Flat-Head Engine Design, 1924

When Fred Zeder, Owen Skelton and Carl Breer developed the original engine for the 1924 Chrysler, they selected a flat-head or valve-in-block design. Chrysler engineers continued to use this conservative design until the new Hemi V-8 in the 1951 Chrysler New Yorker.

In the late 1920s and early ’30s, other auto manufactures used various combustion chamber and valve locations. Chevrolet, Buick and Nash, among others in the United States, used for example the overhead-valve (OHV) arrangement. In Europe, the OHV arrangement was common with a few manufacturers who even used overhead cams. Overhead valves provide greater volumetric efficiency; that is, the intake system is better able to completely fill the combustion chamber with a fuel-air mixture and thus provide more power and greater fuel economy. Overhead valves allow a shorter, more direct path for the gas-air mixture to reach the combustion chamber compared to flat-head engines. So why did Chrysler persist with the flat-head design?

Indeed, the Company was making changes to the engines every year: new castings, new blocks, new bore spacing, new bearing sizes. In fact, Chrysler introduced all new engines almost every year. But the flat-head was always retained — even on the magnificent new Imperial eight-cylinder engine of 1931 — so it clearly was not some attempt to save piece or tooling costs. Clearly Chrysler engineers believed the flat-head design was best for their engines.

Why did they come to this conclusion? William Wertman, the head of Chrysler engine design from 1962 to 1987, and Tom Asmas, an engine specialist with DaimlerChrysler Product Engineering, point out that Zeder, Skelton and Breer had a well thought-out strategy and operational goals for their engines. These engineers aimed at developing a robust, trouble-free engine with smooth, quiet operation and reasonable power for the power plant weight (for that time.) The rigid, compact valve-in-block design eliminated the flexing that was so much a problem with earlier noisy engines. The new Chrysler car was targeted at the “medium” price field. The flat-head design was less expensive to manufacture and tool than the overhead-valve design since the cost of push rods and rocker arms was avoided. This savings could be used to provide other advanced features if the flat-head engine could meet performance

targets.

According to Tom Asmus, “The short distance between the center of the cam and the crank made the mechanical design much less complex.” Compared to an overhead-valve mechanism, he explains, “the valve train was simple and stiff . . . there was not the mass and complexity of push-rods and rocker-arms . . . and importantly lubrication of the valve train was much simpler. No cored and drilled oil passages to become plugged; no problems with oil drainback; no difficult sealing of a valve cover. . . and the block casting was compact and ridged.”

One of the features of the ZSB engines was full-pressure lubrication that ensured reliable high-speed operation. Modern detergent oils and efficient full flow oil filters were not available, and it was necessary to provide a good supply of oil to the valve components to prevent failure. This was much easier with the flat-head or valve-in-block design. Hydraulic valve lifters were not known, so it was difficult to maintain valve adjustment with an OHV layout. OHV heads were more difficult to cast, and often “core shifts” would result in thin walls around the values and short life between regrinds. These shifts could also result in hot spots in the oil drainback passages that would “coke” the oil, plug the passages and trap large amounts of oil in the upper head and rocker arm area. This could starve the oil pan pickup and result in no oil for the crankshaft bearings.

As William Weertman describes the extensive combustion chamber and valve transfer passage work that was carried out on the early cylinder head, he makes reference to the many drawings of experimental combustion chambers with variations of chamber shapes in Carl Breer’s book, *The Birth of the Chrysler Corporation and Its Engineering Legacy.* Weertman says, “Since the poor fuel then available limited compression ratios, the engines had relatively large combustion chambers and large transfer passages so volumetric efficiency was not especially harmed by the side valves and flat head. The early engines were limited more by the carburetors, intake and exhaust manifolds, perhaps even more on OHV engines with the then standard updraft carburetors.

“This combustion chamber and passage flow development work allowed them to use compression ratios higher than competitive engines and also contributed to the smoothness of engine operation,” Weertman continues. “When compared to engines of similar displacement, the power of the early ZSB engines was the equal or

superior to any mass production engine of the time."

These higher specific outputs of the ZSB engines generated more heat, and engine cooling was another area in which the flat-head engine excelled. There was a simple water path through the block and head, and as outputs rose in the mid-1930s, a water distribution tube was added to ensure good cooling around the exhaust valves — something that was hard to do with an OHV layout.

All in all, ZSB produced a series of very good engines well suited to their time. They met the customers' needs for the new Chrysler cars — powerful, smooth and reliable. The flat-head design continued to be their best choice for the new models and car lines, and even in the late 1930s, Zeder, Skelton and Breer could see no reasons to change. The flat-head design was meeting their established performance requirements, and they fully understood the engine. Why change to a more risky, costly arrangement? But the immense improvements in engine and fuel technology during World War II, combined with the greater power required by the higher speeds allowed on improved highways, overtook the flat-head engine and made it obsolete.