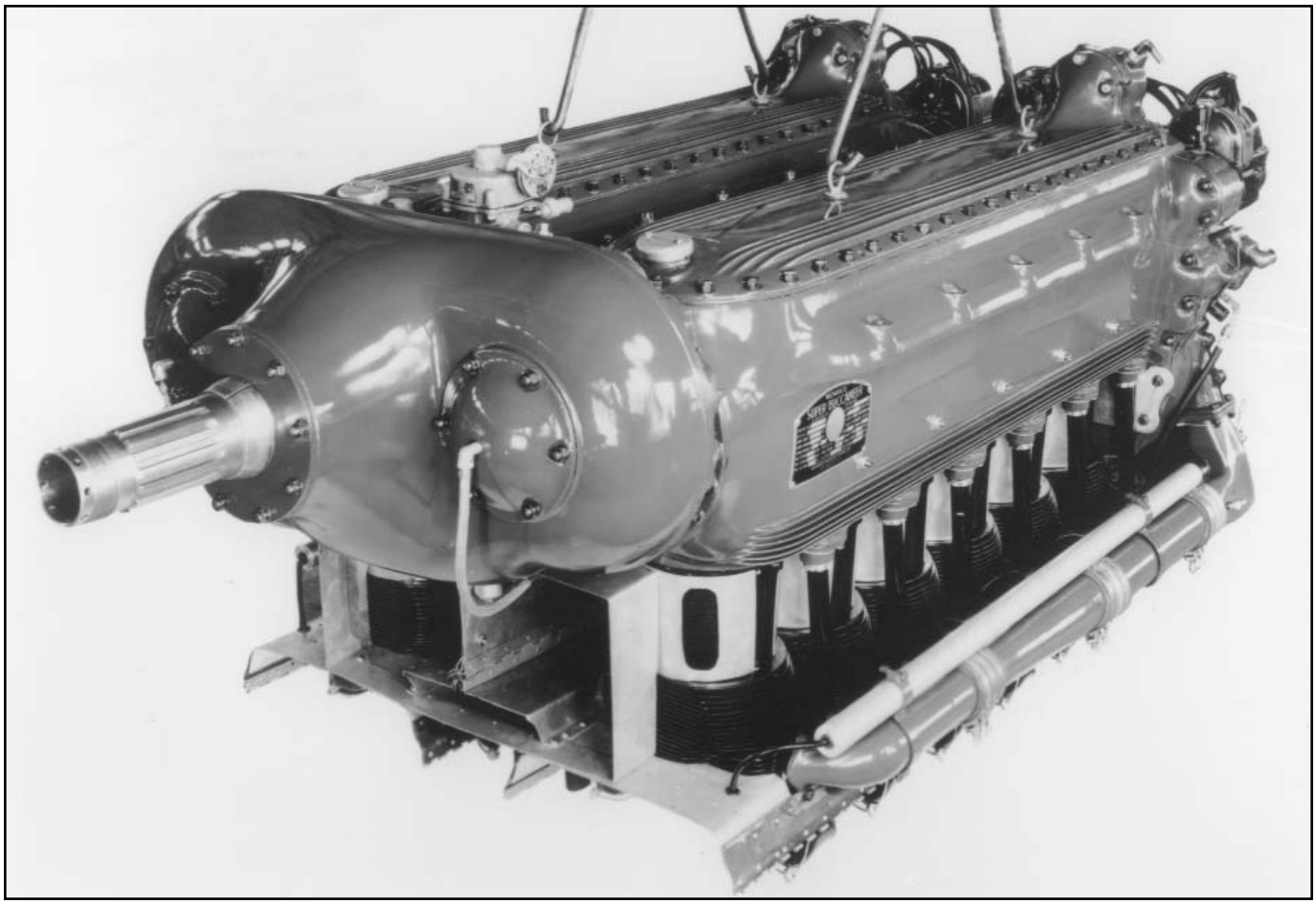
M-50 in San Diego, 1938 Vintage (Rinek Collection)

The company was clearly desperate for business for most of the depression-era 1930s, and company records showed financial losses every year from its 1934 incorporation as Menasco Manufacturing Company until 1941.[27] One reason for this situation was a lack of large-volume production contracts; most of the company's business consisted of special orders, repairs, and small orders of various types. Among the US aircraft of the 1930s equipped with the Menasco inline (usually in small volumes) were Loening Amphibian, Great Lakes, Fleet, Waco "F," Fairchild 22, Northrop Beta, Curtiss Robin, Stearman-Hammond, Model Y- IS, American Gyro Crusader, Rearwin Sportster, Argonaut Amphibian, Ogden Osprey tri-motor, Aeroneer 1-B, New Standard, Gee Bee, Swallow, and the previously mentioned Ryan aircraft. The factory attracted an additional group of offshore customers in England (Miles, Avro Avian), Germany (Focke-Wulf), Poland (P.Z.L., R.W.D.), Australia (Tugan), and Japan (Mitsubishi).[28] Menasco engines were installed in more than 100 different makes and models.

One classic example of the many aircraft engine deals on which Menasco lost money is the special development of the M-50 side-valve flat-four (50 hp/37 kW) model engineered in 1937-1938 for Aeronca model KM light planes. Contracts were announced for up to 500 M-50s for Aeronca,[29] ATC approval was obtained, production was started, but the deal fell through after approximately 10 were delivered. Many of the surplus M-50s later were "souped up" for use in midget race cars in Los Angeles.[30] One aero engine historian labeled the M-50 as a "marketing error".[31] Clearly, Menasco's M-50 was late to the market, soon overshadowed by better 65 hp (48 kW) flat-four engines from Continental and Franklin.

Other special and unusual engine projects of the 1930s at Menasco include the Reis-Menasco water-cooled V-12 marine engines developed for Gold Cup competition; the Unitwin model U-520 for Lockheed;[32,33] the War Department project to modify a C4 for use in the Army T-3 tank (the air-cooled upright E3 engine); and the massive 993 cu in (16.3 l) E6 Privateer engine, with a rating of 500 plus hp (272 kW) @ 2,550 RPM, originally developed for the Navy but also offered to

Northrop.[34] The ill-fated Covic stationary diesel project, with a target rating of 18 hp (13 kW) @ 2,600 RPM, received a 1,000 unit order from Jack Northrop's Northill Co. that was later canceled.[35,36] All these lost opportunities and financial pressures proved too much for Al Menasco, and for the Board of Directors; the result was his 1938 departure "for health reasons" from active management of the company (although he continued to be a major stockholder).[37]



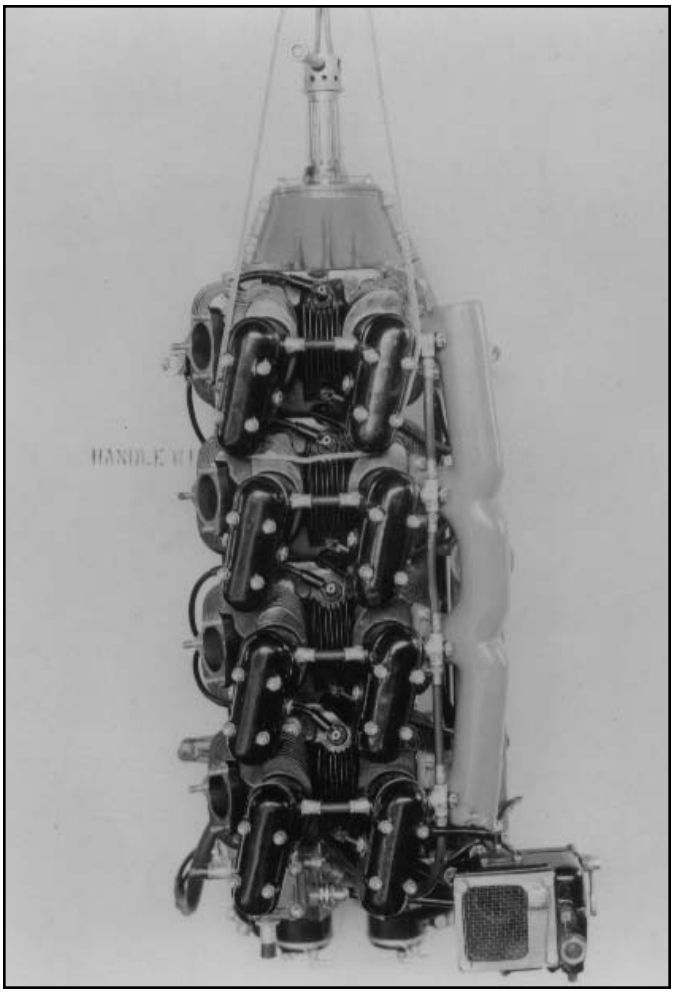
Unitwin U-520 (Smithsonian Institution 96-15896)

Lockheed Vega Starliner with Unitwin (Rinek Collection)

Menasco Manufacturing continued with piston engine production for a few more years, but orders were scarce. Engine operations were moved to a new plant in Burbank by October, 1940, while the foundry and some machining remained at the original McKinley Avenue site in Los Angeles. The principal "post-Menasco" engine developments concerned the D series:

- D4 Super Pirate (125 hp or 93 kW), an improved C4 with all new heads, better cooling, and enclosed valve gear[38]
- D4-87 (125 hp/134 hp or 100 kW for takeoff), an upgraded D4 with stronger steel (SAE 3140) instead of aluminum alloy con rods,[39] built under an order for Canadian trainer aircraft that was (like the Aeronca contract) terminated early
- D4B, an upgraded version of the supercharged C4S, rated at 160 hp (119 kW)[40]
- D6S-1, a developmental upgrade of the C6S series rated at 350 hp (261 kW) @ 2,600 RPM[41]
- D6SG, a developmental geared engine rated at 390 hp (291 kW) @ 3,000 RPM for sea-level takeoff.[42]

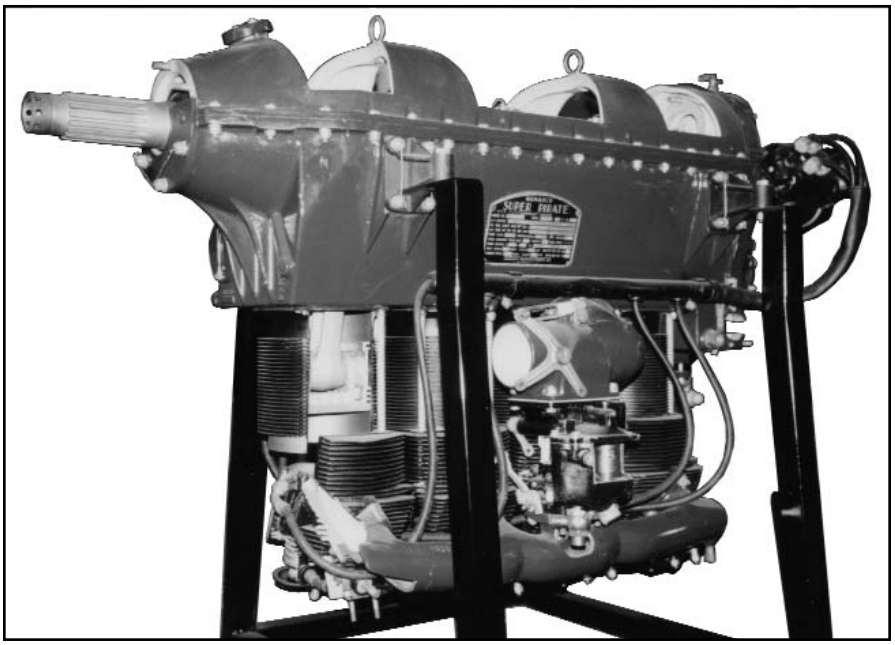
By late 1941, production had ceased on piston engines because Lockheed and defense needs forced a rapid transition to warplane landing gear production, starting with the P-38 fighter program (and later the P-47 and P-51) [43] Menasco had been producing special-order landing gear since 1929 (Northrop EX- 1). By late 1940, Menasco had reportedly built one of the largest and most sophisticated machine shops in the Western United States, which was very useful for hydraulic retractable landing gear, subcontract work for local air-frame builders, as well as engine development.



Menasco D4 Undersidew (Smithsonian Institution 96-15881)

In spite of this change of focus, Menasco Manufacturing continued its engine work, mostly on a US government contract R&D basis, for several more years in the 1940s. Its efforts included such interesting projects as ramjets,[44] turbo-jets,[45] turboprops, 2-stroke 22 hp (16 kW) drone engines[46] and large liquid-cooled aircraft piston engines in the 2,000-3,400 hp (1,491-2535 kW) class.[47]

One interesting WW II application was Northrop's use of 260 hp (194 kW) detuned air racing (from Crosby and LeVier race planes) C6S-4s in the N-9M flying wing project. A 0.35 scale test bed for the XB-35 flying wing bomber, the N-9M used twin flat-mounted pusher Menascos. Plagued by cooling problems, they were later replaced by 300 hp (224 kW) Franklin flat-eights.[48]



Menasco C4S (Rinek Collection)

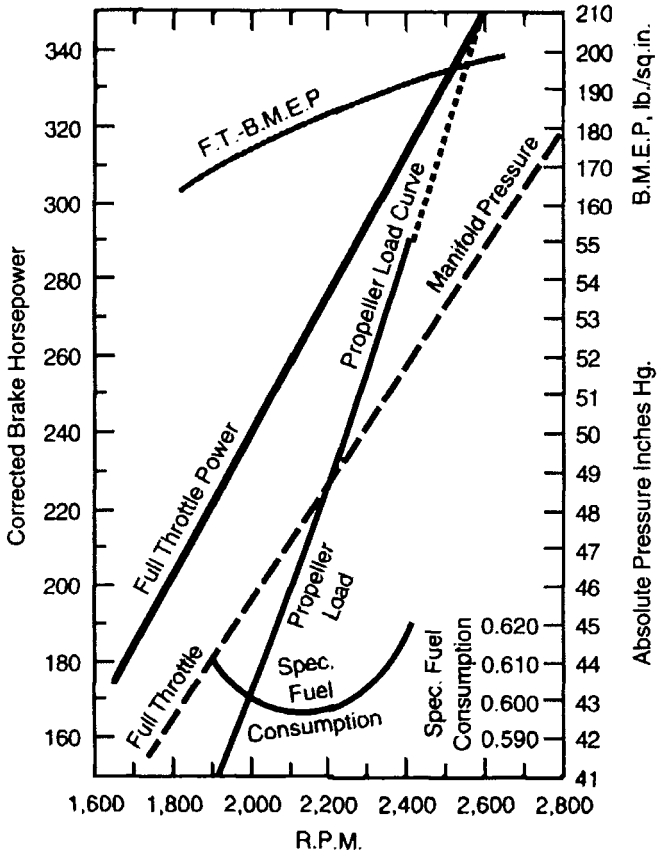
Table 1. Specifications of Production Menasco Aircraft Engines

Model	No. of Cyl	Bore (in / mm)	Stroke (in / mm)	Displacement (cu in / l)	Dry Weight (lb / kg)	Compression Ratio	Power (hp/kW)	Rated Speed (RPM)	Original ATC No.	Original ATC Date
A4	4	4.50/114.3	5.125/130.2	326/5.3	270/122 [3]	5.5:1	90/67	1,900	50	5/10/30
A6	6	4.50/114.3	5.125/130.2	489/8.0	NA	NA	145/108	NA	69	1/14/31
B4	4	4.50/114.3	5.125/130.2	326/5.3	285/129	5.5:1	95/71	2,000	65	11/1/30
B6	6	4.50/114.3	5.125/130.2	489/8.0	385/175	5.5:1	160/119	1,975	68	1114131
B6S	6	4.50/114.3	5.125/130.2	489/8.0	415/188	5.5:1	200/149 [4]	2,250	139	12/26134
C4	4	4.75/120.6	5.125/130.2	363/6.0	290/132	5.5:1	125/93	2,175	67	1/14/31
C4S	4	4.75/120.6	5.125/130.2	363/6.0	305/138	5.5:1	150/119 [5]	2,260	134	11/27134
C6S-4	6	4.75/120.6	5.125/130.2	544/8.9	550/249	5.5:1 [6]	260/194 [1]	2,300	197	7/38
D4	4	4.75/120.6	5.125/130.2	363/6.0	299/136	5.5:1	125/93	2,175	67	See C4
D4B	4	4.75/120.6	5.125/130.2	363/6.0	NA	NA	160/119	NA	134	See C4S
D4-87	4	4.75/120.6	5.125/130.2	363/6.0	320/145	6.0:1	125/932 [2]	2,175	67	See C4
M-50	4	3.50/88.9	3.750/95.2	144/2.4	156/71	5.25:1	50/37	2,550	191	3/38

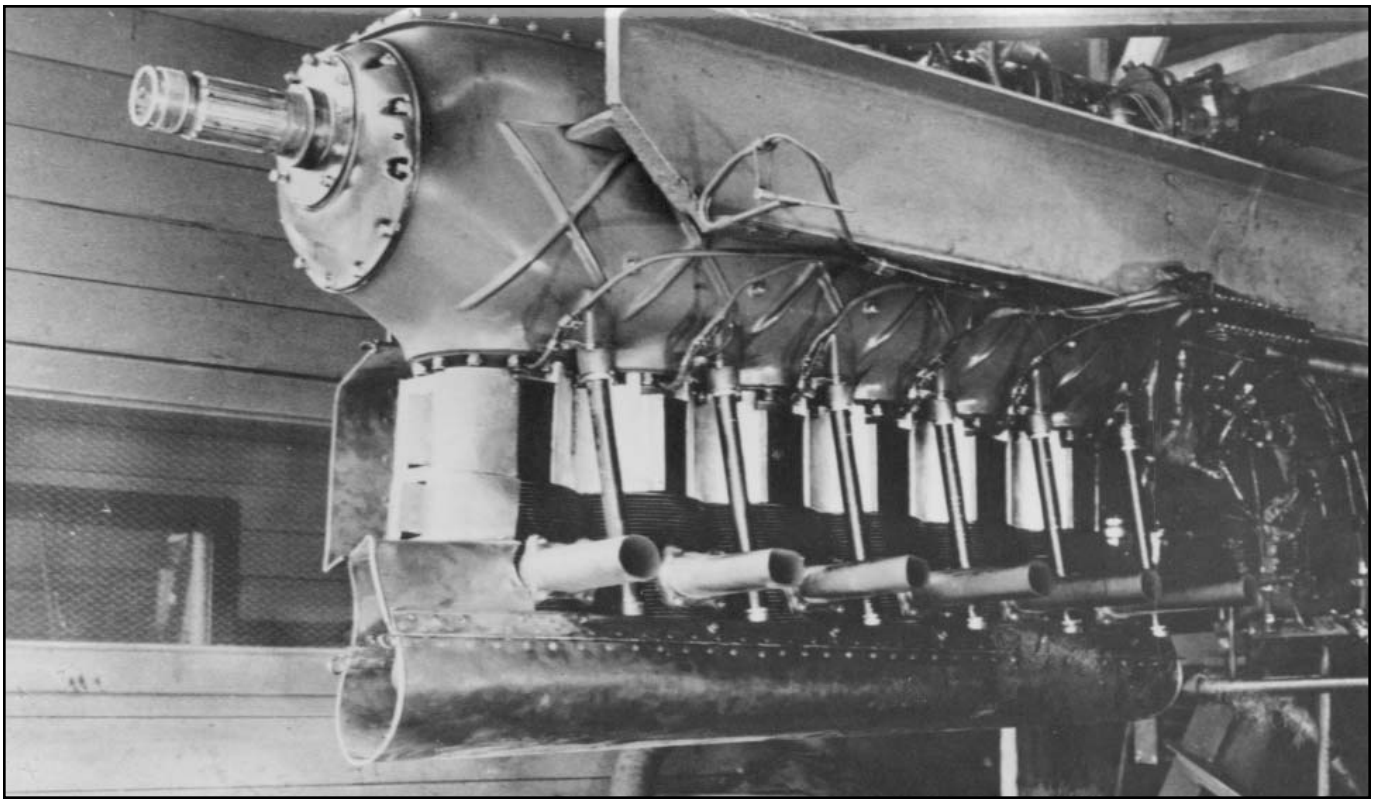
[1] 290 hp (216 kW) for takeoff, 260 hp (194 kW) at 7500 ft.
[2] 134 hp (100 kW) @ 2,260 RPM for takeoff.
[3] Earliest version 270 lb (122 kg), later 280 lb (127 kg).
[4] At 4,500 ft altitude.
[5] At 3,000 ft altitude.
[6] Some production models ranged up to 6.5:1.
Note: With regard to nomenclature of models, the factory over the years listed models both with and without hyphens after letters; I generally left out the hyphens.
Source: Menasco Manufacturing Company literature and data

Table 1 summarizes the specifications of Menasco's key production aircraft engines; all are air-cooled types. Typical materials of construction included cast aluminum crankcases (with some special versions done in magnesium) and two-valve (pushrod-operated) cast aluminum cylinder heads; nickel steel studs to hold cylinder and heads to crankcase; cast and turned nickel iron cylinders (forged alloy steel, for selected race engines, C6S-4 and later D series); forged nickel chrome steel alloy crankshafts and camshafts; and forged aluminum (Duralumin) con rods for most models (later upgraded to forged SAE 3140 steel), plus ball-type thrust and roller rocker arm bearings. These designs were reasonably light (about 2 lb/hp or less, with superchargers) and fairly reliable for civil use, tolerating 500 hours or more between overhauls.

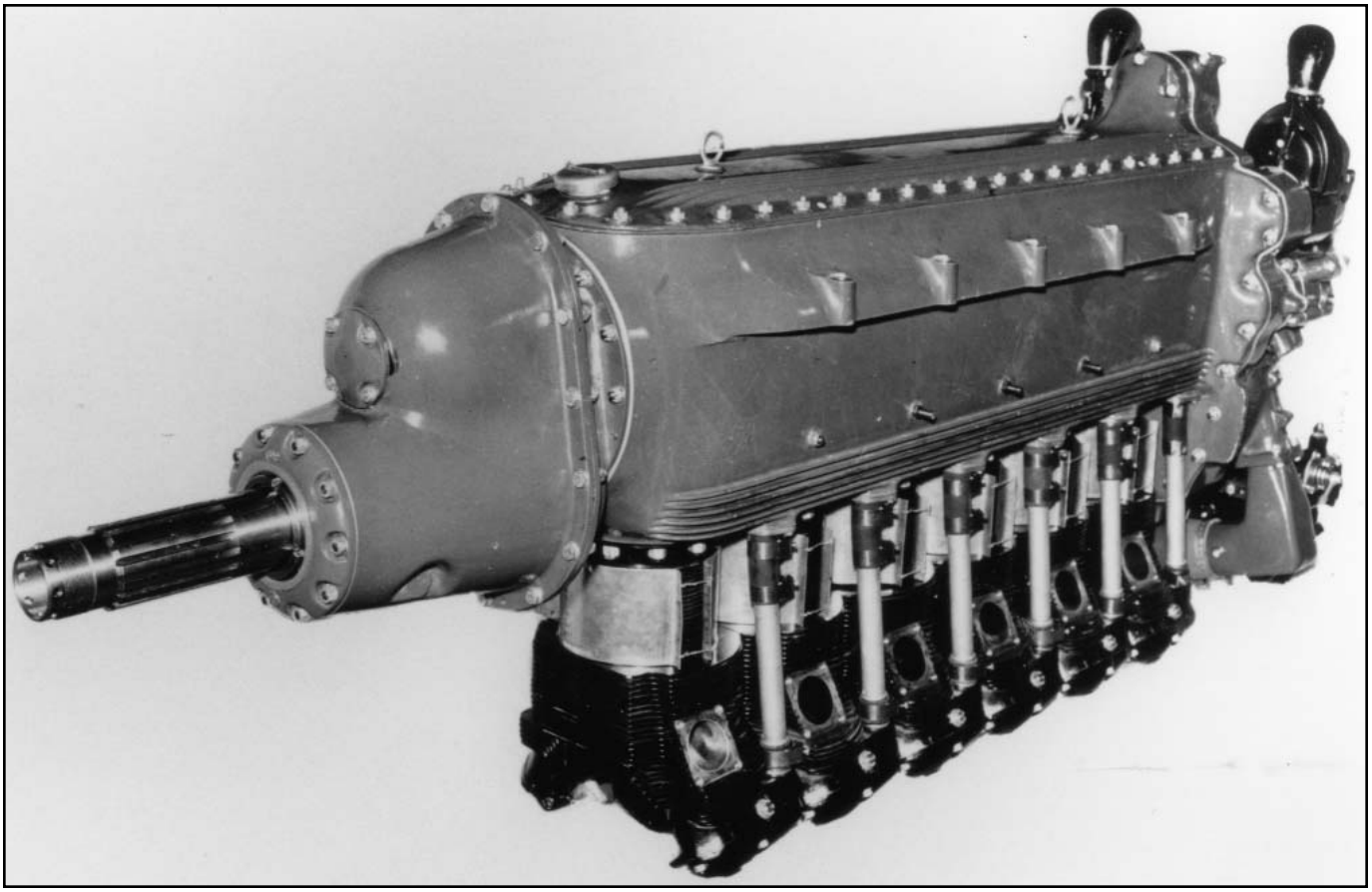
The stock Menasco engines were stressed only moderately in terms of horsepower per cubic inch or brake mean effective pressure (BMEP). The C6S-4 submitted for ATC testing approached 200 psi BMEP[49] at full throttle, but engineering department archives reveal developmental goals as high as 275 psi, as for the E6.[50] For comparison, sophisticated military piston aircraft engines of the early 1940s, such as the Rolls-Royce V-12 supercharged Griffon 60 series, achieved BMEPs over 300 psi.[51] Sharp limitations with regard to cooling potential and available fuel octane during most of the 1930s kept stock Menasco power ratings fairly low. The air racers pushed this envelope severely, extracting a 50 percent or greater boost in power from the same displacement.



Menasco C6S-4 Performance Curves(Aviation: October 1937)



E6 on Test Stand (William R. Lewis Collection)



The Only Photo Believed to Exist of the Menasco D6SG Geared Engine (Menasco Aerosystems)

References and Notes

1. Smith, Herschel, *A History of Aircraft Piston Engines*, 1981, McGraw Hill Book Co., New York (1991, Sunflower University Press, Manhattan Kansas), p. 180.

2. Rinek, Larry M., "Rinek Part I: The 1909 Rinek Voisin: An Unusual Aircraft with Advanced V-8 Engine," *WWI Aero; The Journal of the Early Aeroplane*, No. 137, August 1992, pp. 3-19.

3. Rinek, Larry M., "Rinek Part II: The Engine Family," *WWI Aero; The Journal of the Early Aeroplane*, No. 138, November 1992, pp. 11-19.

4. Rinek, Larry M., *Charles Norvin Rinek: An Early American Pioneer in Advanced Aviation Engines*, SAE 930485, March 1993.

5. Rinek, Larry M., "The 1909 Rinek Voisin: An Unusual Aircraft with an Advanced V-8 Engine," *AAHS Journal*, Volume 38, No. 4, Winter 1993, pp. 278-297.

6. Rust, Kenn C., "Menasco," *Skyways; The Journal of the Airplane 1920-1940*, No. 13, January 1990, pp. 23-35.

7. Rinek, Larry M., *Menasco Aircraft Engines: Air Racing Paragon of the 1930s*, SAE/AIAA 965598, October 1996.

8. Cassagneres, Ev, *The New Ryan*, 1995, Flying Books International, Eagan, Minnesota, p.87.

9. Wellman, Chet, *Vintage Airplane*, Experimental Aircraft Association (EAA), April 1985, p. 10.

10. Schmidt, Ralph J., *The Menasco Story (1926 Through 1991)*, 1994, Aerofax, Inc., pp. 56-57.

11. February 5, 1918 memo regarding Menasco's application for commission, from Major William Ream, Medical Reserve Corps (Office of the Surgeon, US Army Signal Corps Aviation School, San Diego, California) to Capt. A. H. Bobbitt, Los Angeles, California.

12. Schmidt, *op. cit.*, p. 55-62.

13. Menasco Motors Corp. 1928 catalog, p. 5.

14. Schmidt, *op. cit.*, p. 7.

15. *Ibid*, p. 63.

16. *Ibid*, pp. 63-64.

17. Underwood, John, *Madcaps, Millionaires and "Mose "*, 1984, Heritage Press, Glendale, California, p. 35.

18. Menasco Motors, Inc. February 1931 catalog.

19. Menasco Mfg. Co. list, "Engine Numbers and Their Locations," December 15, 1935, pp. 1-3.

20. Cassagneres, *op. cit.*, p. 101.

21. April 29, 1935 letter from T. Claude Ryan to Al Menasco.

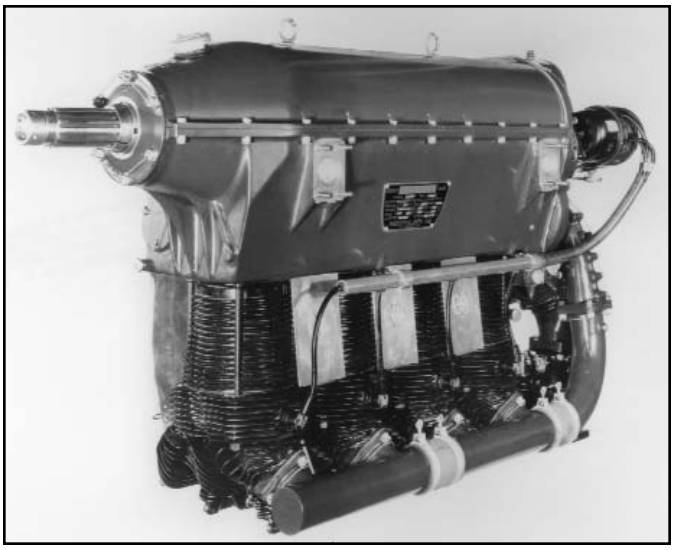
22. November 10, 1995 phone interview with Mr. Bill Keeler (oldest surviving Menasco employee; on payroll 1936-1981), who machined the magnesium blower impellers.

23. According to John A. Rinek, Pratt & Whitney engineering test pilot, 1941-1945.

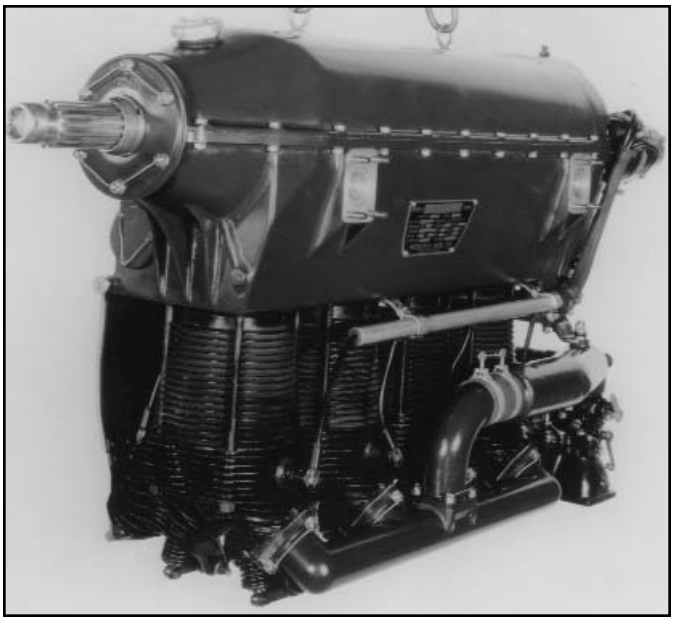
24. Horkey, Edward, "The P-5 1, The Real Story," *AAHS Journal*, Fall 1996, p. 186.

25. Until this point, all production inline Menasco. engines had open valve gear for simplicity and enhanced cooling, but were messy in terms of oil loss. Improved valve spring steels enabled enclosure, and an oil scavenging system was incorporated with rocker boxes.

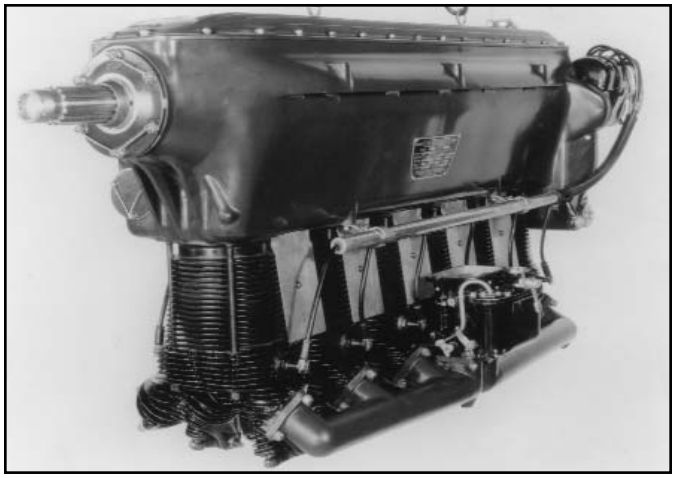
26. Bodie, Warren, "Sky Kings," pt. I, *Airpower*, September 1984, p. 42.



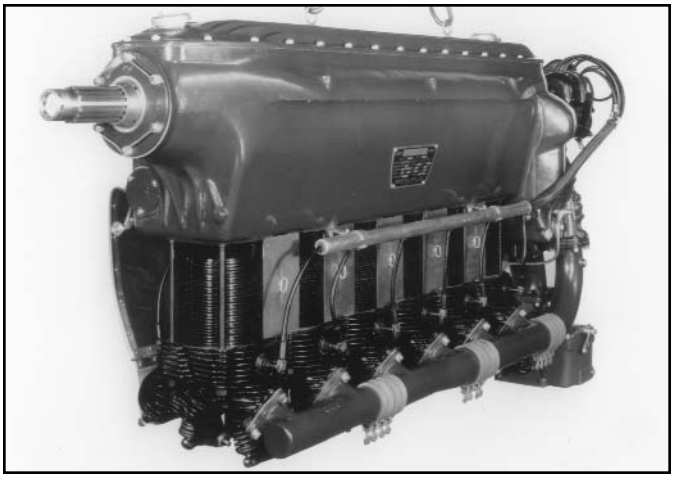
Menasco C4S (Smithsonian Institution88--6564)



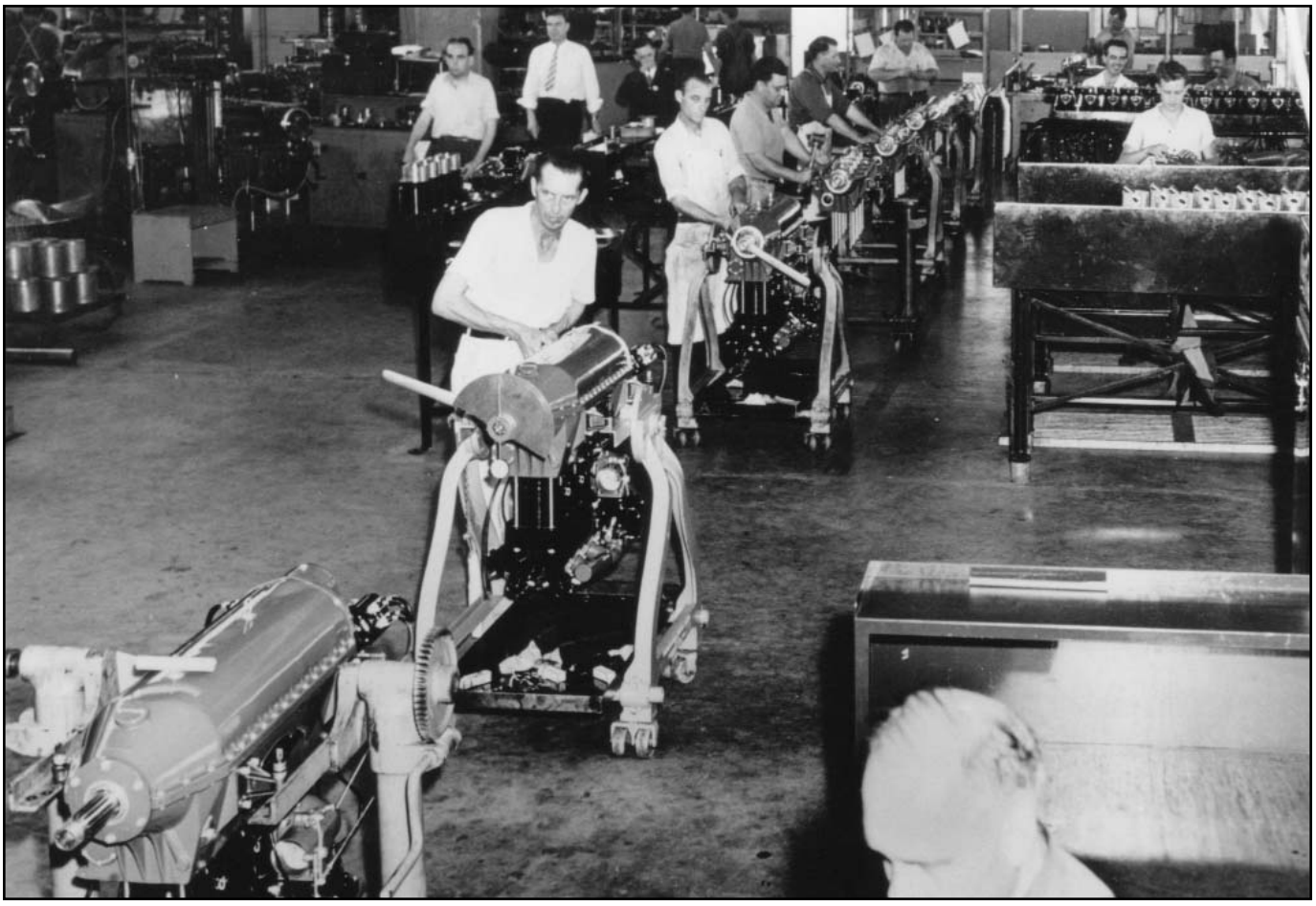
Menasco B4 (Smithsonian Institution 96-15936)



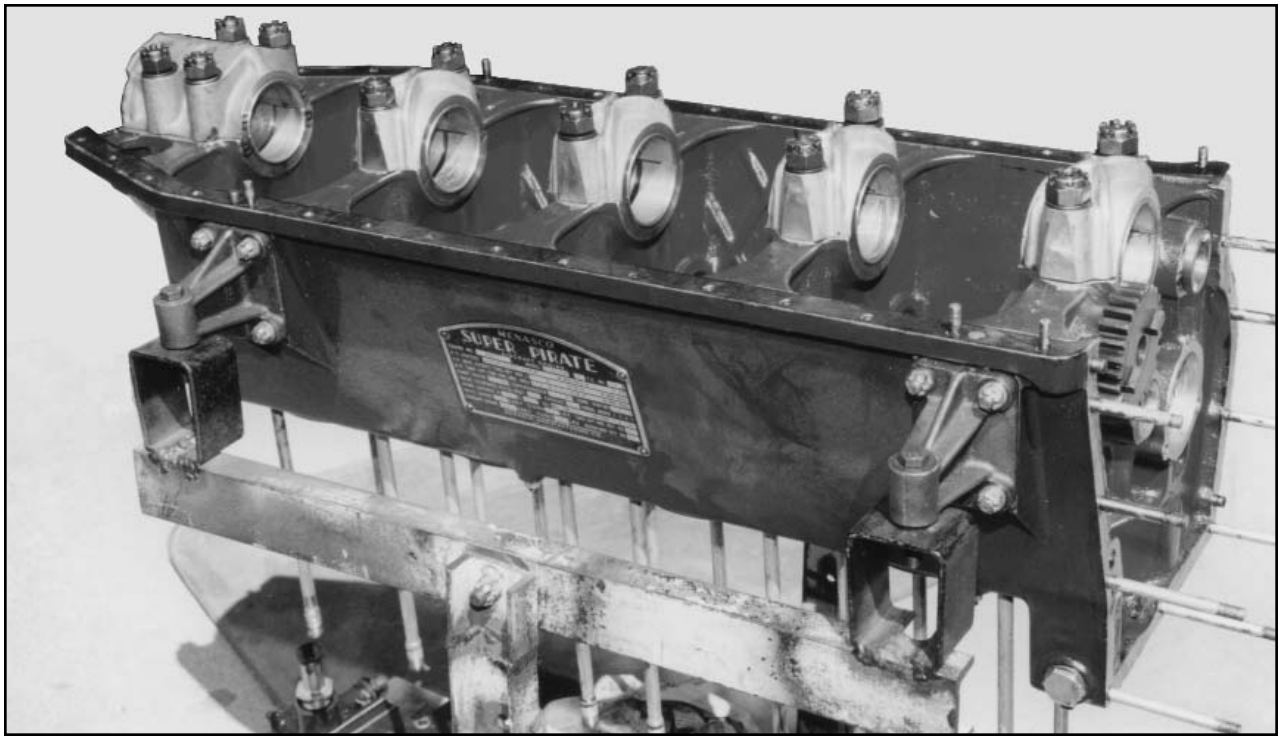
Menasco B6 (Smithsonian Institution 96-15871)



Menasco B6S (Smithsonian Institution 96-15874)



D4-87 Assembly Line in Burbank Plant, circa 1941 (Menasco Aerosystems)

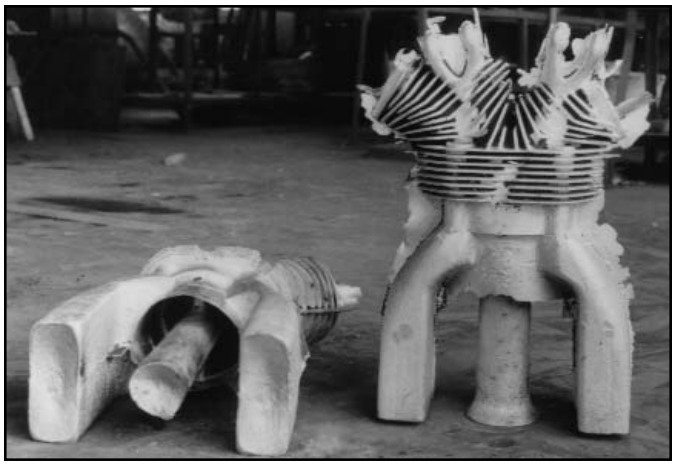


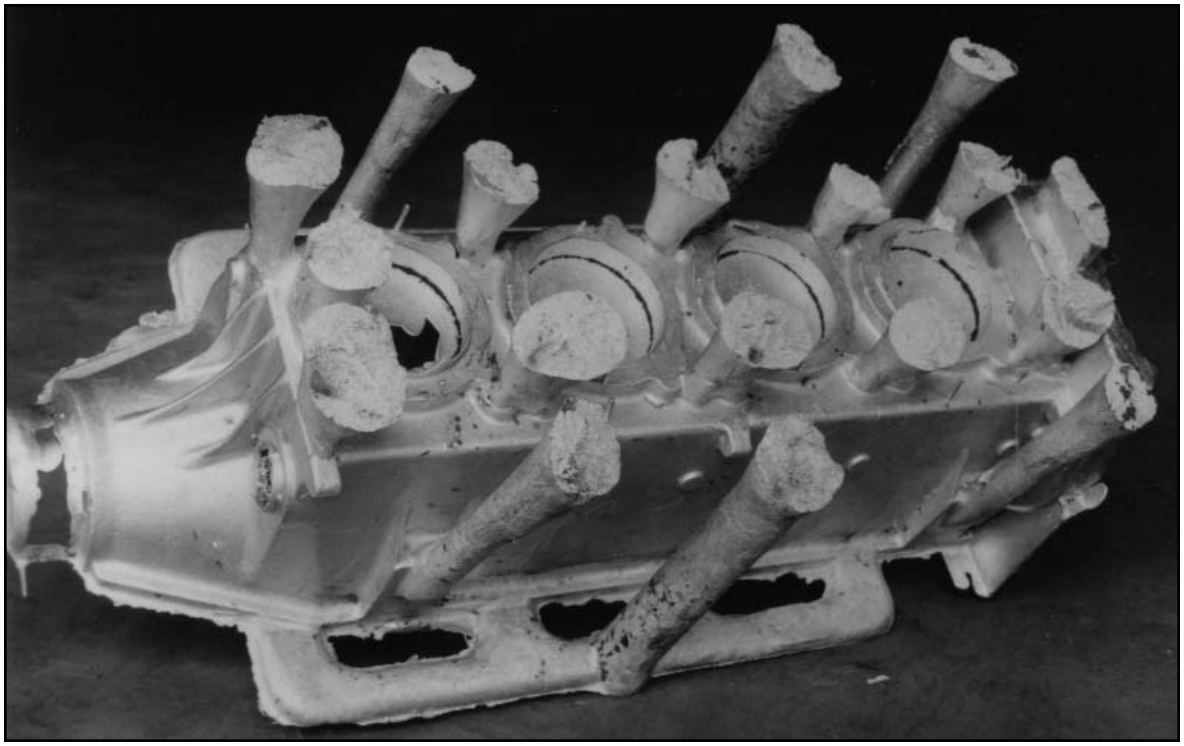
D4-87 Crankcase Interior (Rinek Collection)

27. The June 30, 1954 "Financial History-Menasco Manufacturing Company" in Fort Worth archives shows 1934-1940 total sales of $1,025,102 and total net loss of ($493,274).
28. Prospectus-Menasco Manufacturing Company, November 10, 1936, G. Brashears & Company underwriters.
29. "Menasco Gets Large Order," *National Aeronautics*, March, 1938.
30. May 15, 1995 phone interview with Menasco retiree Mr. Bill Keeler.
31. Gunston, Bill, *World Encyclopedia ofAero Engines,* 3rd edition, 1995, Patrick Stephens Ltd., Somerset, England, p. 107.
32. Twin C6S-4s (520 hp) mounted side-by-side, with common geared propdrive and unique overrunning clutches that allowed safe operation at nearly full prop speed if any one of the engines faltered.
33. Short, Mac "'Unitwin' Power Plant," *Aero Digest*, February 1939.
34. February 1, 1934 letter from Menasco chief engineer Z.V Weisel to Mr. Jack Northrop, Northrop Aircraft Corp.
35. "Menasco Diesel Unit Speeds Up," *Los Angeles Times*, March 3, 1939.
36. News release on Menasco Mfg. Co., *The Wall Street Journal*, Pacific Coast Edition, September 7, 1938.
37. "A.S. Menasco Resigns from Engine Co.," **Evening Herald and Express**, Los Angeles, August 13, 1938.
38. Menasco Engine Handbook, Model D4, 1940.
39. Menasco Engine Handbook, Model D4-87 Supplement, 1941.
40. "Menasco Gets Engine Order," *Los Angeles Times*, December 1940.
41. "Menasco Aircraft Engine Production," undated (circa 1942) typed chronology tables of models and specifications in Al Menasco's personal papers donated to San Diego Aerospace Museum.
42. *Ibid*.
43. Schmidt, *op. cit.*, p. 11.
44. "Menasco Pares Production to Concentrate on Jet Engines," *Aviation News,* June 30, 1947.
45. "Menasco Builds Gas Turbine," *Los Angeles Times*, January 29, 1946.
46. "Two-Cycle Engine Entering Market," *Aviation News*, June 25, 1945.
47. US Air Force (USAF), *Model Designations of USAF Aircraft Engines*, January 1, 1949, pp. 45, 59.
48. Young, Bill and Balzer, Gerald, "Northrop N-9M Flying Wing," *AAHS Journal*, pt. 1-Winter 1993, pt. 2-Spring 1994.
49. "Super Buccaneer," *Aviation*, October, 1937, p. 42.
50. Z.V Weisel's February 1, 1934 letter to Northrop, op. cit.
51. Sherman, Don, "Power Struggle; Why Car Engines Won't Fly," *Air & Space/Smithsonian*, Dec. 1.996/Jan. 1997, p. 77.

About the Author

Larry Rinek works with various industries as the Director of Consulting, Industrial Technologies at Frost & Sullivan in California. He began his career in the southern California aerospace industry prior to graduation from UCLA's engineering and business schools (earning a BS and an MBA). He worked at NASA's Jet Propulsion Laboratory (Pasadena), Menasco's landing gear plant (Burbank), and the US Air Force (El Segundo). Mr. Rinek has authored 15 historical articles and papers for various journals and publishers. He is an active member o f the American Aviation Historical Society (now serving as a Director for the Northern California Chapter), SAE Historical Committee, Aircraft Engine Historical Society (charter member), the Wings o f History, and supports various US aero museums. Mr. Rinek soloed in his family's 1947-vintage Piper J-3 Cub, and enjoyed orientation flights in the cockpit at the controls of various USAF jets. In the course of the Menasco historical research, he experienced first-hand the feel and sound of an antique Menasco engine (D4-87), as a passenger in a restored Ryan ST-A.





Above: Raw Aluminum Heads, Cast by Menasco (San Diego Aerospace Museum)

Left: Raw Aluminum Crankcase, Cast by Menasco (San Diego Aerospace Museum)