Volume LIX • Number 3 • 2011

THE AUBURN CORD DUESENBERG® CLUB NEWSLETTER

An organization for the restoration and preservation of original Auburn, Cord and Duesenberg automobiles

THE YEAR OF THE CORD 810

Vic Kreis's Cord 810 Phaeton 810 2253H

FOR THOSE WHO HAVE NEVER RELISHED THE COMMONPLACE

Investigating Cord Radiator Airflow – Part 2

by Lynn Kissel

In Part 2 I report my initial measurements of the airflow on *Ginger*, our 1937 Cord 812 supercharged Custom Beverly sedan using the anemometers (airspeed meters) whose construction and calibration I described in Part 1.

The Cord radiator and fan

A cartoon of the relative size and position of Ginger's radiator core and engine fan is shown in Fig. 1. Clearly the engine fan dominates airflow through the radiator when the car is at rest. Unfortunately, the stock unshrouded fan covers only 50% of the core. (Part of the fan circle covers the top tank, and the hub area draws in no air.) *Editor's note: Lynn's drawings, measurements and graphs are based on a Custom series Cord, whose radiator is 1-1/2 inches higher than the one in the standard wheelbase cars. In standard wheelbase cars the percentage of fan coverage is about the same. Although more of the fan circle covers the top tank, this is largely offset by the smaller radiator core.*

Fig. 1 illustrates the grid that will be used for subsequent surveys of the airflow, which has four rows and five columns. My nomenclature for columns and rows is shown along the top and left side of the figure. Each of these 20 cells is approximately the size of my 120mm anemometer, so a complete survey of the radiator core will require 20 individual measurements.

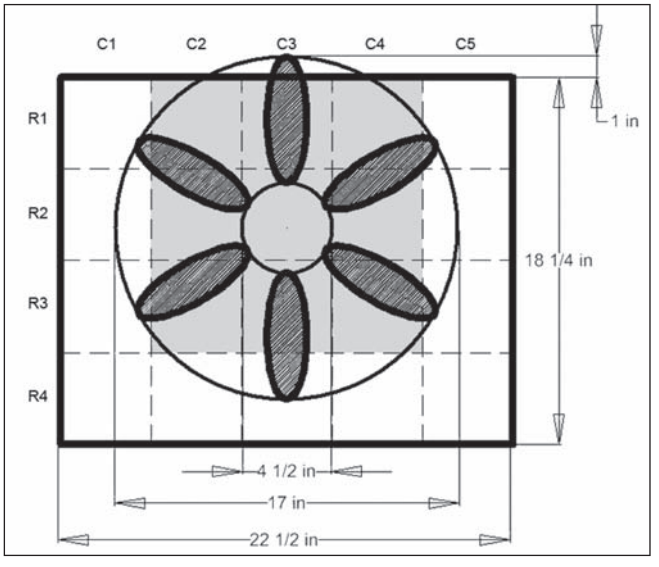


Fig. 1. Relative positions of the radiator core and engine fan on Ginger (as viewed from the front of the car). The fan circle covers about 54% of the core. The dashed lines denote a 120mm grid used for the measurements. A column/row coordinate system is indicated along the top and left side. The nine 120mm-square cells that are directly under the fan are shaded gray.

Several complete surveys were also made with the 60mm instrument which requires 80 individual measurements. Although the 60mm instrument has twice the linear resolution of the 120mm one, it requires four times the effort to complete one survey.

Modifications made in the past

I've been told that the most serious cooling problems occur in idling or slow moving Cords. So although some of the modifications discussed below are most likely to have an effect at speed, all the results reported in this part are for the car at rest. I have hopes of making measurements on a moving Cord in the future.

I have assigned a "Mod" number to each of the modifications listed below for easy reference in tables and figures.

Fan shroud / Fan ring (Mod1). A shroud works by isolating the outgoing air from the incoming air of the fan, reducing blade tip losses and improving efficiency. A conical metal shroud was installed by the Modine Manufacturing Company on aftermarket radiators for Cords sold by the A-C-D Company after 1938.

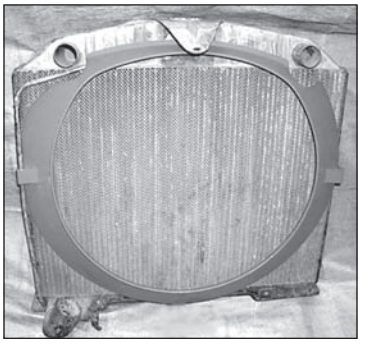


Photo 1. A **fan shroud** acquired on eBay. This is a reproduction of the Modine shroud. Because this shroud was designed for a standard wheelbase radiator the notches for the radiator top tank inlet pipes do not fit accurately. The fan on both series of Cords was the same size, so it is likely that airflow results will be similar for both.

A Fan ring is a shroud that stands perpendicular to the core instead of having a conical shape. It works the same way as a shroud, but draws air from a smaller area on the radiator core. While fan rings were not known to have been fitted to Cords during the factory era, owners fabricated and installed them as far back as the 1950s.

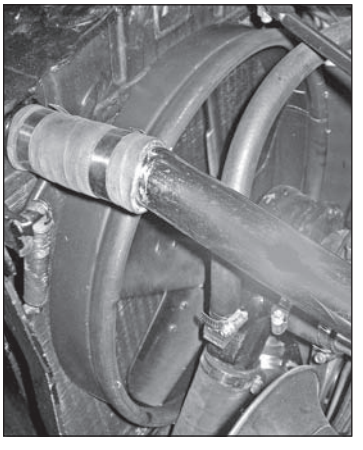
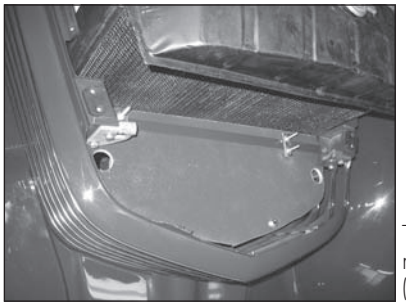


Photo 2. Plastic landscape edging is used to create a *Poor Man's Fan Ring*. (PMFR). (Mod1)

Mid-louver baffle (Mod2). A horizontal vane in front of the radiator that attempts to increase airflow through the lower half of the radiator by redirecting it away from the top. Tom Georgeson developed this idea. (See his article in *Tech Talk*, *ACD Club Newsletter*, 2009-05.)



Tom Georgeson's experimental ***mid-louver baffle*** (Mod2)

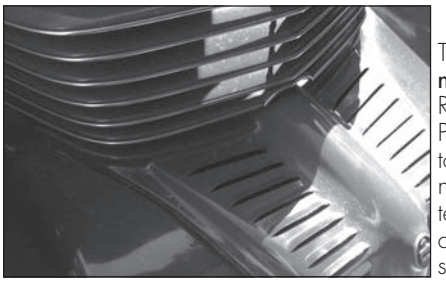
Radiator top seal (Mod3). In later production, Auburn engineers fitted a red sponge-rubber seal to the underside of the hood, conforming to the top tank of the radiator. The seal blocks airflow over and around the tank, in an attempt to force more airflow through the core. The rubber did not have a high tolerance for heat and within a few years of driving had melted into a sticky mess on the radiator top tank.

The ***red rubber seal***, as fitted to the hood of Josh Malks's *Moonshadow*.(Mod3)

Hood baffle (Mod4). A horizontal sheet blocking off the dead air space under the hood and in front of the radiator. This baffle is intended to reduce the airflow up and over the radiator and attempts to force more airflow through the core. Ray Simpson developed this idea, and made one for his Cord out of .024 stainless steel sheet.

Ray Simpson's ***hood baffle***. Notches were required to clear the hood latch arms and return spring. (Mod4)

Transmission cover louvers (Mod5). Photographs show that Ab Jenkins's personal Cord and those he raced at Indianapolis and Bonneville had louvered transmission covers. Some Cord owners are considering adding louvers to existing transmission covers. The intention is to increase airflow through the lower part of the radiator. It should be said, however, that the Jenkins louvers may have been intended mostly to improve transmission cooling, which might have had overheating problems under race and time-trial conditions



This **louvered transmission cover** on Roger Von Bergen's Phaeton is believed to be a factory original. (Mod 5). For my tests, removal of the cover served as a surrogate.

The surveys

I've acquired a reproduction of a Modine fan shroud (Photo 1). I expect that such a shroud will be effective, but I'm not yet ready to install it in my car. So I've chosen to fabricate a simple fan ring out of garden/lawn edging plastic (Photo 2). In my measurements I've used this Poor Man's Fan Ring (PMFR) as a surrogate for the Modine shroud and the steel fan ring.

I do not have access to a louvered transmission cover. To simulate this, surveys were conducted with the transmission cover removed.

Tables 1 and 2 summarize over 200 individual measurements from eight complete surveys that I've made on Ginger's radiator. These measurements were made on four different days over a period of about two weeks. Surveys were made on the stock car and on the car variously equipped with the PMFR, with cardboard fitted to simulate the baffles and with a foam rubber seal over the top tank.

Survey	Engine Speed (RPM)	Config	Air Temp (°F)	Total Airflow (CFM)	Fraction of Airflow that is...	
					Upper Half	Cells Swept by Fan
1	500	stock	52	6.4	59%	71%
2	1,000			17.4	55%	63%
3	1,500			29.3	55%	61%
4	2,000			39.4	54%	62%
5	500	PMFR	57	7.4	67%	89%
6	1,000			19.3	60%	77%
7	1,500			31.8	60%	76%
8	2,000			44.5	60%	76%

Table 1. Upper half Generally the airflow shows an approximately 60-40 split between upper and lower halves of the radiator. I think this is a direct consequence of the position of the engine fan. (The airflow is very close to a 50/50 split between the lateral halves of the radiator.)

Cells Swept by fan The fraction of the total flow through the nine 120mm cells shown by the gray highlight in Figure 1 is listed as "Cells swept by Fan" in Table 1. (By this I mean cells which are directly in front of the fan circle.)

The airflow is strongly concentrated in these cells. Their fraction of the total flow decreases with increasing engine speed, indicating that relatively more air is being drawn through cells that are not swept by the fan.

Fan ring. The PMFR creates a 35% increase in airflow volume in the area within the ring. (Fig. 2 and 3). The percentage of increase for the entire core area, however, is only 12% (surveys 5-8 vs. 1-4) since the fan covers less than 60% of the core.
The airflow for the PMFR (which forces the fan to draw from a fixed circle on the radiator) displays no dependence on engine speed in surveys 6-8. (The small dependence on engine speed shown at 500 RPM in survey 5 may be an indication of greater instrument errors in low-speed measurements.)

Findings

Results for surveys 1 and 4 (stock car at 500 and 2000 RPM) are displayed graphically in Fig. 2, while survey 8 (PMFR at 2000 RPM) is shown in Fig. 3.

The summary of a brief investigation of the impact of modifications to the airflow is summarized in Table 2. For these abbreviated surveys, the airspeed for only the cells in column C4 was measured. Comparison of results of testing a sample of cells vs. direct measurement of all cellsshowed that the relationship appears to be close enough to permit sampling as the basis for future testing of the Cord in motion.

Mod5 (transmission cover louvers) and Mod2 (mid-louver baffle) are intended to supply more air to the lower half of the radiator. While they appear to have little effect on airflow to this area, in fairness these modifications are likely only really effective when the car is moving, so these measurements made on a car at rest are not a complete test.

Surprisingly, Mod2 (mid-louver baffle) does appear to increase the *total* flow by about 15% at idle speed. I am not sure, at this time, how it does this.

Mod4 (PMFR) increased airflow for column C4 by 20-30%. Because of its construction, the PMFR also increased the fraction of air flowing through the top half of the radiator. Generally, the area of the core within the fan circle accounts for the majority of the total airflow. The PMFR is effective in increasing the airflow somewhat. It suffers from drawing air only through the portion of the core directly in front of the fan.

It will be interesting to test Mod2 in conjunction with Mod4 and see if their positive benefits will be additive and further increase the airflow.

During the course of the surveys I checked the airflow with the engine idling and the hood open. There was a 15% increase in total airflow with the hood open. This seems to imply that the closed hood measurably decreases the airflow through the radiator and that the air inflow area between the front hood louvers with the hood closed may be less than optimum.

Engine Speed (RPM)	Airflow for Column C4					Fraction of Airflow in Top Half				
	Stock (CFM)	Mod1 v. Stock	Mod2 v. Stock	Mod3+ Mod4 v. Stock	Mod5 v. Stock	Stock	Mod1	Mod2	Mod3+ Mod4	Mod5
500	1.8	31%	16%	-6%	-3%	50%	64%	51%	53%	48%
1,000	4.5	18%	8%	2%	2%	52%	63%	49%	53%	52%
1,500	7.1	31%	6%	-1%	4%	51%	56%	51%	50%	52%
2,000	9.8	21%	6%	-8%	3%	50%	63%	49%	54%	51%

Measurements taken with 120mm instrument on 02/17/2011 at 57 °F.

Table 2. Summary of measurements made on Ginger's radiator with selected modifications. All measurements are with the car at rest.

So what are my conclusions?

For the car at rest and for very low speeds, it's not what's in front of the radiator that matters; it's what's behind it. The engine fan is clearly the dominant factor in drawing air through the radiator (but you already knew that).

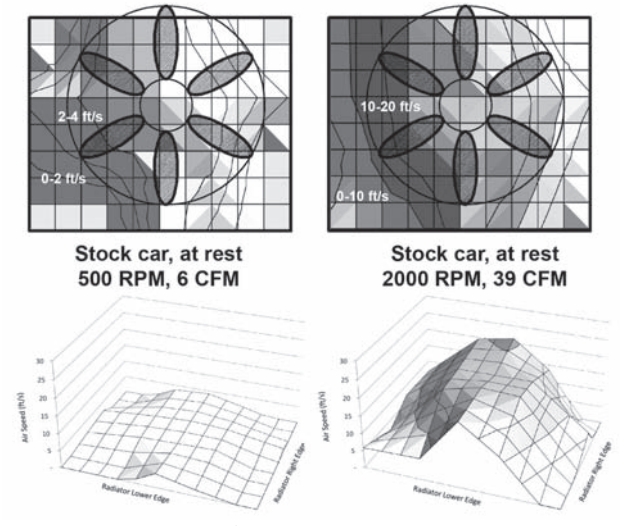


Fig. 2 Contour and surface plots illustrate the airspeed through the core, measured with the car at rest, for engine speeds of 500 and 2000 RPM. Contour plots of the measured airspeed are overlayed with an outline of the fan and core. The airflow is highly correlated with the position of the engine fan.

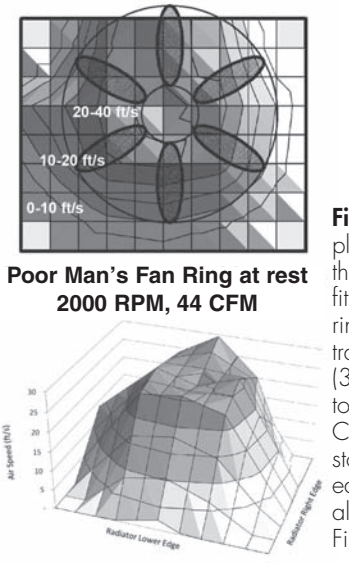


Fig. 3 Contour and surface plots of the measured airspeed through the core, for Ginger fitted with a poor man's fan ring (PMFR). Note that the central airspeeds are 50% higher (30 ft/s v. 20 ft/s), and the total airflow is 13% higher (44 CFM v. 39 CFM) than for the stock configuration. The shaded bands and axis heights allow direct comparison with Fig. 2.

The stock fan is effective in drawing air through about 50% of the core. All four corners and much of the sides and bottom have little to no airflow with the engine at idle and car at rest.

A fan ring (and presumably a circular shroud like the Modine design) is quite effective in increasing the efficiency of the fan. A properly constructed custom shroud *might* draw air through the entire radiator. The reason for the qualification is that the Cord's fan blades spin quite close to the surface of the radiator core so a shroud covering the entire core would be very shallow. While it might indeed pull in more air at idle and low speeds, it seems possible to me that such a shroud might actually interfere with airflow at higher road speeds when the ram effect takes over. It would be counterproductive to solve a low-speed cooling problem by introducing a high-speed one.

The mid-louver baffle also appears to increase total airflow at low speeds, for reasons not yet understood.

And, those Cord owners who instinctively speed up their engines during parades or hot weather traffic are correct – at 1500 rpm the stock fan draws in 4-1/2 times as much air as at 500 rpm!

For the future

After Part 1 was published, I received an email from John McCall, a Connecticut owner of multiple Cords. From his note and a subsequent telephone conversation, I learned that John has 38 years of experience in measurement and simulations of airflows working for a large aerospace company. John brought up a number of important concepts in our exchange, but the one that stuck with me most was that of enhancing the ram effect on the radiator.

For a car in motion, the dynamic pressure from the air that the car runs into is expected to increase with the square of the velocity (related to the kinetic energy of a moving mass). At some speed this becomes the dominant factor forcing air through the radiator.

The sides, top and bottom of the stock Cord radiator are generally open, except for the afterthought red rubber seal. This allows air to easily spill around the edges and reduces the ram effect. Could the ram effect be enhanced if, for example, the edges of the radiator core were sealed within baffles that extend a few inches forward on all four sides?

When I have the opportunity I hope to test this idea, along with the other modifications that I've already noted.

I'd like to thank Josh Malks for many helpful discussions and for encouraging me to write up this effort for the *ACD Club Newsletter*.

For the scientifically minded

Fig 2 and 3 are a direct visualization of the measurements. The info in Tables 1 and 2 are computed/derived results – and are only indirectly related to the measurements.

The airspeed (ft/s) is being directly measured but is only indirectly related to the cooling. The total airflow (CFM) is directly related to the cooling (amount of heat removed), but is not being directly measured.

Rings and shrouds

There are drawbacks to shrouds and rings; they are not stock and they are visible. Fan rings, at least, can be built so they can be easily removed for a show, restoring the car to stock. My PMFR is so constructed. Josh Malks tells me that a steel fan ring that he installed on his Cord in 1958 could be installed and removed without tampering with any stock parts.