Wright R-1820 “Cyclone”

By Kimble D. McCutcheon

If you were a child in the years of 1964 through 1969, your introduction to the sights and sounds of the Wright R-1820 “Cyclone” was probably due to the popular television series “Twelve O’clock High”. In this series, Boeing B-17 bombers flew missions over Germany each week and the heroes always returned home due to guts, skill, and sturdy aircraft with reliable engines. More importantly, a whole generation of kids was introduced to radial engines with their smoky starts and monotonous low drone long before restored B-17s started touring the air-show circuit and before “Warbird” entered the lexicon of aviation enthusiasts everywhere.

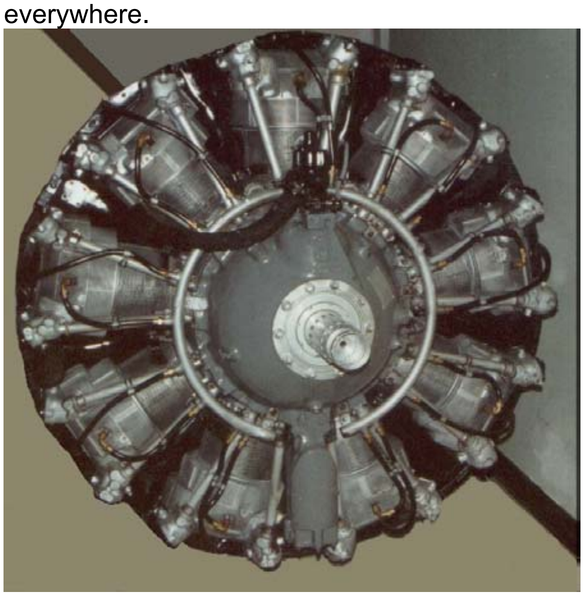

Figure 1. Wright R-1820 "Cyclone"

History

The R-1820 traces its history to the Wright P-1, the first “Cyclone”. Development began in 1923 under a Navy experimental contract for two engines given to Wright largely out of respect for the air-cooled design talents of Charles L. Lawrance. Wright had recently acquired the Lawrance Company, and C. L. Lawrance was a Wright vice-president. The P-1, displacing 1,654 in^3, was based upon a 1919 Army design. In order to keep diameter to a minimum, the P-1 incorporated very short connecting rods and valves aligned fore-and-aft rather than the usual lateral alignment. This valve arrangement necessitated a complex linkage incorporating a bellcrank on the front of each cylinder and a pull-rod across the top to actuate the rear (intake) valve. All engine accessories were mounted on the rear of the engine. The P-1 was reported to produce 406 hp at 1,650 rpm with a dry weight of 812 lb. It was hoped that the P-1 could produce twice the power of the Whirlwind with the same diameter. This was not to be. The engine was very rough running, its valve gear was troublesome, and short rod ratios imposed severe piston side-loads, eventually resulting in piston failures. Although the engine was extensively flight tested in a Douglas DT-2, it was not a success. Wright quickly moved on to design the second engine, and cure the problems with P-1.

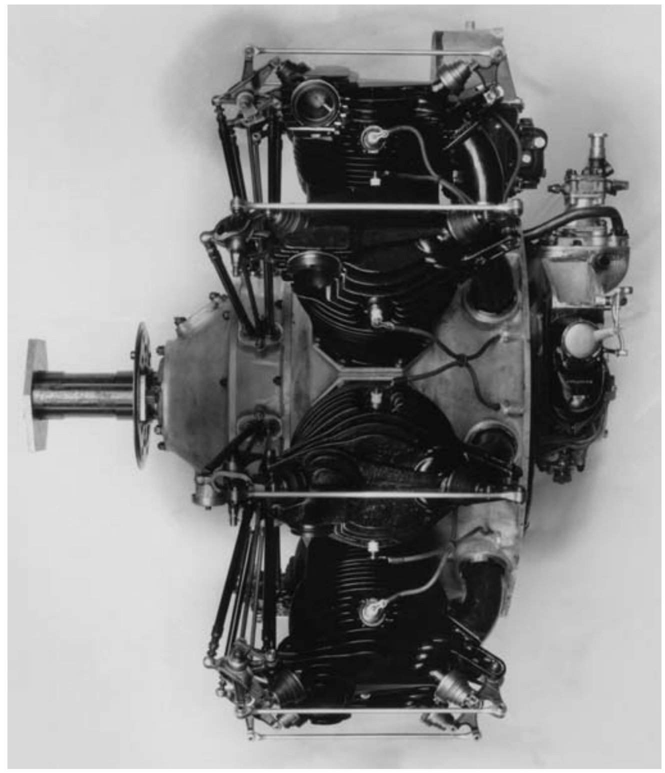

Figure 2. Wright P-1. Note unusual valve gear.

The P-2, begun in 1924, used the same bore and stroke as the P-1 but used more conventional cylinders with enclosed lateral valve placement based on the types J and M cylinders designed by Sam Heron of the Army Power Plant Laboratory at McCook Field, Dayton, Ohio. Opinion was changing as to the importance of small frontal area, allowing a larger diameter and more orthodox cylinders. The P-2 was the first Wright engine to incorporate a gear-driven centrifugal supercharger. During the development of the P-2, Frederick Rentschler, President of Wright, had a falling out with the board of directors and departed. C. L. Lawrance replaced Rentschler as president. Wright’s top engineering, design, and production talent soon followed Rentschler, hurting the P-2 project. The engine was eventually type and flight-tested in 1926, producing 435 hp at 1,800 rpm and 500 hp at 1,900 rpm with a specific fuel consumption of 0.56 lb/hp/hr and weight of 851 lb. The P-2 was never produced.

The Navy asked Wright to develop a smaller radial for the Vought O2U, a carrier-based observation aircraft. The Simoon, based on the P-2 was designed, but in the meantime, Rentschler's new company, Pratt & Whitney Aircraft, had introduced the R-1340 Wasp, which was far superior to the Simoon (and all other competition). The Simoon was never produced.

In 1926, E. T. Jones, head of the powerplant section at McCook Field, and Sam Heron came to lead Wright's engineering team in the development of the R-1750.

This 9-cylinder engine with a 6.000" bore and 6.875" stroke incorporated Heron's new type M cylinder with enclosed grease-lubricated valve gear and sodium-cooled exhaust valves. The pistons were of the "waffle" head type, with ribs running in both directions under the piston crown to facilitate cooling. It was type-tested in 1927 with an output of 525 hp at 1,900 rpm and a weight of 760 lb. It was available with or without propeller reduction gears.

In 1929, Wright merged with Curtiss, bringing the engine design talents of Arthur Nutt (of Curtiss D-12 fame) on board.

About 100 R-1750s were sold to power a number of Navy twin-engine flying boats.

Design and Development

In the early 1930s, Wright found itself developing no less than six engines, some air-cooled and some liquid-cooled. This was due to a number of factors, including the merger with Curtiss, demands from Army and Navy development customers, and the need to improve the bread-and-butter Whirlwinds. But the engineering team was spread too thin and was accomplishing nothing in a hurry. It was decided to throw all development effort into the Cyclone. The bore of the R-1750 was increased to 6.125" in 1932, and gave rise to the R-1820E. The exhaust port was moved to the side of the cylinder, allowing either front or rear exhaust collectors. Air deflectors and individual spark plug coolers were provided, marking Wright's first example of attention to engine cooling in its final installation. The R-1820E introduced (for Wright) the first use of cast-in rocker arm housings. The R-1820E was rated at 575 hp at 1,900 rpm with fuel and oil consumption of 0.55 and 0.035 lb/hp/hr respectively.

The R-1820F Cyclone introduced several new features for Wright, including forged aluminum crankcases and actual supercharging via increases in the gear ratio of the supercharger impeller, a down-draft carburetor with automatic mixture control, cylinders with closer, deeper fins and tighter baffles for improved cooling, and improved valve gear lubrication. As better gasoline became available, compression ratios, top rpm and power ratings were increased. Provisions were also made for controllable-pitch propellers using engine oil as a hydraulic actuating medium.

In 1934, geared R-1820s with controllable-pitch propellers began breaking propeller shafts. Orval Cook and Turner A. Aims of the Wright Field Propeller Branch traced the root of this difficulty to the increased weight of the new controllable-pitch propellers, which increased the effective propeller inertia to the point that crankshaft torsional periods fell into the engine operating range. E. S. Taylor of MIT proposed the use of pendulum dampers. Roland Chilton of Wright designed a mechanism consisting of a large counterweight suspended like a pendulum from the crankshaft in a manner that allowed movement in the direction of rotation. Counterweight mass and pendulum length were calculated to vibrate at 4.5 (the number of power pulses per revolution) times the rate of crankshaft revolution, but out of phase with the crankshaft. This tended to remove crankshaft torsional vibration, reduce wear and tear on magnetos, supercharger drives, and propeller components. Chilton received a patent for this innovation, which has been used in almost every high-powered aircraft engine since.

Figure 3. Wright crankshaft showing two-piece construction and Chilton vibration dampers

The F model crankcase was split along the cylinder centerline to form two sections. The cylinders were a further improvement of Sam Heron's type M cylinder, incorporating a steel barrel with machined cooling fins, screwed and shrunk into an aluminum head. Steady improvement of casting techniques allowed production of cylinder heads with deeper and finer cooling fins. Two valves were provided in the hemispherical head, with the exhaust valve being sodium-cooled. Valve lubrication was accomplished by periodically supplying pressurized lubricating oil via a manually operated valve to the rocker arm shafts. No provisions were made for returning this oil to the engine. A one-piece master rod necessitated the use of a two-piece crankshaft that was supported by massive roller bearings. The master rod bearing was steel-backed lead-indium-silver.

Multi-pinion planetary reduction gearing was contained in a magnesium nose case that also housed the cam ring and roller cam followers. The supercharger was of General Electric design. Carburetion was via a two-barrel downdraft Holly. Scintilla magnetos mounted on the rear accessory housing provided ignition. Performance was from 575 to 890 hp and weight was typically around 1,000 lb.

The G model Cyclone provided a forged steel crankcase and still more cooling area (now around 2,800 in² per cylinder). It also was the first Wright engine to use a supercharger developed in-house. After realizing that the GE-designed supercharger was inefficient and hampering the overall power output of the engine, Wright engineer Kenneth Campbell developed a single-speed single-stage supercharger with an efficiency of 65% and a pressure ratio of 1.5. By the end of production, efficiencies of over 75% had been achieved. The Cyclone G also incorporated automatic valve gear lubrication for the first time at Wright. This was accomplished by forcing engine oil through the valve push rods and rocker arms. Excess oil was returned to the sump via the push rod housings.

Numerous other small changes were made to the pistons, cylinder heads, induction system, and dynamic counterweight. The final series of the Cyclone line produced 1,525 take-off hp at 2,800 rpm with anti-detonation injection and weighed 1,469 lb. Cruise specific fuel consumption was 0.43 lb/hp/hr.

Service

Wright had a number of significant design wins with the R-1820. It was chosen by Douglas to power the DC-2, DC-3 and SBD Dauntless; by Boeing to power the B-17; and by Grumman to power the FM (General Motors-built) Wildcat. It was even used to power the Army T-1 heavy tank. The majority of World War II engines were manufactured under license by Studebaker in facilities at South Bend and Fort Wayne, Indiana. After the war, Lycoming built R-1820s under license.

Competition for the R-1820 came in the form of the Pratt & Whitney R-1830. Where the R-1820 was a single-row 9-cylinder engine, the R-1830 was a two-row 14-cylinder. Each company touted their respective advantages: The R-1820 was lighter and simpler, the R-1830 was smoother and smaller in diameter. Both were fine engines, but the R-1830 was built in far larger numbers that the R-1820.

The R-1820 was copied by engineers of the former Soviet Block. In this Metric version, it continued to be manufactured in Poland as the PLZ-Kaulisz ASZ-62IR-16 and powered a number of passenger and agricultural aircraft including the Antonov AN-2.

Specifics (R-1820-82)

Configuration:	9-cylinder, air-cooled single row fixed radial
Output:	1,525 hp @ 2,800 rpm and 56.5 in Hg @ S. L.
Weight:	1,469 lb
Displacement:	1,823 in^3
Bore x Stroke:	6.125" x 6.875"
Compression Ratio:	6.8:1
Brake Mean Effective Pressure:	236.6 psi
Specific Weight:	0.96 lb/hp
Specific Output:	0.84 hp/in^3
Cruise Fuel Consumption:	82.0 gal/hr @ 75% power
Cruise Specific Fuel Consumption:	0.43 lb/hp/hr @ 75% power
Cruise Oil Consumption:	3.05 gal/hr @ 75% power
Cruise Specific Oil Consumption:	0.020 lb/hp/hr @ 75% power
6 hr mission specific weight:	0.66 lb/hp/hr (engine + fuel + oil @ 75% power)
Fuel Required:	115/145 grade gasoline
Reduction Gear Ratio:	0.5625:1
Supercharger Gear Ratio (low):	7.21:1
Supercharger Gear Ratio (high):	10.0:1

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