

A NEW APPROACH TO UPDATING THE PANTERA'S COOLING SYSTEM

By John Taphorn

Let's face it, cooling mods for the Pantera's bodily fluids, oil and water, has to be the oldest conversation piece about the car and the topic with the most documented articles. What more could possibly be said or done? Well, we have a new approach! With suggestions, insights and assistance from owners on this list, we have cracked the cooling code. Indeed, this is a Texas heat and race track tested modification that will keep your kitty cool and collected.

Prior to making the modifications, my car ran acceptably cool on the street. I've got the big laydown single pass radiator up front with the dual sucker fans and a high volume water pump. Granted, it was never tested in Houston summer traffic for an extended period of time, but otherwise no major issues cooling the 408 Monster Stroker.

The problem that encouraged me to enhance the cooling system was high oil temperatures on the track at Club events. Spirited driving caused elevated oil temps that were dangerously high and contributed to reduced oil pressure. While my coolant temps were in the 200-degree range, my oil temperature would climb to over 300 degrees after only a few performance laps. Methodically, I'd putz around a few laps until the oil temps dropped and then hammer it again. The cycle repeated itself.

I was surprised to learn that the difference in temperature between the coolant and the oil could be so great. Without the benefit of an oil temperature gauge, I had always believed that my engine oil was operating in a safe temperature range on the track because the coolant temps were low. I had assumed incorrectly; my recent addition of an oil temp gauge enlightened me to a problem that needed to be addressed.

Another issue that I wanted to improve was the loss of oil pressure in the turns. On high-speed turns and 180-degree carousels, my mechanical Autometer oil pressure gauge was communicating serious pressure drops. Through the Texas World Speedway Carousel, I could even get my oil pressure warning light, which is set at 15lbs, to flicker.

The project embraced the following goals:

- 1) Reduce oil temperatures to less than 260 degrees during spirited higher RPM driving
- 2) Reduce oil starvation in high G turns.
- 3) Maintain coolant temperatures below 210 degrees.
- 4) Elegant installation of additional accessories

COOLING SYSTEM ISSUES

1) Reduce oil temperatures to less than 260 degrees during spirited higher RPM driving.

An oil cooler seemed appropriate; but what type? Lack of good airflow near the engine seems to compromise the effectiveness of air to oil coolers on a Pantera. I am unaware of anyone employing this approach effectively. In view of this, I selected a heat exchanger manufactured in Sweden by Laminova and distributed by Aeroquip (<http://www.bakerprecision.com/aqp10.htm>). A heat exchanger transfers the heat from your oil to your coolant. After I purchased the unit and before I installed it, there was some discussion on the DeTomaso Forum as to whether or not this unit was adequate in size to handle the task. Fortunately it is. A significant challenge with the use of a heat exchanger is the routing of the oil lines. You can't go under the engine, it's very busy in the front, and the oil line length is excessive when you try to go around the rear. To solve this, we got creative.

2) Reduce oil starvation in high G turns.

My solution to this problem was two fold. I was running the Hall 10 quart pan with the single baffle. Several members opined that the single baffle pan was inadequate as it did not have side baffles to prevent oil from staying from the sump in turns. Fortunately, Gray Gregory had a used steel Aviad pan with the four baffles that he was willing to exchange for my Hall unit. The second component to help solve my starvation problems was the addition of an Accusump (http://www.accusump.com/acc_tech_valve.html) manufactured by Canton. The Accusump stores 3 quarts of oil and releases it when the oil pressure drops in the engine.

3) Maintain coolant temperatures below 210 degrees.

Another question that I had to consider was whether or not my current cooling system had adequate additional capacity to absorb the heat energy from the oil without overheating in around the town driving or at idle. While it currently seemed adequate, I desired to address the flaws inherent to the system's design to improve its efficiency. These flaws included circuitous routing of the coolant lines, a restrictive thermostat that impedes flow, the swirl pot with its pressure cap on the high-pressure side of the system, and the routing of heater hoses into the cockpit that heats the cabin. It is true, the later problem can be reduced with shut off valves under the car; but it is not an ideal solution.

The challenge was how to eliminate the radiator cap from the high pressure side of the cooling system, plumb the heat exchanger with reasonably short oil lines, and mount the 3 quart Accusump in a clean if not elegant way in the Pantera's engine bay and still fit the rear trunk. I inquired to the DeTomaso list and

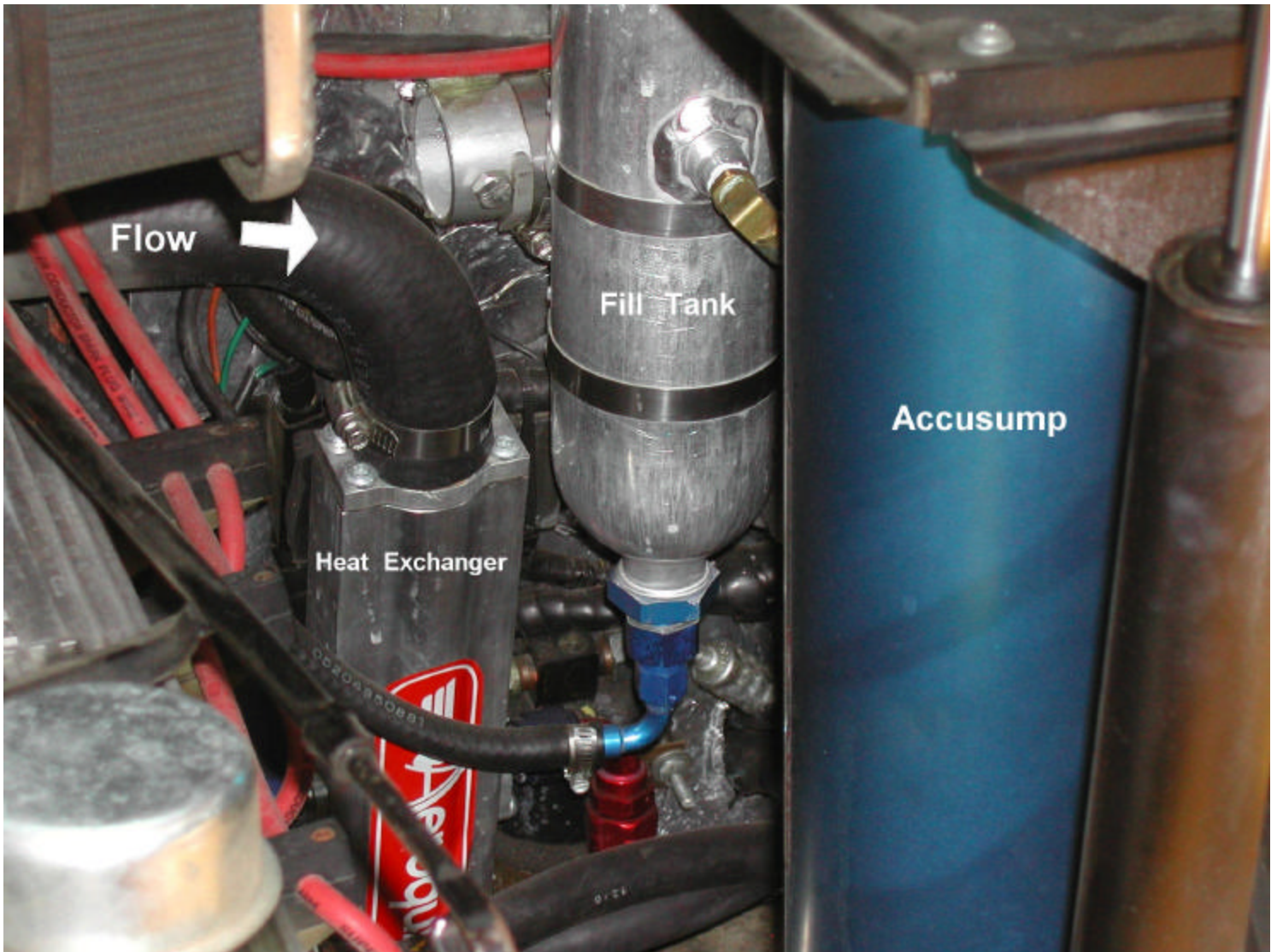
received a private reply from Mike Trusty who outlined a methodology that carried my initial thought to a superior conclusion. Mike's ideas were derived from the cooling system approach used by Mercedes, BMW, and more recently Ford. The principles applied were consistent with those espoused on the oft-quoted Stewart Components Website (www.stewartcomponents.com/html/tech_support/). Mike hadn't incorporated these concepts to his Pantera yet; but spoke confidently about their applicability. I dove right in and applied the approach to my car.

According to Stewart Components, fluid flow is the name of the game. Higher coolant flow will ALWAYS result in higher heat transfer. Coolant cannot absorb heat after it reaches its pressure corrected vapor point. Furthermore, coolant absorbs heat at a progressively slower rate as it approaches this point. The more flow the better. Therefore, any type of restriction that reduces the flow of coolant through the block is counterproductive. Optimizing coolant flow through the engine became our mantra.

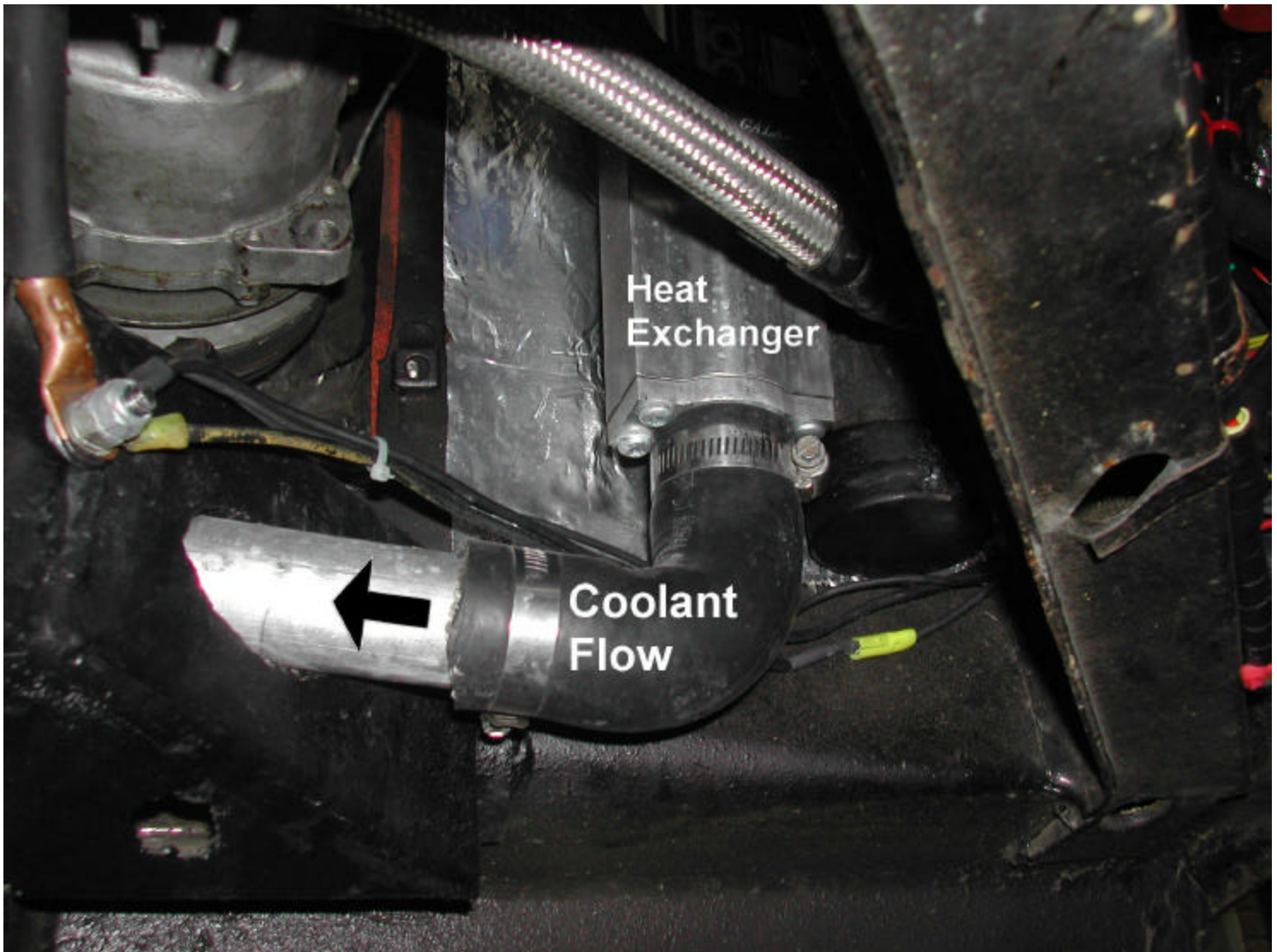
DESIGN OF THE NEW COOLING SYSTEM

In the new system, coolant flows out the block unrestricted by a thermostat. The traditional Cleveland thermostat is removed. Stewart Components explains that coolant flow has a direct relationship to area and an exponential relationship to pressure. Meaning that when you double the area of an orifice and maintain pressure the flow doubles, but when you double the pressure and maintain area the flow is only increased by 1.414 (the square root of 2). I'd venture to say we have doubled the area of that block exit orifice with the removal of the Cleveland "hat style" thermostat possibly doubling flow.

Coolant flows through the block outlet pipe alongside the rear window. With the outlet pipe modified, the coolant makes a 90-degree bend toward the ground alongside the firewall.



The heat exchanger is mounted vertically on the firewall. The coolant flows through the heat exchanger and upon exiting then turns 90 degrees toward the center of the car remaining parallel with the firewall.

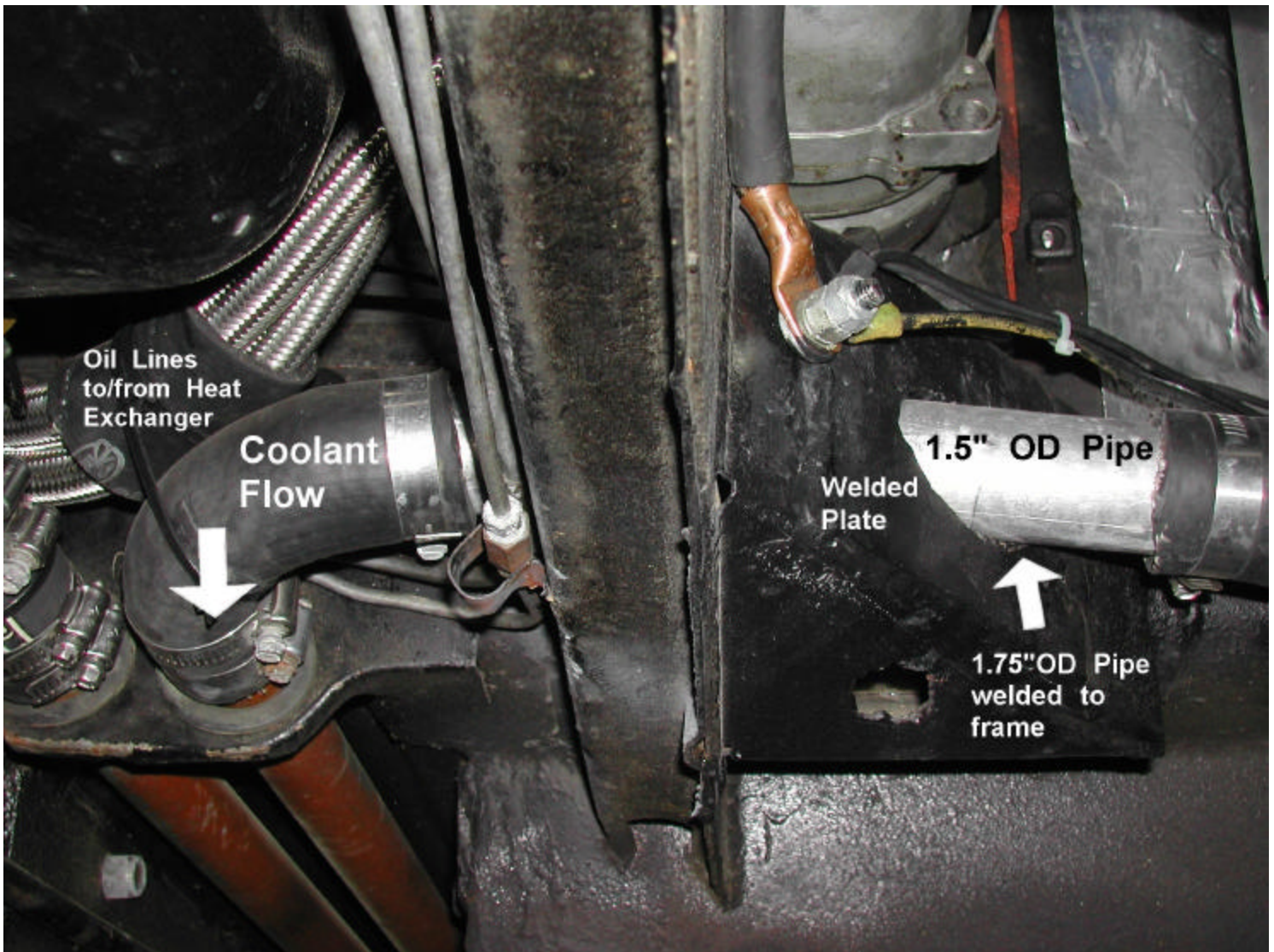


Minimizing bends, the coolant line passes through the frame rail and makes another 90 degree turn to join the radiator bound coolant tube.

To mitigate any compromise in frame strength caused by the new 1.75" orifice, two steps were taken. First, a 1.75" OD galvanized pipe was placed through the hole protruding 1/8" on both ends relative to the frame rails. These ends were welded to the frame rail around their circumference. Second, 1/8" thick steel plates with appropriate cut outs were placed against the frame rail over the pipe, which extruded 1/8", and welded to the rail and the pipe. Special thanks go to Dan Mixon, '74 Pantera owner, who ran the beads.

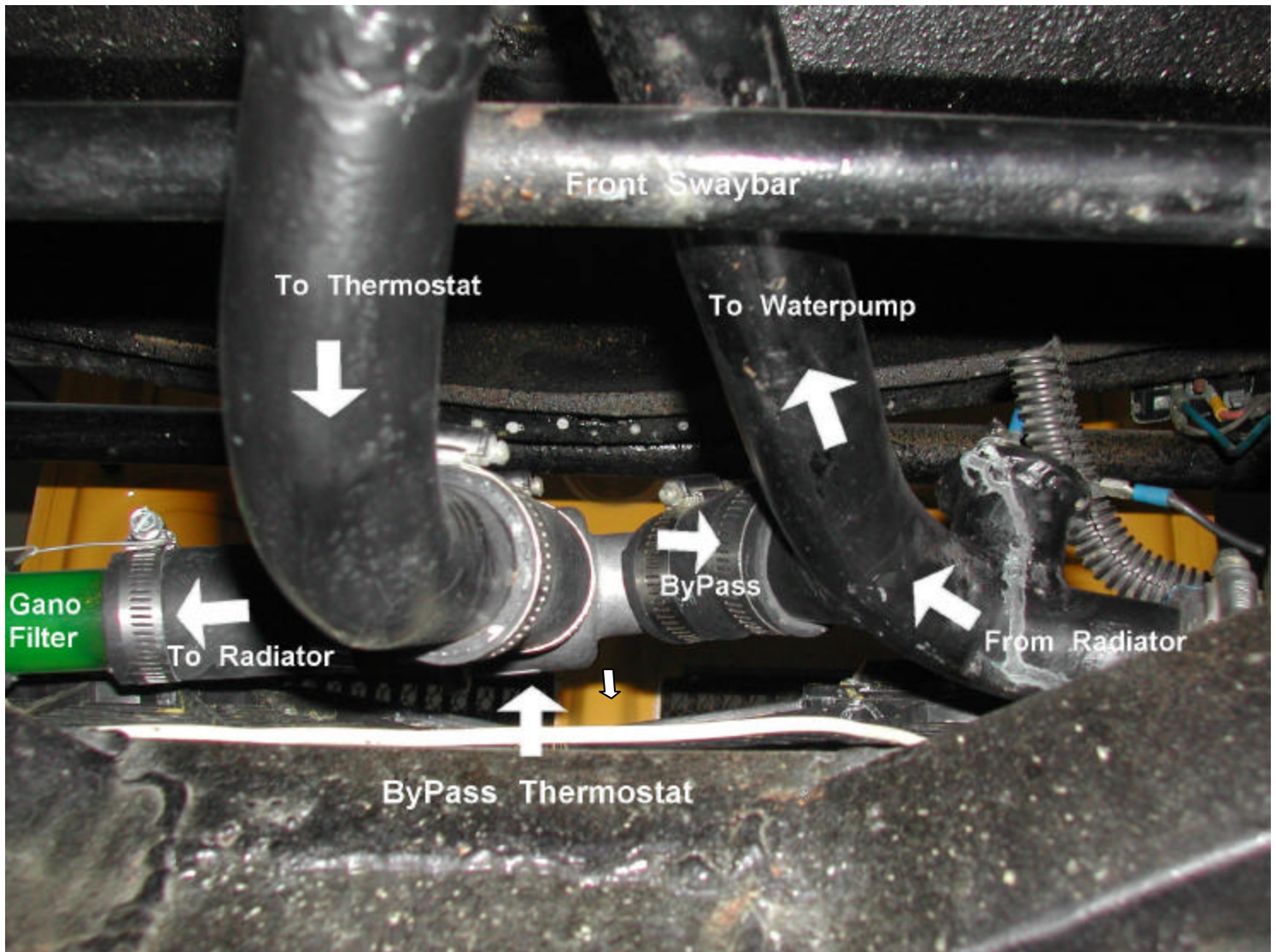
A 1.5" OD pipe fits perfectly in the 1.75" OD pipe, and it has the coolant hoses attached to it. Passing the coolant line through the frame eliminated the need for additional bends that would have otherwise been necessary. David Bell, '72 Pantera owner, informed me that a 90-degree fluid bend has the flow resistance

approximately equal to 3 times an identical length and diameter of straight tubing. I estimate we removed at least another 180 degrees worth of bends and the Swirl Pot. Flow is improved.

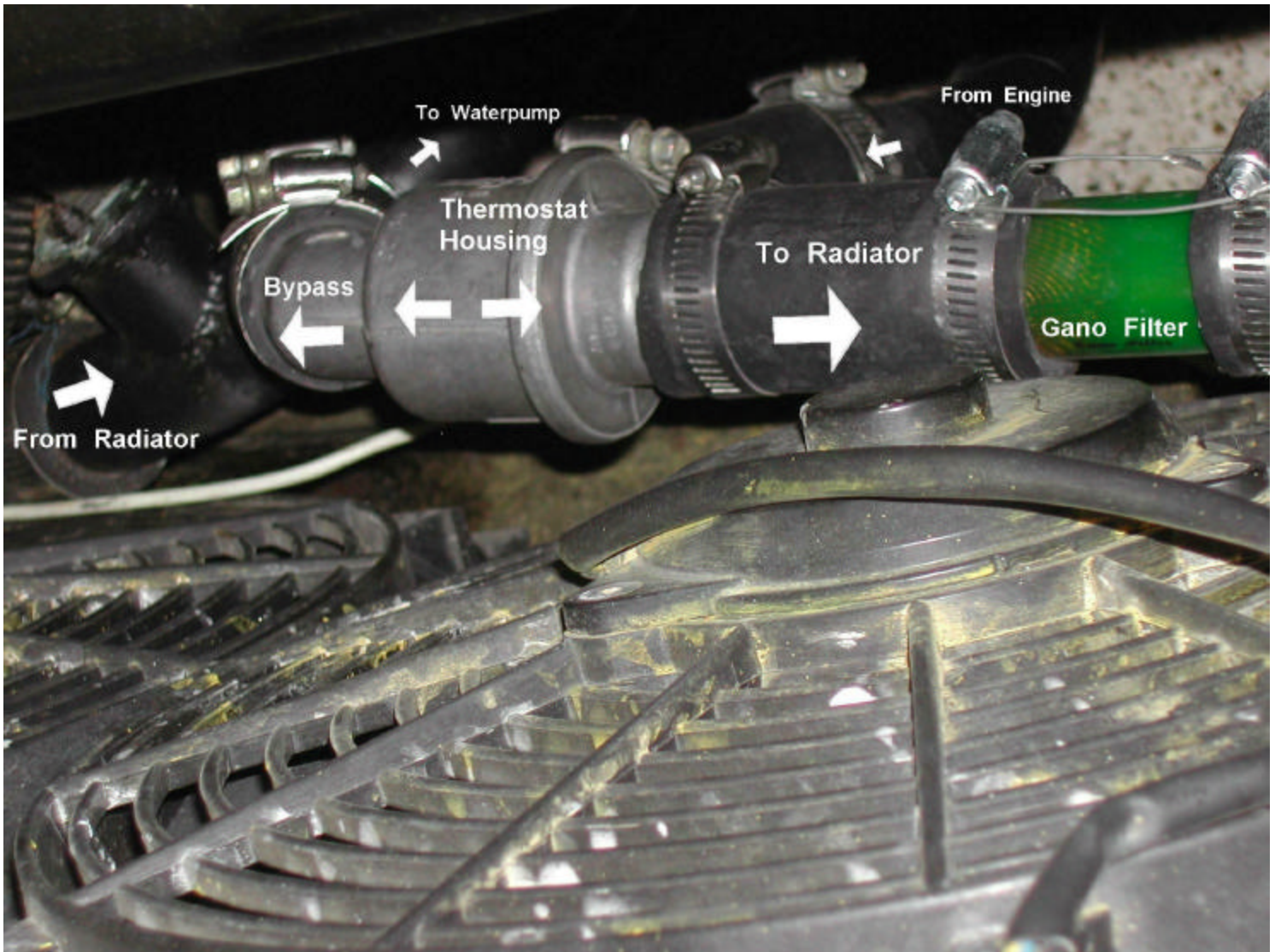


After passing through the coolant pipe under the car, the coolant enters a bypass thermostat prior to the radiator. The bypass thermostat is manufactured by Stant for a BMW 318i. If coolant temp is less than 185 degrees, this high flow thermostat directs the coolant to the return pipe that travels to the water pump and back through the engine to repeat it's cycle. When the coolant achieves temperature, the thermostat opens and redirects the coolant through the Gano coolant filter and into the radiator. The flow capability of this Stant thermostat design appears superior to that of the Cleveland hat type. Caution: Not all manufactured bypass thermostats for the BMW 318i appear to have superior flow characteristics. David Bell recently purchased one from a local auto parts shop

that was inferior in design. Look for a unit manufactured by Stant. I have not compared it to a direct replacement from BMW.



It is difficult to see the thermostat in this picture. This view is from under the car looking up behind the radiator. The location of the temp sender worked well prior to the installation of the bypass thermostat as it captured coolant temps after the radiator. However, now the location is too close to the bypass return outlet and the lower switch point of 176 degrees versus the thermostat at around 187 had the fans running before the thermostat opened and sent coolant to the radiator. The car ran too cool and the fans unnecessarily. I have since added a 190-degree fan switch to the water pump.



This is a better picture of the thermostat from above.

An additional benefit of the bypass thermostat is better recirculation of coolant through the engine when the thermostat is closed. With the hat style thermostat, the Cleveland block's cast in bypass orifice circulates only a small amount of coolant through the block when the thermostat closes. It is possible to have coolant boiling adjacent to an exhaust valve while the coolant near the thermostat is relatively cool keeping it closed. The bypass thermostat provides full flow through the block without engaging the radiator. Better flow through the block reduces the likelihood of hotspots. Incidentally, I have noticed no significant difference in the time that is required for the engine to achieve operating temperature with the new bypass thermostat mounted up front.

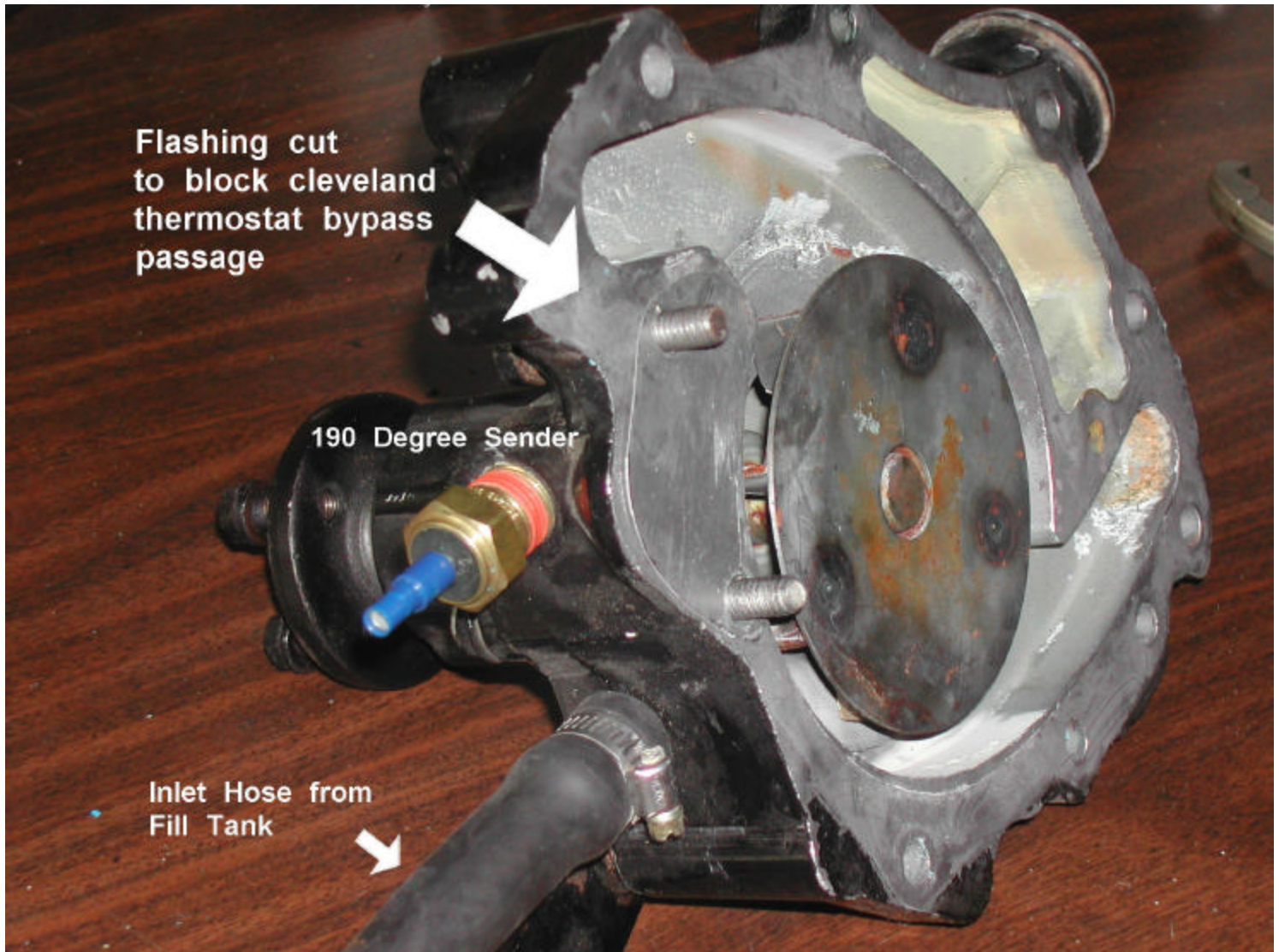
The radiator is a single pass to reduce coolant flow resistance and is tilted forward to create room for sucker fans. A shroud, which compromises air flow in high speed / high RPM conditions, is unnecessary with this system.

Several opine that because of the stock Pantera's difficulty in achieving good coolant flow, the Pantera benefits from a dual pass radiator through which the coolant's velocity is doubled. This added velocity increases fluid turbulence that causes the coolant in the center of the tube to be forced against the outside of the tube, which allows for better thermal transfer between the coolant and the tube surface. Unfortunately, double pass radiators require 16x more pressure to flow the same volume of coolant through them, as compared to a single pass radiator. Thus, many end up installing a dual pass radiator as a compromise to address a flow compromise, and with this practice, we are further reducing flow through the block. Ideally, one removes the system's flow restrictions and installs a less restrictive single pass radiator.

Stewart Components points out that the radiator becomes less efficient as the coolant outlet temperature approaches ambient. Therefore, a low flow rate keeps the coolant in the radiator longer. The longer the coolant stays in the radiator the lower the efficiency of the radiator.



After leaving the radiator, coolant travels through the return pipes to the high volume water pump. I have wired a 190-degree temperature switch in the water pump to trigger the relays to turn on the cooling fans. Since we are no longer using the stock thermostat, it is necessary to block off the Cleveland's cast in by pass. There are several methods to do this. I choose an inexpensive one. I closed off the Cleveland's bypass passage with a thin sheet of roof flashing sandwiched between the water pump and the block.

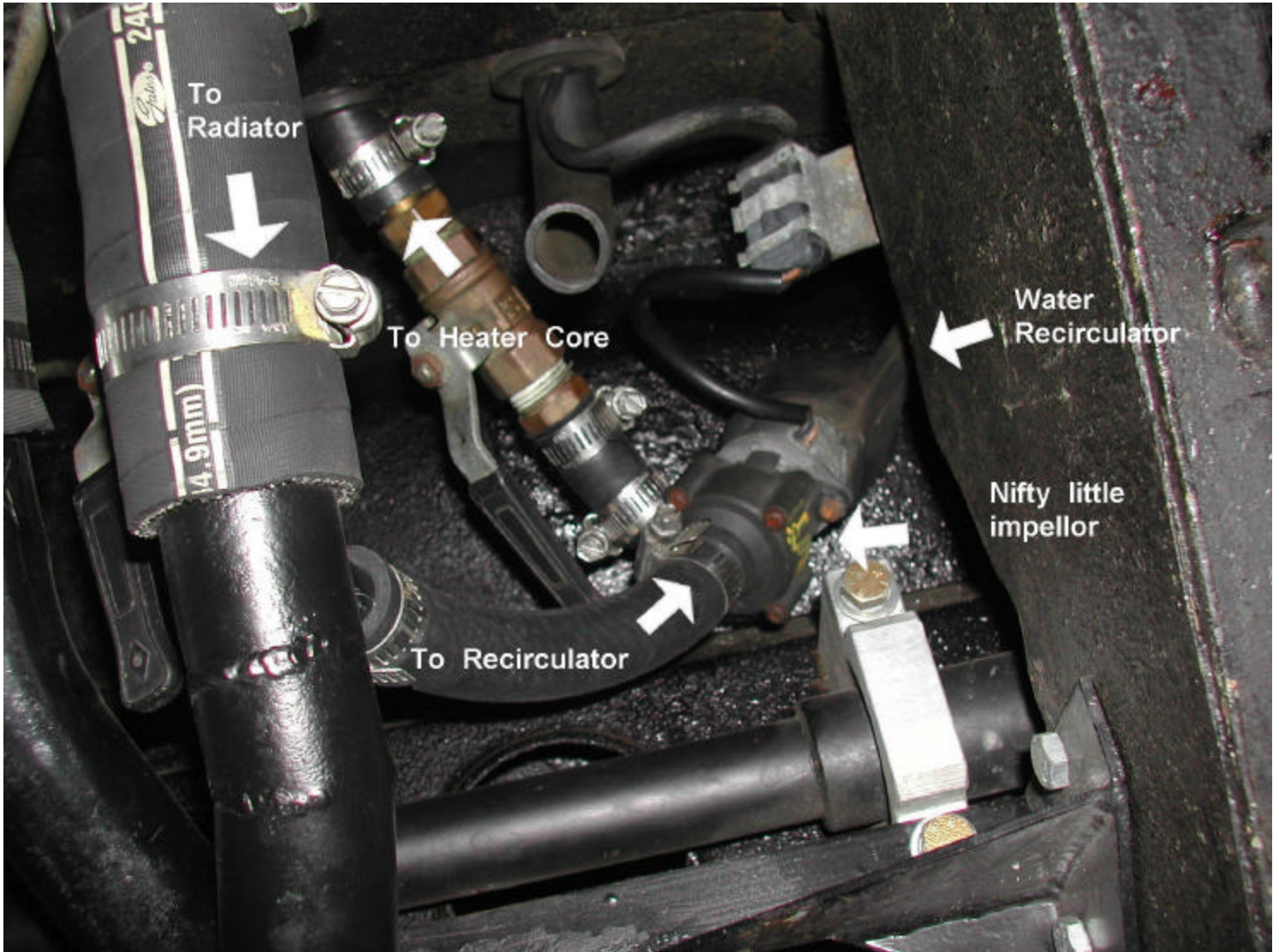


Picture of the water pump prior to assembly. Flashing is cut to fit around the two bolt locations to keep it in place during assembly.

REVISED COOLANT DELIVERY TO THE HEATER CORE

Coolant for the heater core, exits the coolant pipe at a location prior to the new thermostat at the front of the car beneath the trunk. I welded to the existing coolant pipe two $\frac{1}{2}$ " hose nipples. One angled properly for outflow and the other for inflow. The short $\frac{1}{2}$ " diameter outflow hose is connected to our Mercedes Benz Water Recirculator. The Recirculator is a very small electric water pump that MB uses to flow coolant through their auto's heater cores. I picked this one up at a local junkyard for ~ 40 bucks. Be certain to get the mount bracket as

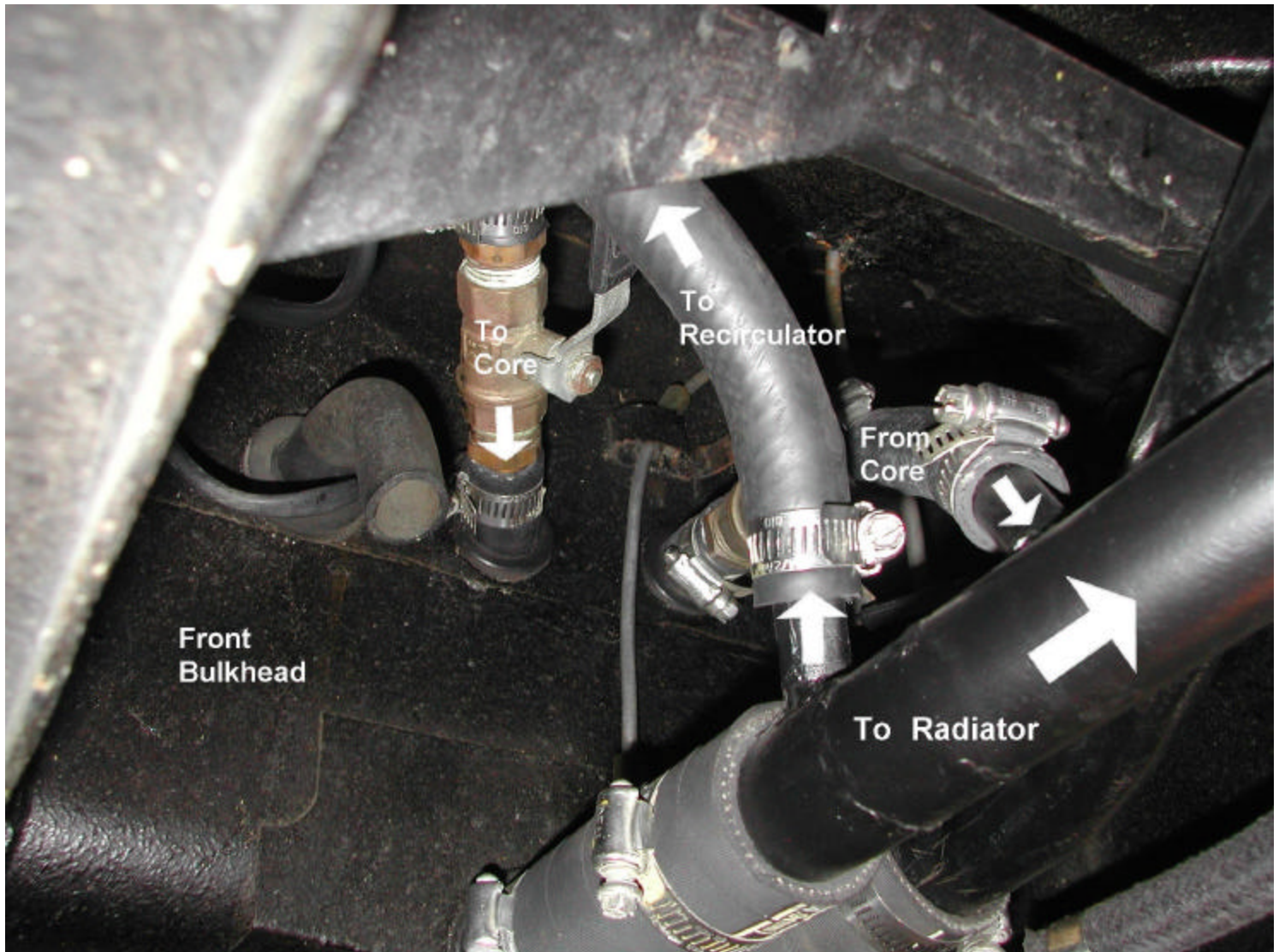
well. It mounts with two bolts and works perfect. A new pump without the bracket is about \$250.



This view is from under the front of the car aft of the steering rack. It takes a second to get oriented, eh. Assume that you are on your back with your feet sticking out the front.



I wired the pump to the additional relay on my Rick Moseley kit. When energized, the pump circulates coolant via a hose that passes through the forward bulkhead and connects to the stock heater control valve prior to the core.

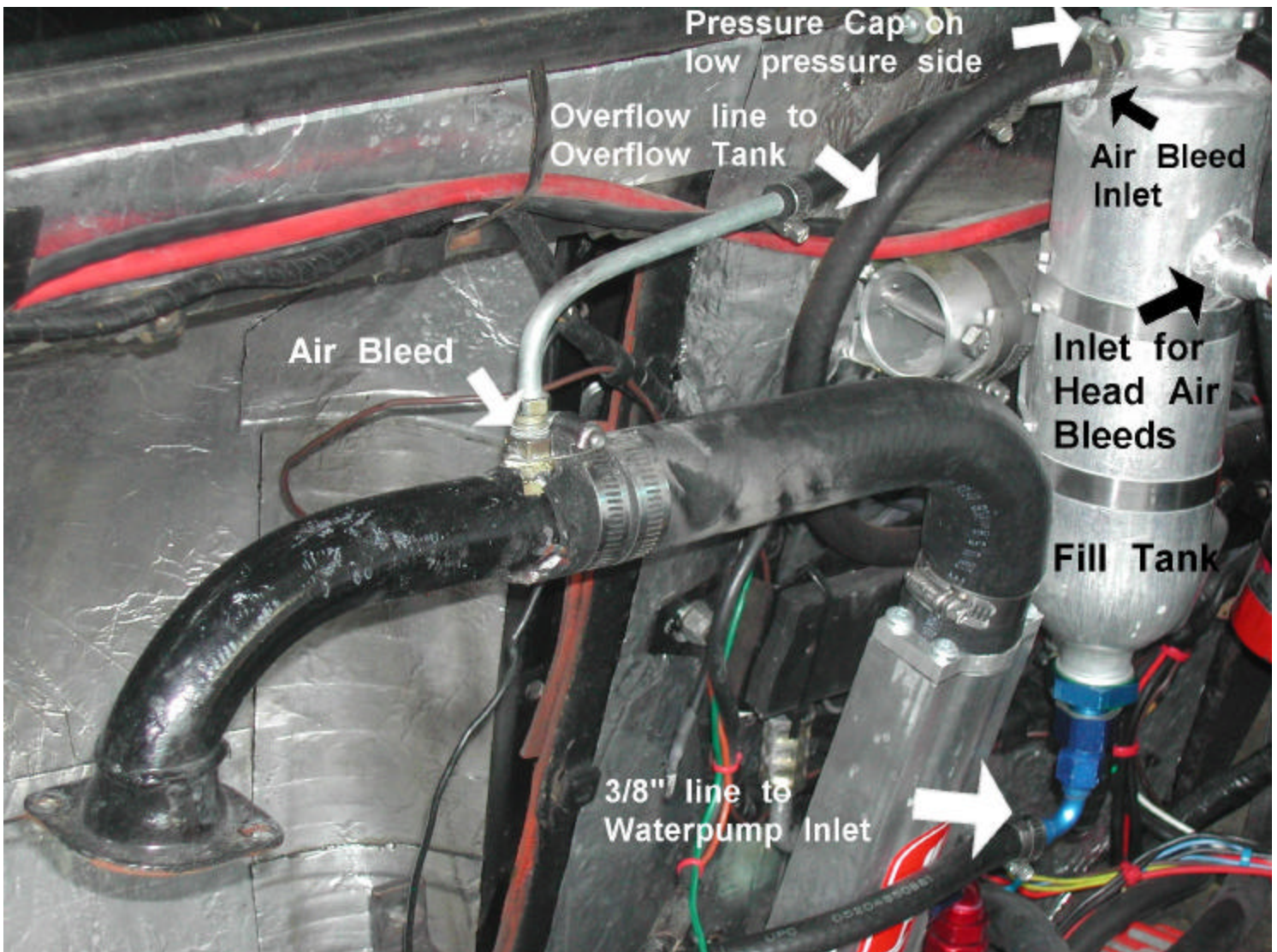


A return hose exits the heater core then passes through the forward bulkhead and returns to the original coolant pipe prior to the thermostat, yet aft of the original exit.

While I installed heater shut off valves, they do not seem to be necessary. When I switch the pump off, coolant flow seems to be blocked effectively by the pump's rotor. This I have proved by switching off the pump while driving; the warm air discontinues blowing despite the heater control valve being open. Another benefit is that I no longer need to deal with heat in the cabin due to convection from the heater hoses passing through the tunnel.

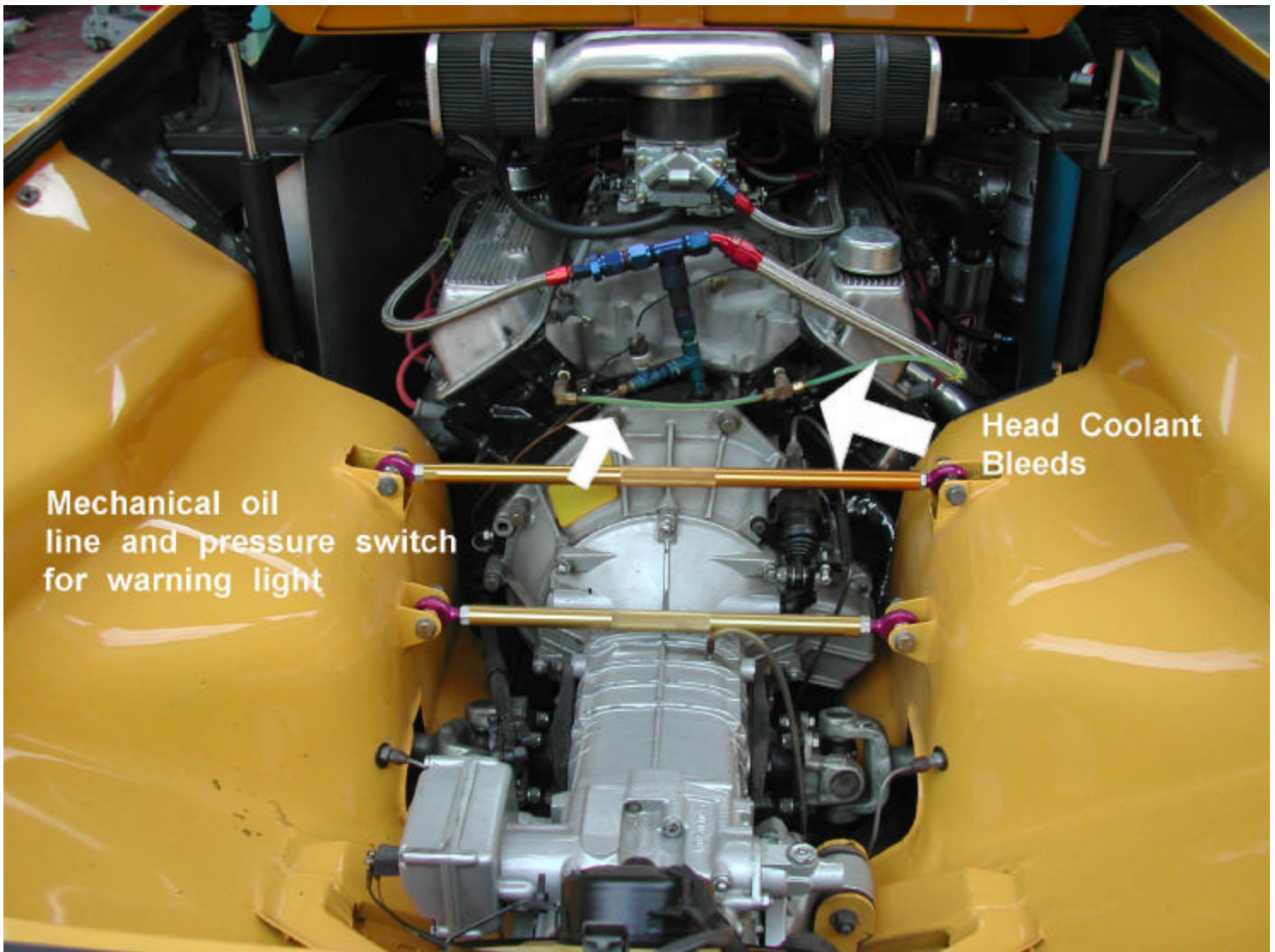
PURGING AIR WITHOUT THE SWIRL POT

On cars where the radiator is not at the high point of the system's fluid flow, a swirl pot is generally used for coolant fill and bleeding air. Since our aim is to remove this restriction, we need an alternative approach to bleed the air and fill the system. Our new design will bleed air from the coolant's primary system at three points. The critical location is from the highest point in the system where the air would naturally migrate. This is now the top of the metal outlet tube exiting the block. A 1/4" brake line runs from a silver soldered fitting to a new Fill Tank that is outside the primary system. I purchased this Fill Tank from Speedway Motors. www.speedwaymotors.com I purposely connected the brake line to the aluminum Fill Tank with a 5" length of rubber hose. The rubber hose will provide some dampening from the engine's torque twist on the aluminum input nipple that is welded to the Fill Tank. I also mounted the Fill Tank in this location to ensure it was at the high point in the system.



Two additional bleed lines are tapped into the highest point of coolant in the heads at the rear of the engine. While these are great in bleeding the air out of the engine at startup, another motivation is the questionable potential of improved head cooling. The rationale is that air pockets can form at the rear of the heads as this is the highest point in the block. Coupled with poor circulation of coolant in this region, hot spots can occur over the exhaust valve accelerating valve seat recession or contributing to pre-ignition. This is a real concern on the Ford 2.0 L engine in my Formula Continental and it is addressed with a similar bleed line. I don't know if the Cleveland also has poorer coolant flow at the rear of the heads; but the practice is applied.

These lines are made of Imperial Nitro Seal 1/8" tubing and are clear. This clear tubing enables one to view air purging from the heads. This stuff is tuff; when I raced Formula 500s, we actually used it as brake line!



On my old cooling system design, I ran clear Nitro Seal lines from the rear of the heads that connected to the original swirl pot at the old sender location. One reason that I believe the swirl pot to be restrictive to flow is that when air bubbles were in the clear Nitro Seal lines, they would run from the swirl pot into the back of the heads. This meant the pressure was higher in the swirl pot than in the engine. With the new set up, air bubbles are clearly seen flowing from the heads to the fill tank. Evidently, the pressure level is now lower in the fill tank than the block.

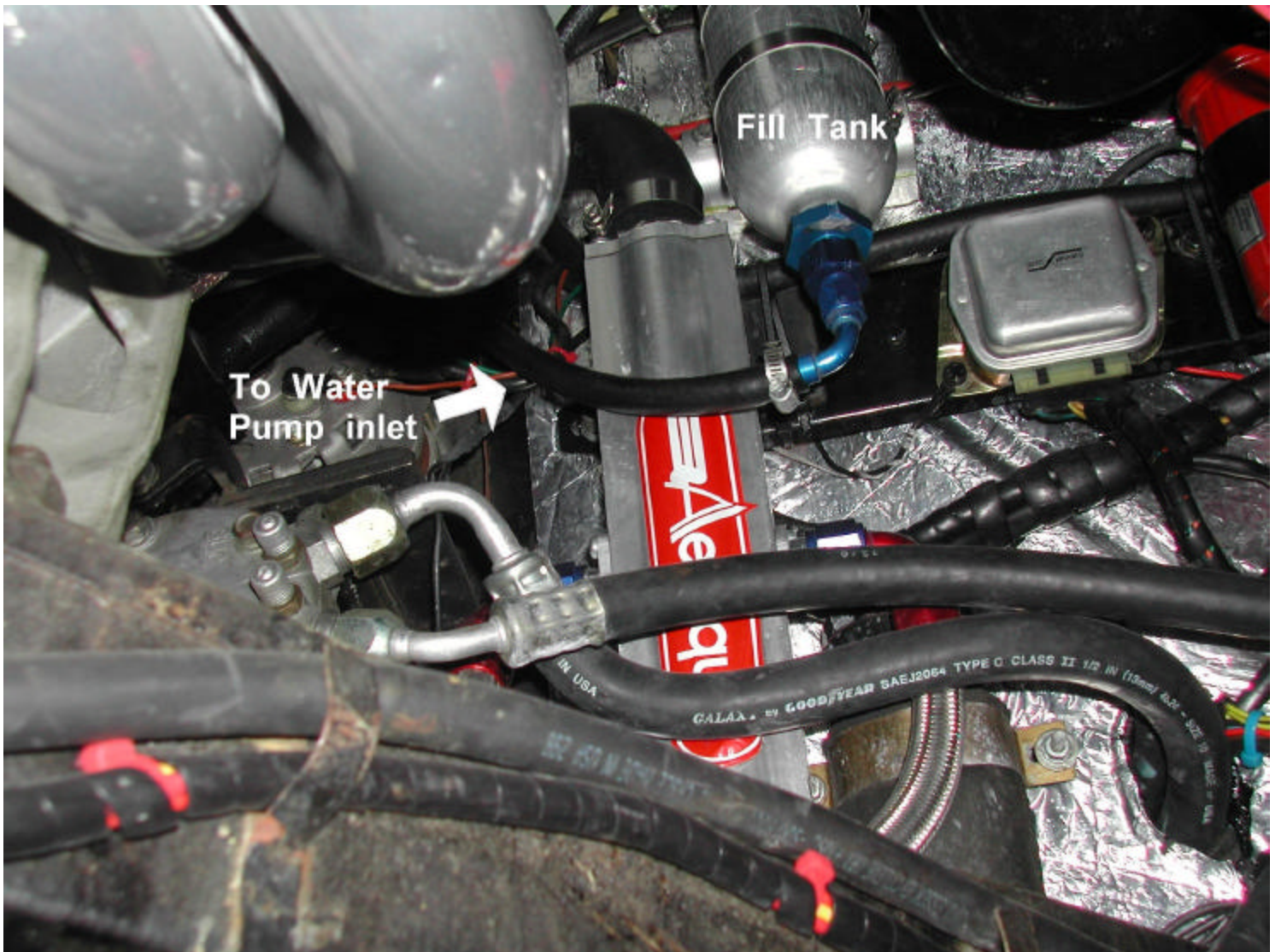


We managed to fit all the tanks nicely in this section. Further testing will determine the need for the Overflow tank. It would be nice to see it go.

At the bottom of the fill tank, a 3/8" coolant hose is attached which connects to the inlet side of the water pump at the same location the heater hose is generally attached. The circumference of the 3/8" hose to the water pump is greater than the combined inlet lines of 1/8" and 1/4". I do not know if this is the ideal relationship for maintaining proper pressure and flow in the Fill Tank; however, it seems to be working fine.

Fulfilling our objective, the Fill Tank is connected to the low-pressure side of the system. In other words, the radiator cap sees the coolant pressure after the radiator and need not contend with high RPM pressure surges.

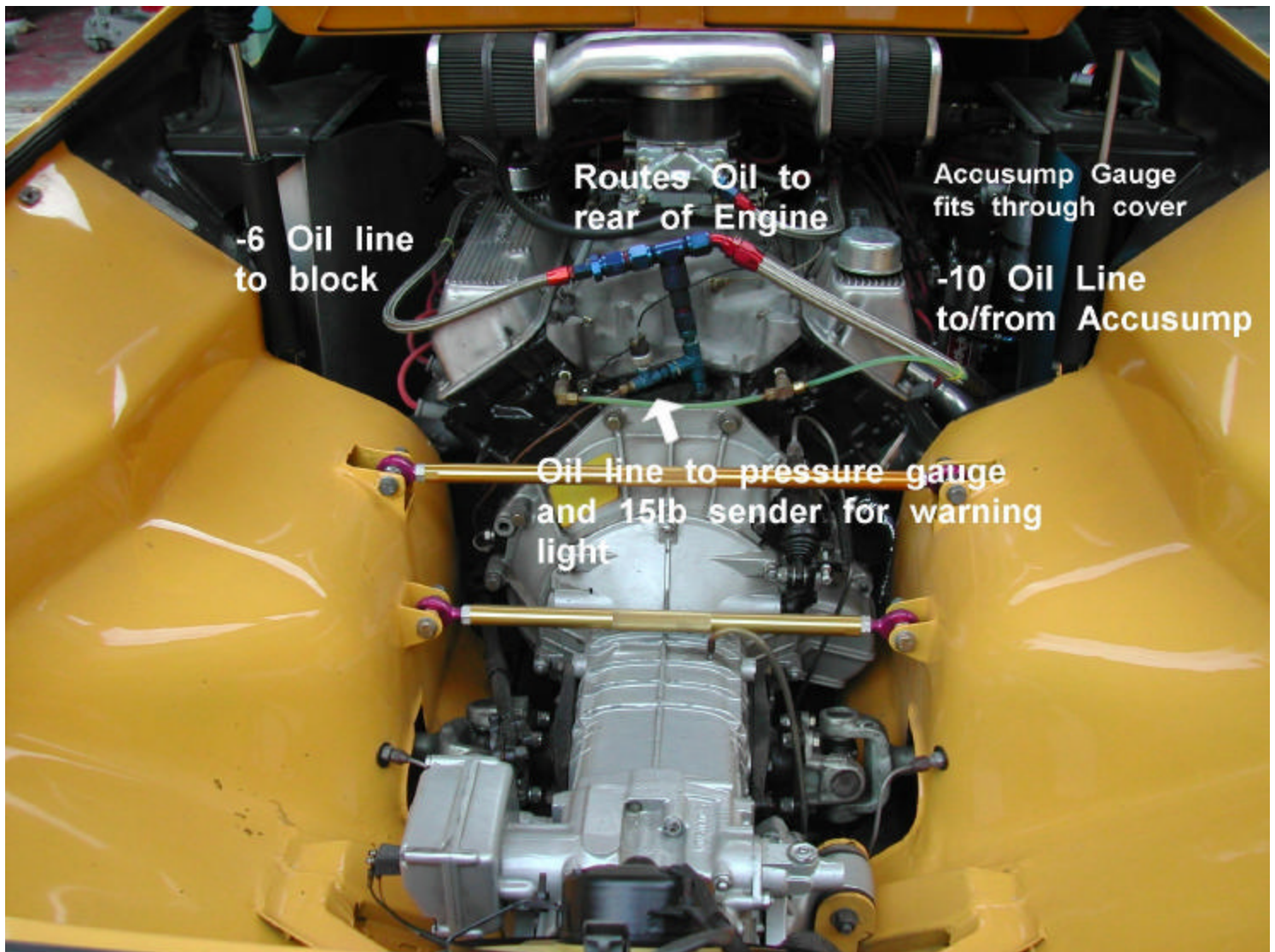
Employment of the water recirculator made this connection to the water pump feasible. Without it, the water pump inlet has a heater hose attached in the Pantera's standard configuration.



The new Fill Tank has an overflow above the cap seal that runs into the original overflow tank that has been moved to a new location. With the Fill Tank in this configuration, it is questionable whether an overflow tank is necessary. The newest Fords utilize this cooling system design with the fill tank only half full to contend with fluid expansion and no overflow tank. I have not tested this method. Another Space City Pantera Club member, Dan Mixon, intends to apply this strategy on his Pantera this winter. If it works, it would be nice to eliminate that large heavy Overflow tank.

THE NEW OIL SYSTEM: FLOW AND COOLING

10 quarts of oil are held in the Aviad pan and 3 quarts are held in the Accusump. The Accusump is plumbed into the engine at the small orifice at the rear of the block (oil pressure sender location) and at the oil galley access rearward of the fuel pump above the oil filter.

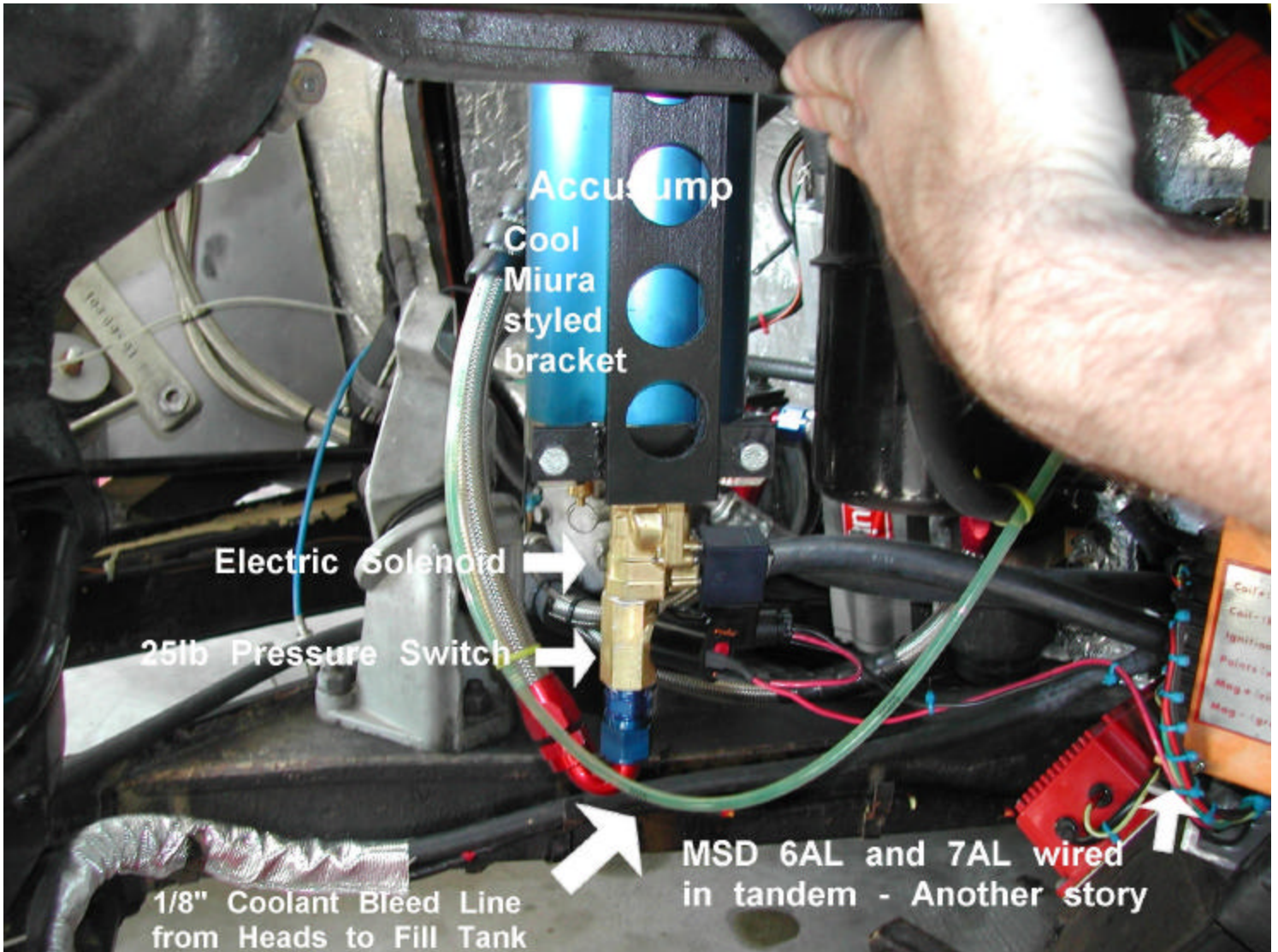


I am least excited about this Christmas tree arrangement of fittings at the rear of the engine. I will need to obtain a custom fitting to tie these three disparate sizes together in the future

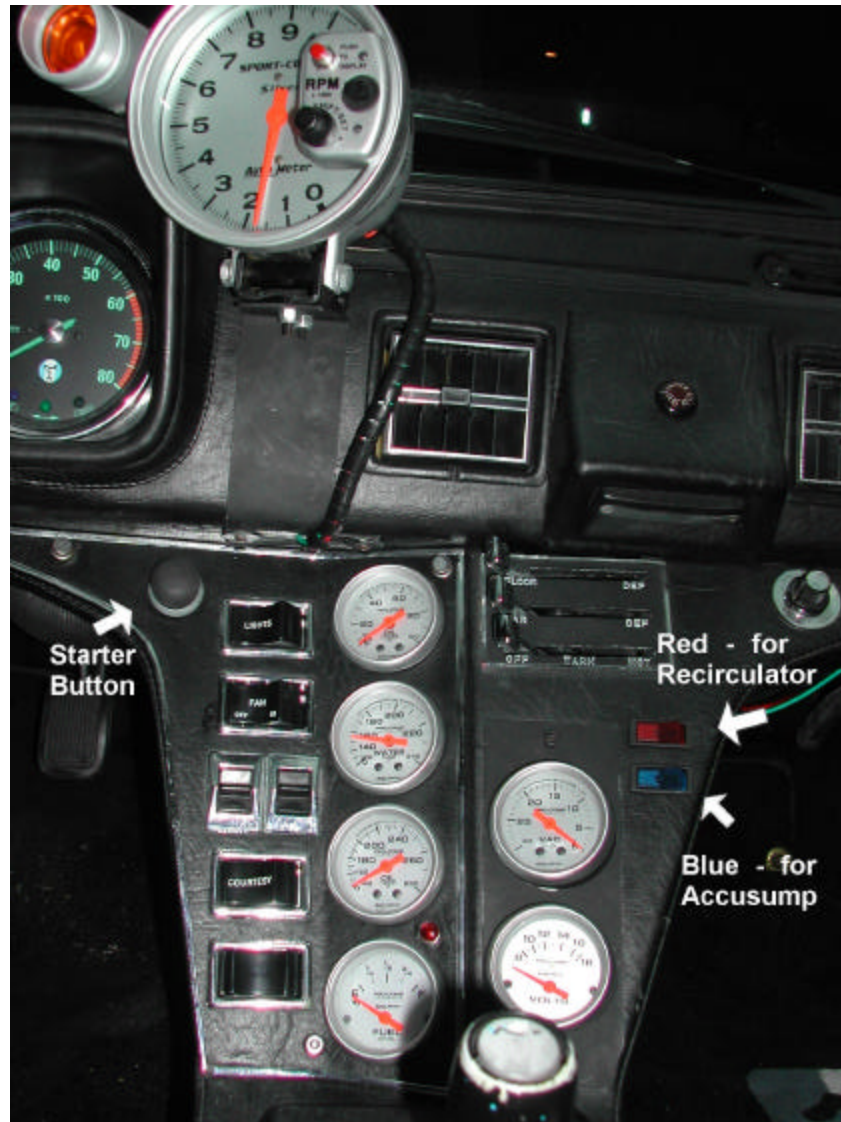
I have an electric solenoid mounted to the Accusump and a 25 psi pressure switch. The switch prevents oil from leaving the Accusump until engine oil pressure drops below 25 psi. I selected 25 psi since my idle oil pressure was about 30 psi. On the flip side, the Accusump will not rob oil from the engine at start-up, as it will not refill until engine oil pressure is north of 25 psi. This switch is an improved, new product that Canton very recently introduced. The switch not only better controls the release of oil from the unit; but as importantly, permits the electric solenoid operated Accusump to fill as fast as the manually operated unit. In the past, slow refills were a serious compromise associated with the

electric solenoid and made it a poor choice for road racing applications. No more!

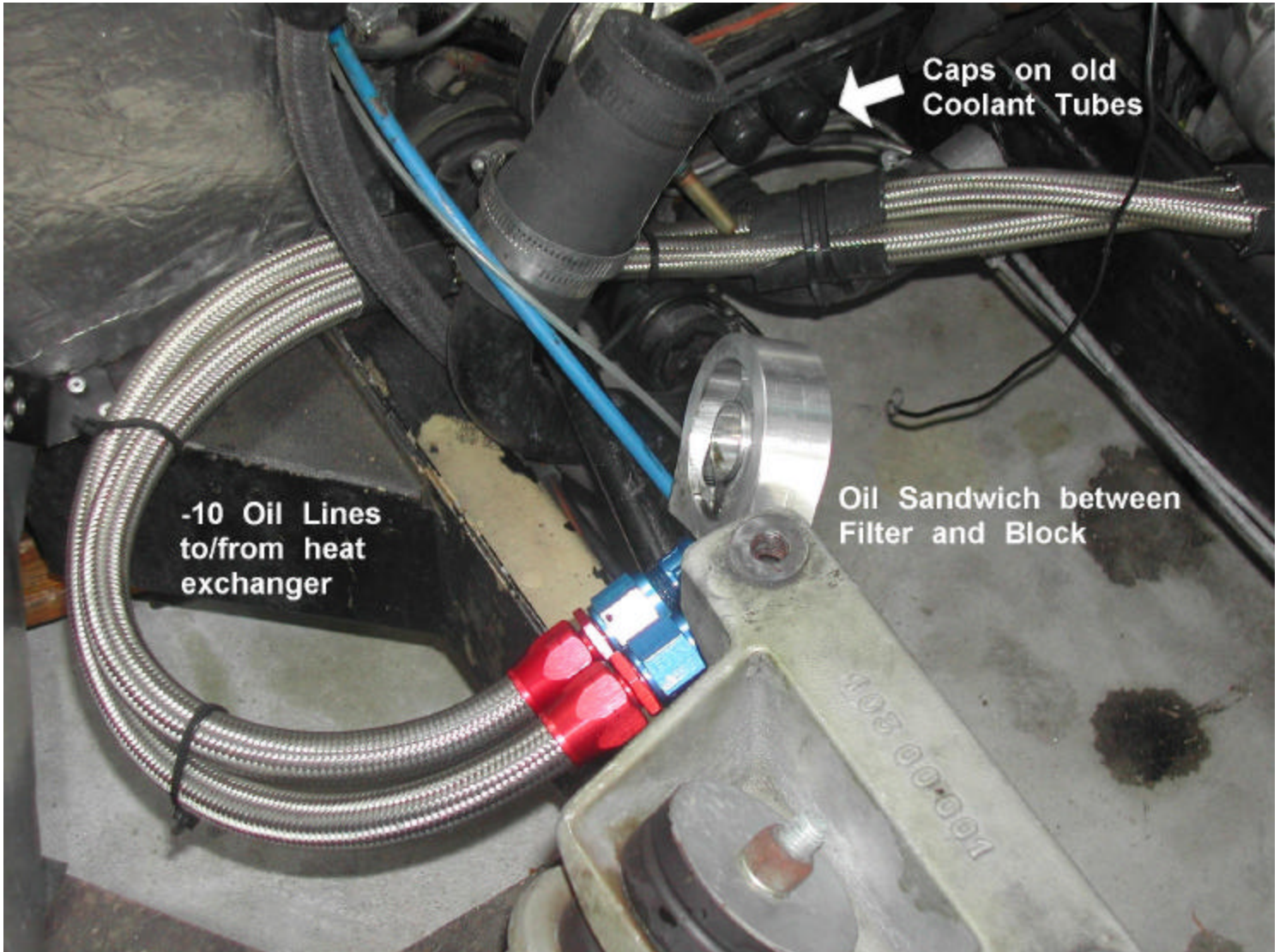
I fabricated a special bracket to hold the Accusump properly at its ends. Dan Mixon took the welding honors for this bracket.



Prior to starting the car, I energize the solenoid with a switch on my dashboard. Three quarts of oil begin circulating through the engine. The oil will pressurize the system for about 45 seconds when cold. However, after about 20 seconds, I hit the starter button to have a second chance if the engine fails to fire.



Oil is sucked from the Aviad pan through an oil sandwich that directs oil (after passing through the filter) to an oil line routed to the Heat Exchanger.



The -10 oil lines take a direct route around the front of the engine under the pulleys where the heater hoses used to enter the pipes leading to the heater core. After passing through there, they make a 90 degree turn to and from the Heat Exchanger. The Heat Exchanger comes stock with -12 AN fittings. I requested -10 AN fittings which I believe are adequate. Had I not relocated the heater hoses to the front of the car, I would have been unable to route these oil lines so direct and kept their length to a minimum.



Oil returning to the sandwich flows into the engine where a portion is redirected to the rear of the engine to supply the Accusump and #5 main bearing.

On another note, I will disclose that the Aviad oil pan does not appear demonstrably superior in controlling oil migration in hard cornering when compared to the single baffle pan. High G corners create a similar pressure loss with the Aviad pan when the Accusump is disengaged. Thus, if you are running the single baffle pan, there is no reason to panic with your selection.

RESULTS

I could not have been more pleased with the results of this project. All of the goals were achieved.

At our TWS track event this spring 2003, my oil temperatures on the track never exceeded 220 degrees and my coolant temps stayed under 195 degrees. It is amazing! In the same environment last year, my oil temps exceeded 300 degrees. Was I running hard? Well, I was accelerating hard enough to crack the crankshaft without detonation in the monster stroker.

David Bell offers this testimonial.

“Unfortunately by virtue of our front radiator/mid engine layout, we’re stuck with most of the long tubing runs but John has attacked many of the other weak points with his new cooling system. John has a single pass radiator and he’s eliminated some of the most serious choke points, like the block thermostat, the surge tank, and several extra elbows around the old surge tank. The hole in the frame helps streamline the coolant flow as well. John also moved the pressure cap from the high pressure side of the system to the intake side where it’s not affected at high rpm by pump pressure.

On the way home from our drive last Friday John and I got stuck in Willowbrook Mall traffic on 1960. We still had John’s walky-talkys and were each watching our coolant temps. John’s temp never got above 187F. Mine got up to about 210F and was still inching up. And that was on a cool day.

So I’m convinced that John’s system is the way to go.”

If you would like to incorporate elements of this conversion into your Pantera, I would be happy to provide additional information. You can reach me at jtaphorn@kingwoodcable.com