EUREKA MOMENT WITH ENGINE COOLING

We live in Phoenix and have owned our '56 Thunderbird for nearly 16 years. Driving our Bird was frequently a struggle with overheating. Even driving in our Thanksgiving Day Parade that starts at 9:00 AM and only takes 20 minutes has been a challenge.

Four years ago, we had the engine rebuilt, and while inspecting the parts of the Y-block engine involved with coolant flow, i.e. water jacket, heads, water pump, etc., I observed an aspect of the water pump spacer that I had not seen, heard, or read about before, and I had sought out anything regarding the spacer because it is unique to the '55-'57 Thunderbirds. It only serves to move the water pump forward 1.1 inches to make the Y-block engine fit in the car.

In all other applications of the Y-block, the water pump mounts directly into the cylinder front cover (also known as the timing chain cover). This positions the water pump impeller to operate adjacent to the opening of the fluid path (referred to as a "volute" in fluid pump terminology). The volute is angled back into the cover at approximately 51 degrees and extends approximately ¾ inch beyond the opening. Figure 1 is an oblique view of the volute opening from slightly in front and to the right and well below the opening.

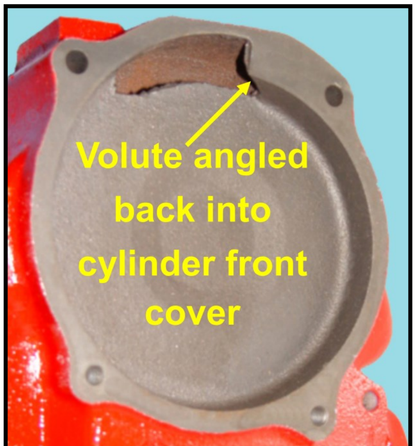


Figure 1

The factory Thunderbird water pump spacer is missing a design feature to extend the volute from the timing chain cover to the front of the spacer. Without extending the volute, the impeller operates at 0.7 of an inch in front of the volute opening. Fluid departs the impeller vanes at 90 degrees to the helix offset in the internal surface of the spacer. Rather than channel the coolant, the spacer presents an obstruction to flow that generates turbulence. Figure 2 is the same oblique view of the cylinder front cover with the spacer in place. This observation was clearly a *Eureka Moment* after 60 plus years of Thunderbird cooling issues.

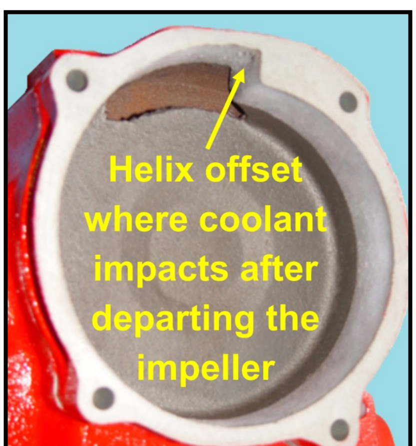


Figure 2

The question then was; what is the most effective and elegant design change to address the problem? I lacked the knowledge of the theoretical considerations, so I enrolled in *Introduction to Thermal and Fluids Engineering* at Arizona State University. I have always enjoyed the challenge of education and training environments, but at times this course proved to be more "enjoyable" than I cared to experience. For the semester, Mrs. Ames' suggestions of a movie, or dinner out elicited responses of "I have Thermal homework," or "I have a test coming up in Thermal." But the course provided the knowledge I needed to develop viable design theories.

When I speak of elegance in design, I am setting goals of perfection in the various aspects of the project. For the spacer project, these were:

1. An effective solution.
2. Isolated to a minimum number of existing components, ideally one.
3. Constrained to the least complex components, preferably non-moving, small, and accessible.
4. Compatible with other existing changes, i.e. the "High Output" water pump.
5. Acceptable as original for Concours judging.

From a practical perspective, I believe the effects of the design change on coolant flow must be measurable in the car as it was built by Ford Motor Company so I replaced our aluminum radiator with a standard radiator for all flow tests. Additionally, the measurement should be sensitive to the low end of the operating range but have a minimal parasitic effect on the measured flow. To that end, I acquired a 1½ inch Hedland EZ-View Flow Meter to come as close to the upper radiator hose diameter as possible without exceeding it. Figure 3 pictures the meter installation.

Figure 3

After hundreds of 3D CAD designs, nine plastic models, and three machined prototypes, a design I have branded the "A-432," provided the best improvement in coolant flow. This design includes an integrated volute extension over a 43.2-degree arc aligned with the volute opening in the timing chain cover. The extension's fluid channeling surface has a 2.5-degree clockwise twist from the front (water pump end) of the extension to the back. Figure 4 shows the back side of the A-432 prototype and Figure 5 shows the A-432 prototype installed in the timing chain cover with the mating point of the volute extension to the existing volute called out.

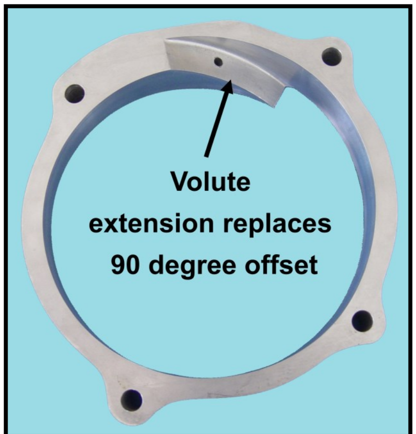


Figure 4

A comparison of flow test data for the factory vs. the A-432 spacer, for six engine speeds ranging from 500 to 2500 RPM is graphically presented in Figure 6.

So why does my T-Bird overheat idling along at approximately 625 RPM in the Thanksgiving Day Parade? Checking the factory spacer flow test at 750 RPM we see that it showed no measurable flow! Zero flow means no movement of hot coolant through the radiator, no rejection of heat from the radiator into the air and ultimately no engine cooling!

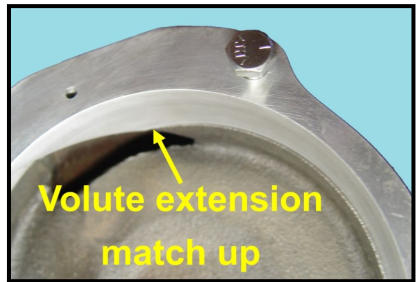


Figure 5

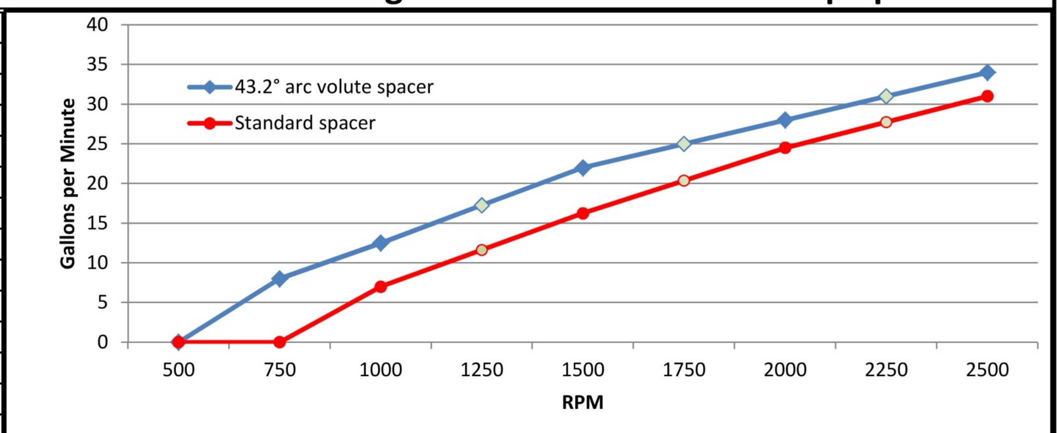
The good news is that with the A-432 installed, the flow at 750 RPM is 8 GPM (Gallons Per Minute). By interpolation, the flow at 625 RPM is 4 GPM.

But the proof is on the street. I drove the 2017 Thanksgiving Day Parade with the A-432 installed, and the car didn't go over 190 degrees.

How elegant is the A-432? It is effective, isolated to a single, non-moving, medium sized and moderately accessible component. It is cast iron with a sand cast outer surface finish and the same reliefs as the factory version.

Coolant Flow Comparison - Standard vs 43.2 Degree Arc Volute Water Pump Spacer

Model year:	1956
Engine:	312 C.I.
Radiator:	Standard
Coolant:	50/50
Water pump:	Standard
Spacer:	43.2° arc volute
Thermostat:	180°F
Fan:	Six blade rigid
Auxiliary fan:	Electric
A/C:	Yes
Ambient air temp:	78°F
Barometric press:	30.04 Hg



	RPM	500	750	1000	1250	1500	1750	2000	2250	2500
Coolant flow GPM:	43.2° arc volute	0	8	12.5	17.25	22	25	28	31	34
	Standard spacer	0	0	7	11.625	16.25	20.375	24.5	27.75	31
	Percentage change:	Undefined	Undefined	78.6%		35.4%		14.3%		9.7%
Notes:	Data with light green backgroud is Interpolated.									

Figure 6

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