The Beginning of it all: The 1924 Chrysler Six

Automobile companies are product-driven. Their management, operations and organization must accommodate the relentless demands of assembly-line production and promote the continuous development of new products. In this sense, the vehicles they produce largely define the corporations that produce them. Not surprisingly then, several Chrysler Corporation vehicles have signaled turning points in the Company's history, each in its own way determining the direction of the Company in the years to come. The earliest of these milestones was the original Chrysler Six.

Acclaimed by many as the first modern car, the 1924 Chrysler Six created a turning point in the Company's history by establishing the leading role of engineering at Chrysler Corporation. In addition to the highly touted ZSB engine, the Chrysler Six boasted several mechanical and engineering firsts. It was lighter, performed better and stopped more quickly than other cars of its size and class, and it had a "harmony" about it that none of its competitors could match. All of this was only made possible by the application of scientific engineering principles and processes to design and production. Because the car was so successful, the discipline created by engineering's problem-solving approach spread throughout the Company. For more than 10 years, "the Engineering Corps," as Walter P. Chrysler called this staff, reigned supreme.

The key to the car's performance was its engine. Eugene Weiss describes the final design hurtles this way:

> During the summer of 1922, ZSB had approached all parts of the engine development problem. They started with the 3,000 rpm and seven main bearing design that they used on their first engine.

Exhaust Valve Cooling

A major problem in engine design is how to keep the exhaust valve cool. If it is too hot, it will pre-ignite the fuel, causing a "knock" which limits engine power. The exhaust valve is in the direct heat of the combustion gases and is cooled only when the heat can be conducted away while on the valve seat. The faster the engine runs, the less time per cycle that the exhaust valve has to cool from the hot combustion temperature. It will run hot and pre-ignite the fuel. The hot valve also results in a loss of valve or valve seat shape and seal, a major problem for engine durability, as evidenced by contemporary engines of the 1920s that required frequent valve re-seatings. The engineering challenge faced by ZSB was that of careful design of the water passages around the exhaust valves to obtain excellent cooling. The new Chrysler engine had full water jackets around each valve and cylinder. It also used a water pump to ensure that the coolest water was distributed to the rearmost cylinders and valve seats rather than shortcutting across the front of the engine.

Manifolding

Another problem faced by ZSB was even fuel mixture distribution. At the time, the updraft carburetor used by the industry tended to be rich at the middle cylinders and lean at the end cylinders. A December 27, 1923, story in *Automotive Industries* reports that during the earliest development of the Chrysler engine samples were taken from each cylinder to be sure that the manifolds provided each cylinder with an even fuel mixture and even low pressure exhaust. Even and full power with all cylinders working was the result and therefore this was a very smooth and powerful engine.

Combustion Chamber Shape

During 1921, there were several design studies of combustion chambers, including an interesting chamber that was partially machined. A major design change in late 1921 incorporated the combustion chamber concepts of Sir Harry Ricardo. At the time, events dealing with the seemingly instant events of flame front travel were beyond the level of practical engineering study. At 2,000 rpm, the speed of contemporary engines, the top dead center events (within 18 degrees of crankshaft rotation) occur every 0.0015 seconds. At 2,000 rpm, the speed of the new Chrysler engine, the time scale is 0.001 seconds, and flame front travel time is very much in scale with the top dead center events.

Sir Harry Ricardo, a British engineer, concluded that the advancing flame front, as the cylinder fired, would squeeze the remaining fuel mixture at the edge of the chamber causing it to pre-fire and knock. The solution that he proposed was to have a thin "squish" area over the piston that would have an exceptionally large area for cooling the last of the fuel mixture to prevent pre-fire and knock.

An added benefit of this design was that the fuel mixture was turbulent as the piston moved thereby increasing mixing for faster flame front travel, more complete curing and power. The ZSB drawing clearly shows the Ricardo design feature and the compression ratio shown on the drawing was raised to 4.4. The chamber also had a dome over the valves to improve breathing around the valves. This feature was later called “Silver Dome” in Chrysler advertising.

The exact date of the new combustion chamber design cannot be determined because the drawing is undated in a series of other dated drawings in late 1921.

Engine Design Details

- The later machine tools for the new engine were designed so that the final boring of each cylinder was made by the same tool to reduce size variation between cylinders.
- This engine, like the first ZSB design, also used seven main bearings to ensure engine life at the higher than usual 3,000 rpm of the new engine.
- The alter production design had the “squish” area made thinner from 1/4 inch to 0.05 inch thickness to the top of the piston. This is the same design that is used today on engines that have a “squish” area.
- The compression ratio was then raised to 4.7, and still 50 octane regular fuel could be used without knocking — a major engineering accomplishment. This was a full-featured engine with aluminum pistons, full pressure engine oiling, oil filter, air filter, and an engine temperature gauge on the instrument panel.

Final Design

The result of excellent exhaust valve cooling and seven main bearings was to allow a high-speed engine with durability. A carefully worked out manifold system and modern combustion chamber resulted in full power from each cylinder. The new Chrysler engine developed 68 horsepower at 3,000 rpm from only 201 cubic inches of engine displacement. This was a new industry standard of 0.34 horsepower per cubic inch of engine displacement.

The following chart shows the engineering practices of 1924:

Name	**Size CID**	**Power**	**HP/CID**	**RPM**	**CR**
Six Cylinder			0.34	3000	4.7
Chrysler	201	68			
Hudson	288	75	0.26	2400	4.7
Flint	268	69	0.25	2600	4.2
Buick	255	65	0.25	2600	3.5
Stutz	268	66	0.24	3000	4.5
Packard	268	54	0.20	2600	4.5
Four Cylinder		35	0.16	2000	4.0
Dodge	212				
Chevrolet	171	26	0.15	2000	4.0
Ford	176	20	0.11	1600	4.0