RETROFIT OF ALTERNATOR – NOTES

I purchased the special alternator from Retroair to eliminate my generator-driven electrical system in my 1959 Jaguar Mark 9 Saloon. This is the first prerequisite step in installing a modern-day air conditioner system, as the original stock generator would never have enough output to power the compressor clutch, blower fan, and electrical cooling fan.

This is a heavy-duty alternator with a through-shaft and nicely machine coupling on the rear which mates with the stock power steering pump. All the necessary brackets come with the unit, and installation is straightforward. The only modification I found necessary was to shorten the alternator belt tension adjustment bracket an inch or so (on the end without the slot), and drill a new mounting hole. Otherwise, the adjustment range of the bracket interfered with the inner fender wall as well as the compressor mount bracket. The picture below shows the installed alternator in place, with the A/C compressor bracket already installed. Note that the Idler pulley which comes with the A/C system is already installed using the water pump attach bolts:

The biggest task in converting to a negative ground alternator is the job of reversing the polarity of all the positive-ground-centric components on the car.

If the car has the old-style SU fuel pumps, then they will most likely need to be altered internally to function properly with negative ground. I found that one of my pumps was a later clone, with two separate wire connections coming from the pump.. for that unit, it is simply a matter of reversing the two connectors. The other, older-vintage pump was sent to Dave at SU Pumps SUfuelpumps@donobi.net . I found Dave to know EVERYTHING there is to know about SU pumps. After I sent him a couple of pictures, he was able to identify the particular pump model, and recommend the correct modification. I then sent the pump off to him for modification at a very reasonable price.

Next came the front and rear clocks. Most likely one or both are inoperative anyway. I sent them both off to Mike Eck, well-known (in Jag circles) clock guy, compudes@optonline.net, www.JaguarClock.com, who got both running perfectly again, and changed the polarity on both. Be sure and check the bulb in the rear clock, Mike has replacements for this otherwise unobtainable-at-Napa tiny bulb.

Changing from positive to negative polarity at the battery necessitated new battery cables. I decided to fabricate my own, purchasing raw battery cable, terminals, and solder slugs from www.wiringproducts.com. www.pitstopusa.com is also a great source for the solder slugs, which makes constructing new cables simple. You just drop one of these slugs into the open end (facing up) of a terminal, heat the terminal with a propane torch until the solder melts, then push the battery cable (insulation stripped of course) into the terminal and hold it still until the solder hardens… voila, new cable. Since I was making up new cables anyway, I decided to add a battery cutoff switch underneath the front seat. I siamesed the two negative (ground) posts from my 2 12V batteries as shown:

and then ran the single ground cable down underneath the car to the battery cutoff switch:

Don't be too concerned about the proximity of these bare terminals to the metal frame parts. After all, it is just a ground connection anyway.

The other terminal on the cutoff switch just goes to ground. To insure a permanent, solid ground connection, I welded the head of a small bolt to the side of the frame, and then used the accompanying nut to attach the grounding battery cable:

The alternator comes with clear and simple wiring instructions. There are only two wires from the alternator, which has its own built in voltage regulator. One wire essentially just ties right into the battery, but using the terminals on the old voltage regulator, if following Retroair's instructions. The other wire goes to the charging light on the dash (again, via a connection on the regulator).

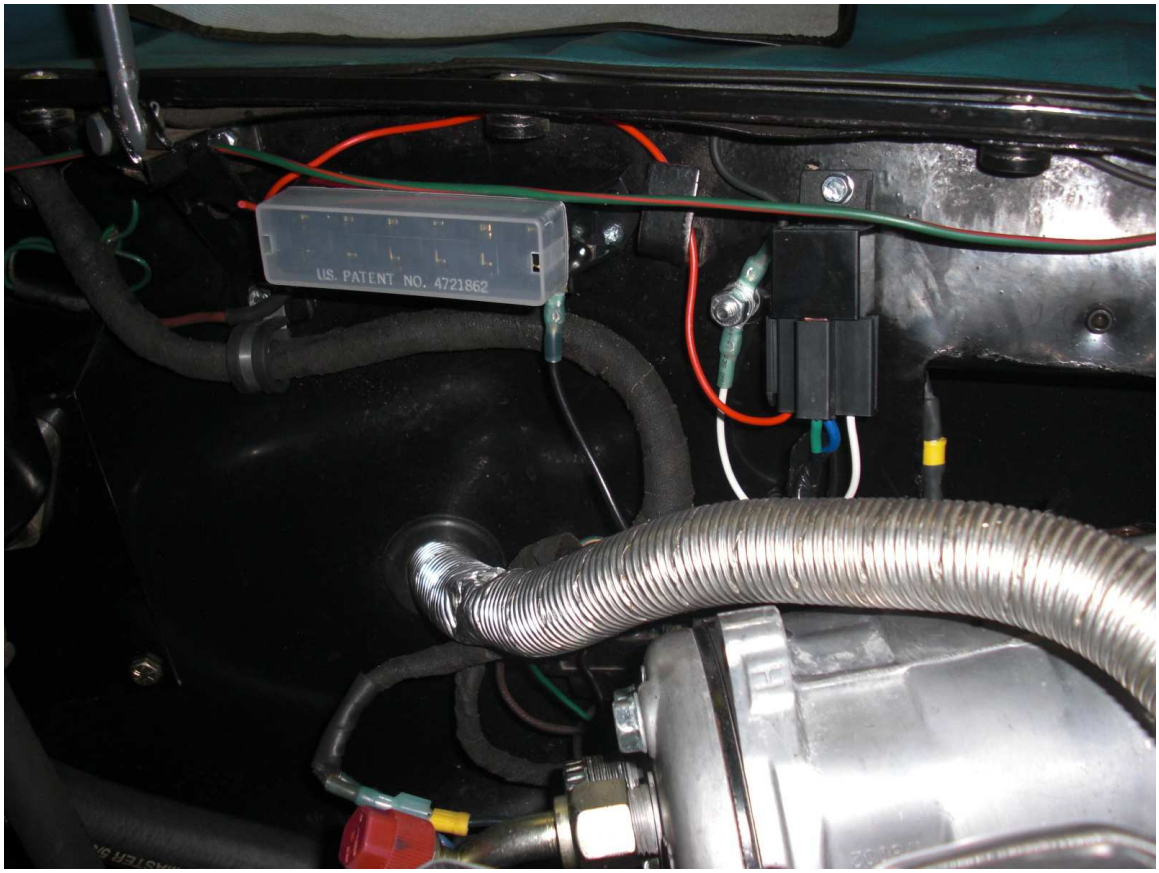
The original regulator itself is rendered inoperative and bypassed by following Retroair's diagram. However, I decided there was no particular need to have that regulator body taking up valuable space in the engine compartment for no reason, so I just followed the instructions but soldered and heat-shrunk the appropriate wires directly together for a more secure connection, and removed the regulator body altogether.

With the regulator gone, a perfect place opened up next to the existing fuse box for me to install a new, auxiliary expansion fuse block, using modern spade-style fuses. With the old fuse block partially unbolted from the firewall (be sure and disconnect the battery for this exercise), I followed my MK IX wiring diagrams to find the master feed wire from the ignition switch, and branched off that to the new fuse box. Hence, any new components connection to the new fuse box will have ignition-switched power, and each will have its own appropriate fuse. I immediately set up fuse connections for the existing radio (which originally had just been connected to one of the existing 4 fuses), the electric cooling fan, and the relay power switch for the to-be-installed A/C system. I purchased the fuse block from www.delcity.net.

While I had the original fuse block detached from the firewall, I ran a couple of spare wires from inside the passenger compartment behind the dash, through the main interior-to-engine-compartment grommet, and terminated them inside the original fuse block cover. This way, I will

have wiring already in place in case I ever want to add any additional component in the interior (such as wide screen TV!).

Additionally, because I knew I would be needing several high-amperage, non-switched connections for the relays for the A/C system and cooling fan, and perhaps later for a headlight relay upgrade, I ran a 10 gauge wire directly from the power side of the starter solenoid (where the main positive battery cable attaches) around to the inner left-side fender well, and installed a separate non-switched fuse block there (please ignore the temporary separate wires which will be properly bundled and routed when all is complete):



A good source for period-style bulk wiring, connectors, fuses, grommets and such, is www.BritishWiring.com.

That completes the wiring and installation of the alternator system!

INSTALLATION OF COMPRESSOR, FAN AND CONDENSER – JAGUAR MARK IX

(Phil Auldridge – Austin, Texas)

I use my vehicle occasionally for wedding limousine service. I didn't really care for the idea of a couple of small A/C vents in the front dash to cool my passengers way in the back seat. Rather than purchase the complete Mark IX kit from Retroair, I bought just the engine compartment components from them (alternator, compressor brackets, compressor, new engine-driven fan, condenser, receiver-drier, and condenser hoses. Then I purchased separately from Vintage Air in San Antonio (www.VintageAir.com) a well-known provider of after market A/C systems, their "Trunk Monster" Rear trunk (boot) evaporator system: 685000-VUY.

This kit comes complete with everything needed to complete the system, except for the two refrigerant hoses which will run from the front of the car back to the trunk. I found the installation and wiring instructions to be very intelligent and complete. A full wiring harness is provided, ready to go, with relays already wired and plugged in.

INSTALLATION OF ENGINE COMPARTMENT COMPONENTS

1) Remove front grill, as well as upper radiator cross support

2) Disconnect radiator hoses, then pull radiator straight up (hint… cut a piece of cardboard or thin metal roughly the shape of the radiator core, then slip it between the fan and the radiator to protect the cooling fins while removing the radiator

3) Remove original engine-driven fan and pack it away with it's fasteners (you'll be using the upgraded fan, with it's own attachment bolts)

4) Before installing the compressor brackets, it is best to go ahead and cut the rectangular hole in the left hand inner fender to provide clearance for the compressor. This hole will be cut as a VERTICAL rectangle, and after cutting, the supplied rectangular sheet metal box will be installed and sealed from the back side (inside the wheel well). You can either weld the box to the backside of the fender well, or simply drill and attach it with machine screws. It will probably be necessary to reposition some of the wiring harness if it interferes with the opening.

Location of the hole: 2 ½" below the top of the fender flange, 4 ½" back from the radiator flange (for the front side of the opening) and 9 ½" from the radiator flange for the rear side of the opening (giving a 5" wide open cutout). The vertical length of the cutout is 10" measured down from the topmost cut. (Note, the above dimensions were provided by RetroAir. This installer found that making the forward cut at 4 ¼" from the radiator flange was necessary to allow sufficient clearance in the opening to install the fan belt on the compressor. Here is the rough cutout in the fender well:

5) Below is the completed cutout with the inner box (provided in the kit) installed:

6) To install the rear mounting bracket for the compressor, you will need to remove the inverted head hold-down stud that is almost directly in line with the center stud on the generator/alternator bracket. This stud will be replaced with the longer one provided in the kit, to allow for mounting the rear compressor bracket.
The easiest way to remove this stud:

1) remove the existing nut and lock washer from the stud, then replace the existing nut WITHOUT the lock washer to give more thread access for step 2

2) tighten a second nut (fine thread!) onto the stud.. use two wrenches to get the two nuts as tight as possible against each other.

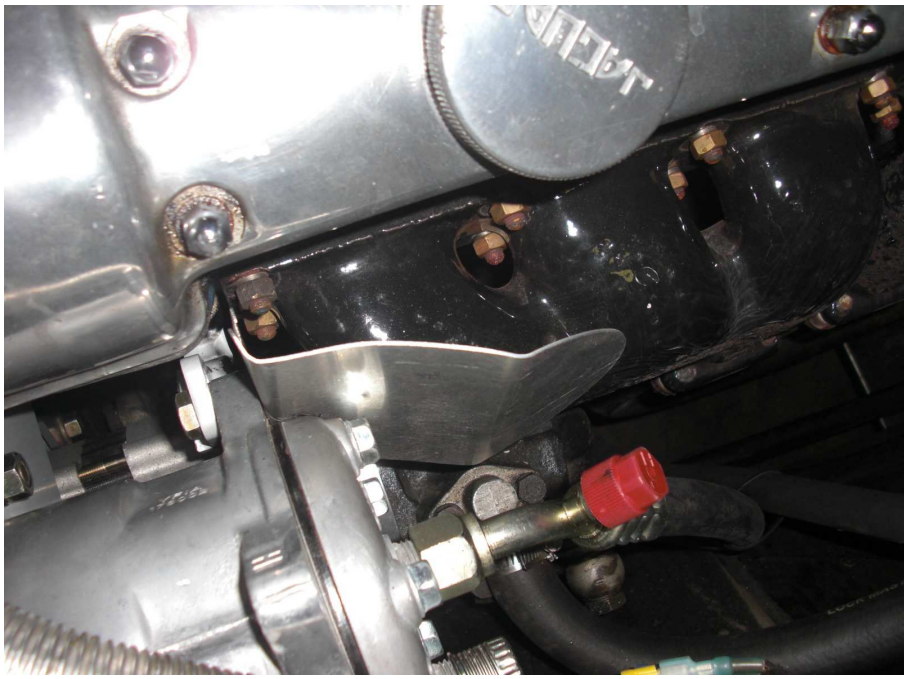
3) remove the stud by placing a wrench on the upper nut (closest to head surface) and turning.

4) Install the new, longer stud, in the same manner, by tightening two nuts together and then using a wrench on the lower nut to tighten the stud into the head.. use Locktite to hold the stud permanently in place. Note the stud has course threads on one end (going into the head) and fine threads on the other, which will protrude out from the head.

Install the front compressor bracket with the supplied 5/16” bolts and washers in the upper outermost holes in the front timing chain cover (just below the head), replacing the existing bolts with the longer ones provided in the kit.

7) Install the idler pulley assembly and fan per the enclosed instructions. See picture of this installation in the alternator discussion section as well as below:

8) The heat shield can either be installed on the 2 forward-most exhaust manifold studs, or by drilling a different hole in the shield to match the mount on the rear compressor mounting bolt (this was the approach I took). If installing on the exhaust manifold, it should be installed prior to installing the compressor, and then the shield must be bent to clear the compressor. It may be necessary to trim the top of the shied to clear the upper head flange (where the cam cover mates). (Note: installing on the exhaust manifold studs will make it almost impossible to remove the manifold at a later date without disassembling the entire compressor system.) Otherwise, the shield can be installed after the compressor has been installed



9) Install the compressor, leaving all the mounting bolts slightly loose until the belt is installed, to insure that the pulleys all line up properly. (Leave the belt loose enough that the fan can turn easily while re-installing the radiator.

CONDENSER INSTALLATION

1) (Note: complete all pre-mounting steps outlined here BEFORE re-installing the radiator) Before installing the condenser, it will be necessary to either bend up or enough of the lower flange on the upper radiator support for enough width to accommodate the width of the condenser. If you choose to bend it (not easy, as this is virgin British steel!), it should be bent toward the back side (radiator side) of the mount, to allow the condenser to install as close as possible to the radiator. This installer chose to just cut out the flange completely with an air tool, since the condenser itself will provide plenty of rigidity to the radiator support bracket once secured in place.

   The supplier's instructions call for additionally notching out the lower radiator support to allow clearance for the coolant hard line attachment points. However, this installer decided to mount the condenser a little higher in the opening to avoid having to weaken the lower support. This entailed notching out the center part of the condenser mount flange to clear the hood release mechanism. If you are going to utilize an auxiliary electric fan, (highly recommended, if not mandatory in my opinion), it will be important to get that condenser just as close to the radiator as possible.

   Here's what the condenser looks like after installation. Note that I also modified the lower (center) condenser mount bracket to accommodate this slightly higher positioning of the condenser.:

2) Now install the hard line from the compressor high-pressure port to the condenser (the line on the right hand side in the above picture). Note that these hard lines are very soft, and can be very easily reshaped by hand as necessary (and it WILL be necessary) to fit properly underneath the condenser. There is no need to attach the left-side hard pipe at this time, as it will eventually be connected to the #6 refrigerant hose which runs all the way to the rear boot area.

3) I chose a SPAL 12" fan as an auxiliary fan. After much research and measurement, I'm convinced that this extremely low profile fan is the only brand, and size, that will fit in the very limited space between the condenser and the front grill. I bought mine from The Fan Man, www.the-fan-man.com. I decided to NOT use a temperature activated switch, but just to wire the fan, through a relay, direct through the ignition switch bus, thus the electric fan will run anytime the ignition is on. The fan is then installed flat against the condenser, using the optional push-through nylon mounting rods (must be ordered separately from the same company). Below it the completed fan installation. Note the beveled cut on each upper corner of the condenser mounting tab to clear the radiator cross-mount, and the "dished" out section in the center to clear the hood release mechanism:


SPAL

REAR MOUNT EVAPORATOR INSTALL

Installation of the rear mount system, wiring, and hoses is pretty straight forward, following the instructions that come in the kit. A few notes:

Since I own several vintage cars with air conditioning, or anticipating future A/C systems, I decided to opt for fabricating my own A/C hose connections. I sprung for a heavy duty hose crimper made by Mastercool:

This baby is expensive, but I'm convinced that the savings over custom-made hoses, and the convenience of being able to measure and make up hoses on the spot makes it worthwhile. This system has jaws for all the standard A/C hose sizes, #6, #8, #10, and #12. This installation required using #6 hose for the high pressure front condenser to trunk evaporator, and #10 hose for the low pressure rear evaporator to compressor.

This tool is easy to use, requires only a vise for mounting, and no skill to create perfect crimped fittings every time. (I'm happy to lend this out to any Jag forum member).

Hose can be purchased in bulk lengths, and the individual "bead-lock" fittings are available from a number of online vendors. I actually found www.vintageair.com to be one of the least expensive sources for hose fittings. I really lucked out on the hose, and found a vendor selling a couple of 25 foot lengths of brand new barrier hose for a fraction of the normal cost, on eBay.

I ran the smaller, #6 high pressure hose from the left hand side (facing the condenser), up the inner fender wall, just high enough to clear the oil filter housing, then down along the frame, actually between frame and body, back to the rear of the car. It is important to securely anchor the hose along the way, using Adel clamps to prevent chafing.

My procedure: crimp the correct fitting on one end of the hose, run the full length exactly through the intended path to the rear, decide on the exact length on the other end, cut, remove, crimp the fitting on the other end, and then reinstall the hose. Do yourself a favor and spring for a nice hose-cutter tool from Sears or other source, instead of trying to hack the hose in two. You'll use this tool hundreds of times:

Since there is very little unused inner fender well real estate available under the hood, I decided to mount my receiver-drier (which came with the Retroair kit, along with a binary safety compressor cutout switch), underneath the car, along the inner frame, just aft of the fuel pump mounts. This component can be positioned *anywhere* in the high pressure line between the condenser and the rear-mount evaporator. Other installations may not have the required space underneath the car, in which case I'd opt for mounting somewhere inside the trunk/boot. You can see the binary switch (blue wires) attached to a port at the receiver drier:

From the receiver/drier, I decided to do it right and install “bulkhead” fittings for the hose transition from under the car to the inside of the boot area. These fittings are hard connectors which require a much smaller hole to be drilled in the metal bulkhead, and then are securely fastened and sealed with a large nut on the other side. One side of the fitting is crimped to the underside hose; the fitting is then passed through the bulkhead and secured by a nut on the other side, where there is a standard o-ring screw on male fitting.

These bulkhead fittings are relatively inexpensive, and make for a much cleaner installation, eliminating the need to actually pass a large hose through the wall, and try to seal it with a rubber grommet. In the picture below, you can see the smaller hose on the left coming from the receiver drier; the larger hose on the right is the low-pressure return from the evaporator back to the engine-driven compressor. The blue wire is the compressor magnetic clutch power wire, coming from the binary safety switch on the receiver drier, and following the low-pressure line back to connect at the compressor:

On the other side of these hose fittings, the evaporator unit is mounted in the boot area,. Just two very short hoses are required to make the connection between the evaporator and the through-bulkhead fittings (shown just aft on the left side of the unit. Notice also the small black condensate drain fitting on the left side, which attaches to a short hose underneath the car to keep drain water out of the boot area:

The evaporator unit doesn't intrude too much into the boot area, in fact it is confined to the upper shelf as shown. The two flex tubes are for the cold air delivery up to the parcel tray outlets. The long tray at the top foreground of the unit is the return air intake. Vintage Air provides a black plastic "duct" to connect the evaporator input to the return air grill flange which is fastened underneath the parcel tray. However, I've decided to fabricate my own return air duct using ½" foam insulation board, which will be more rigid and airtight, preventing sucking heat from the boot area back into the unit's intake.

The electrical harness provided by Vintage Air makes the wiring easy. There is just one small bundle that needs to go back to the evaporator from the main power and fan switch up front. However, there is a big 4-pin connector attached to the end. I decided to just cut the 3 wires in the cable (all color coded), drill a small hole in the upper floor boot area, install a rubber grommet, and push the cut wiring through. At the other end, from inside the front passenger compartment, the other cut end of the bundle was fed through the main wiring harness grommet near the steering wheel (RH drive) into the engine compartment. There the automatically resetting 30 AMP inline circuit breaker was mounted on the firewall near the brake fluid reservoir, and the remaining cable bundle routed back to the boot area, where the two ends of the cut cable were rejoined with solder and heat-shrink tubing.

The harness comes with 2 power relays (one for the compressor clutch, one for the blower fan motor) wired in near the in-dash fan switch. I merely tie-wrapped those two relays underneath

the dash area, out of the way along with all the other underdash wiring. Additionally, it should be noted that the yellow supply wire from the fan switch has a one-way diode incorporated in-line, just a few inches behind the fan switch itself.

Here is a picture showing the evaporator unit relative to the boot interior. The two refrigerant lines on the left, and the wiring as it exits on the right:

Installing the return air grill and cold air outlets on the package tray is pretty simple. Lift out the upholstered board behind the rear seat to expose the metal underneath. There are already “lightening” oval holes cut in the metal underneath the package tray, making it pretty easy to enlarge these with a power metal shear or nibbler, to fit the dimensions of these components. There is a good overlap of trim material around the edge of each component, so the hole dimensions cut into the upholstered board are not so critical. Once the holes are cut, these components are attached to the metal with screws provided by the supplier:

This makes for a very neat installation. With the outlet vents turned upward, cold air is directed along the roofline all the way to the front. Airflow is very robust, and a nice movement of air can be felt by front seat passengers.

The final step was finding a place to mount the single, combination on-off/fan speed switch, the only control in the front of the cabin. I couldn't stand the thought of using the ugly plastic switch mount that came with the kit:

So I fabricated a small switch mount bracket from 3/16" sheet aluminum, polished it to a mirror finish, and installed it underneath the wooden dash overhang, just behind the steering wheel, so as not to detract from the look of the interior. The knob that came with the switch is soon to be replaced with a small vintage bakelite knob with no markings, to further match the original interior:

OPERATION:

Operation of this system couldn't be simpler. Unfortunately, the TEMPERATURE control, since it uses the typical after-market electro-mechanical switch that has a capillary tube probe into the evaporator, is mounted on the evaporator unit itself, so regulation of temperature has to be done from the boot area. The sole control in the cabin is the single On-Off, fan speed switch depicted above. Turn it one notch to low fan to turn on the unit and activate the compressor. Thus, to

some degree, temperature can be regulated by merely regulating the airflow via fan speed. I don't foresee this is as a problem in Texas summers, as I'm certain the plan will be to operate the system at full power from April until late November!

OPERATIONAL UPDATE - SUMMER 2010

Well, summer has finally arrived in Texas, with temperatures already hitting 95+ and more to come. I've already had plenty of opportunities to test the cooling efficiency of the new rear-mount air conditioning, and have found it to exceed all my expectations. The air flow from the rear tray is sufficient to cool the entire car, and keep all the occupants comfortable!

Nothing good comes without compromise however. In my case, I hadto swap out my huge electric fan (Permacool brand) with a much smaller SPAL fan due to limited clearance after installing the A/C condenser on the front of the radiator. This smaller fan, combined with the extra heat and airflow restriction of the condenser, brought me full circle back into the engine overheat issues, which I had originally solved with the big Permacool fan.

I found that as long as the car was moving, cooling was no issue. Even on the hottest Texas summer day, the temperature would stabilize somewhere south of 90 degrees C. However, standing still at a stop light, even for a very short time, proved to be disastrous for the old beast.

I found that the OEM 4 lb radiator cap would allow the radiator to boil and overflow, even if the temperature just barely hit 100 C. I solved that problem by replacing with a new 7 lb cap from XKS and adding a $10 plastic overflow tank from NAPA (concours purists, go ahead and roll over in your grave!). That fix at least resolved the boil-over problem once and for all, and I haven't lost any coolant since. Of course, it did nothing to reduce the engine operating temperatures at rest.

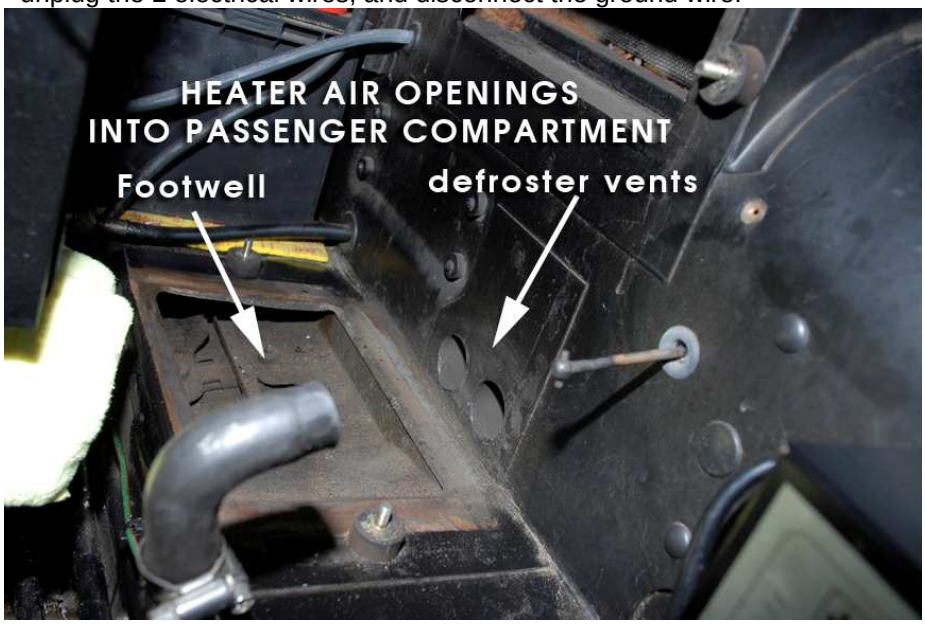
One evening, after driving through downtown Austin and hitting every red light, the temperature pegged at 100C +. After dropping off my passengers, in desperation I turned off the air conditioner, opened the windows, then turned on the heater full blast. To my amazement, the coolant temperature dropped almost instantaneously a good 10+ C (almost 20 degrees F).

This experience got me thinking about perhaps adding a reserve heater core, somewhere under the car or aft of the front wing, to fix my problem.

Last week, I took of the cover of my stock heater box (under the bonnet), and once I saw the layout of the heater fan and core, it dawned on me that a simple solution was right in front of me. I saw how I could easily divert all the airflow from the heater away from the cabin, and back into the engine compartment, allowing fresh cool air from the center vent to pass through the heater core and reduce the coolant temperature.

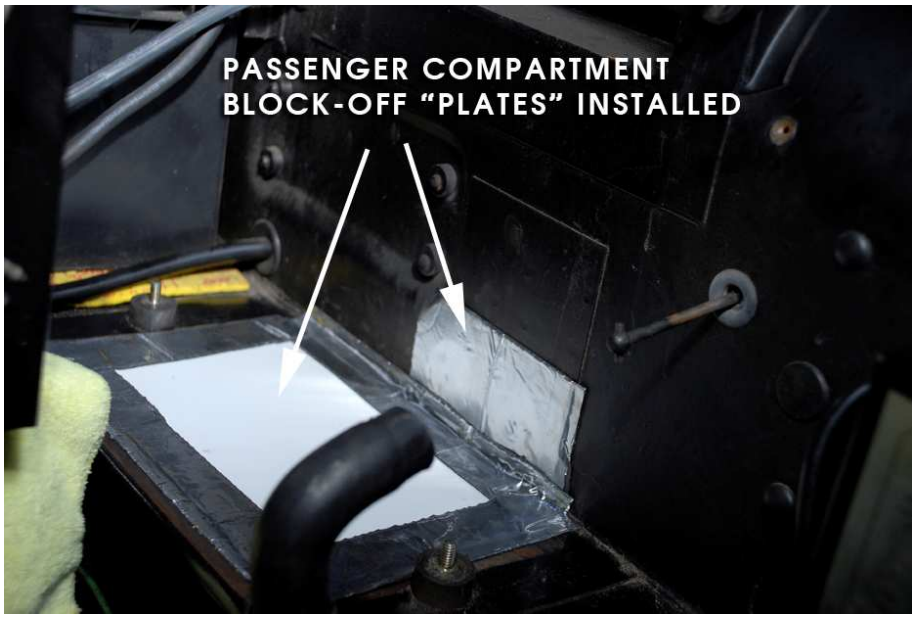
To accomplish this took several fairly simple steps:

- Temporarily remove the complete heater box. This is about a 30 minute job:
  - remove the four 1/4" securing nuts.. 2 on upper edges, 2 on the lower flange
  - disconnect the water hose on each side. This can be done without draining the radiator, just have a container ready to capture the coolant in the heater itself
  - loosen the heater valve connector so it is free from the cabin control shaft
  - unplug the 2 electrical wires, and disconnect the ground wire.

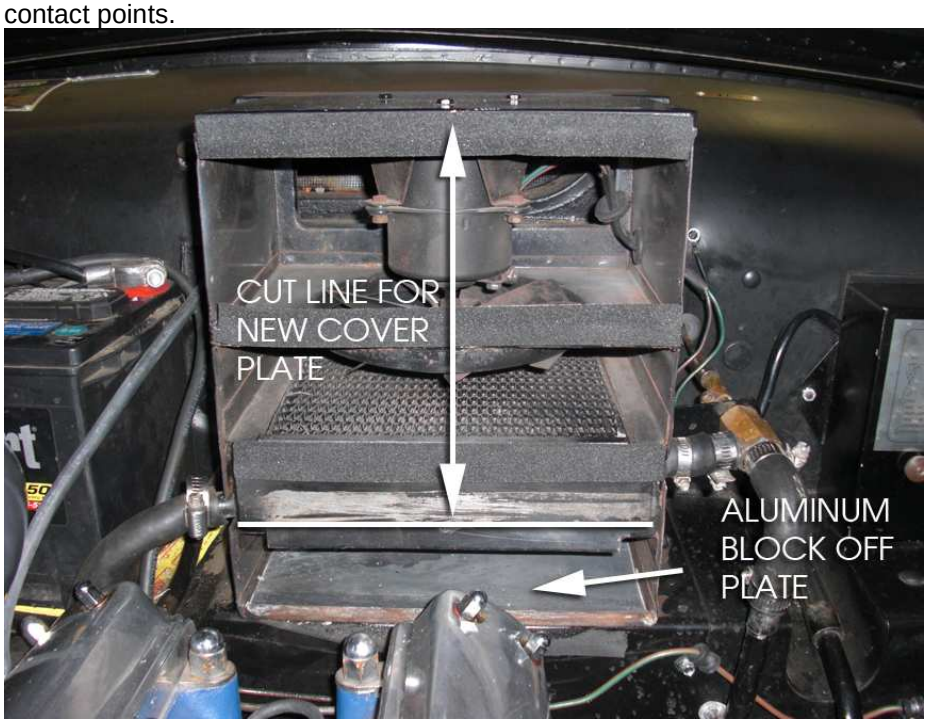


- Fabricate a cover plate for the main heater air flow opening into the footwell. I used a very thin piece of aluminum, and then secured it with thin perimeter strips of self-adhering heat barrier material. I used material left over from my interior passenger compartment heat insulation project. These sheets were purchased from www.jegs.com item 70500 "Quiet Ride' Heat Barrier Kits. This stuff is incredibly effective, much cheaper than Dynamat, and super easy to install.

Additionally, I just used a piece of the Heat Barrier material alone to cover the two round defroster vent openings on the firewall:



- Re-install the heater box, then remove the original front cover from the heater box, clean off any sealing goop, and install self-adhesive foam insulation strips at all horizontal contact points.

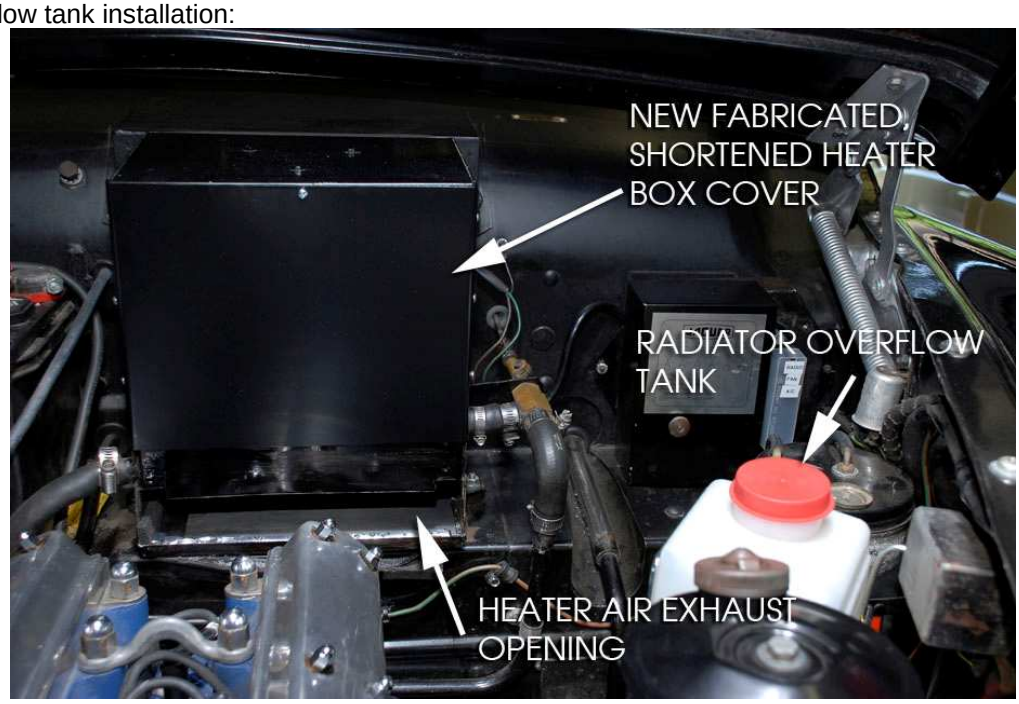


- Then fabricate a new cover,using 18 ga sheet metal and a sheet metal bending brake, with approximately 2.5-3" cut off the bottom to allow the heater airflow to exit into the engine compartment.

- Cut a stiff (3/16" thick) aluminum plate to lay in the bottom of the heater box,(optional) for additional blocking of any heat into the passenger cabin.

- To recommission the heater for winter use, it's a simple matter of removing the aluminum blocking plates from the bottom of the heater box, and reinstalling the original heater box cover, using the 4 screws on each side.

Here's the final result, showing the new shortened heater box cover in place, as well as the overflow tank installation:



I'm happy to report that this simple solution has had amazing results, and I am now able to sit at a standstill with the engine and air conditioner running for an indefinite period of time, with the temperature stabilizing at a maximum of 95 C. Problem solved!

WIRING MODIFICATIONS TO ACCOMMODATE 60 AMP ALTERNATOR

Once summer arrived, and I began operating the vehicle with ALL electrical loads on (at night, headlights, air conditioner evaporator fan and compressor clutch, electric cooling fan, and heater fan), I started having problems with the battery charge going low after extended night time use.

To investigate, I opened up the dash. There I found that the 10 gauge main power wires coming into the ammeter had charred and the insulation had partially melted. Investigating further, I could start the car up, turn on all electrical accessories, and those incoming wires would get almost too hot to touch in just a very few minutes. Ouch! Thus followed a weeklong period of research, and consultation by an experienced electronics engineer. Using a clamping type ammeter, we discovered that on peak usage, those wires to the ammeter could be passing as much as 40 amps!

Further testing revealed that the ammeter itself is just incapable of passing that much current, and thus creates a huge resistance (and significant voltage drop across to the output terminal). Even though I had connected all my high-power accessories through relays connected directly to the battery, we surmised that the alternator, in its attempt to replenish the battery, was unable to push that much amperage through the ammeter.

The final solution, which resolved all the wiring overload issues, AND resolved the charging issue, was accomplished by four steps:

1. Replace the old high-current wires (alternator to ammeter, ammeter to battery) with new 10 gauge wiring.

2. Eliminate the limited-capacity ammeter altogether, by bridging all the wires from both terminals together (I used an electrician's cable connector, allowing a very tight connection, and covered the connection with two layers of heat shrink tubing)

3. Install a 50 AMP auto-resetting circuit breaker on the inner fender wall near the alternator, and wiring inline from the larger alternator output wire

4. Connect the relay power source for the A/C system and cooling fan directly to the output side of the circuit breaker, instead of connection direct to battery.

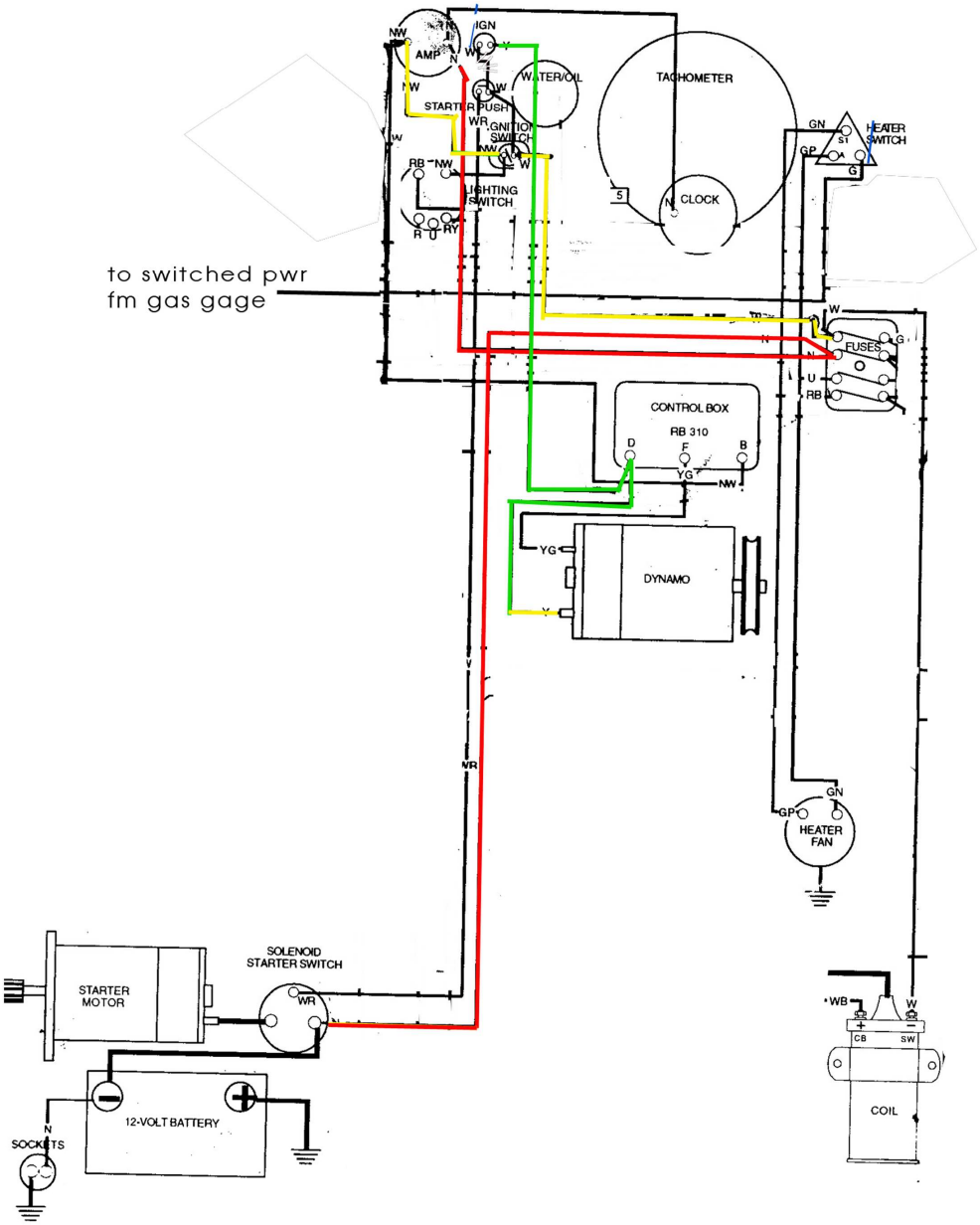
With these modifications in place, my wiring has greatly reduced load. In fact, when the system has all components up and operational, there is less than 20 amp total current draw from the alternator.

An additional, but optional change I made was to remove some of the original load from the ignition switch by using the sole switch output wire as a trigger to actuate a main power relay, which then feeds an auxiliary fuse buss. This included re-routing the power wire from heater fan to a separate fuse on the new buss. Additionally the wire from the ignition switch to the ignition (charging) light was rerouted and tied into the switched heater power wire (for convenience), to insure complete isolation of the charge light and the ammeter when the ignition switch is off.

Attached below are two wiring diagrams showing the charging system wiring for the Mark IX. For ease of readability, all extraneous circuit wires which are not directly relating to the charging system have been removed from the schematic, and the most important circuits have been marked off in color (these do NOT depict the actual wire color).

The first chart shows the system as it originally exists on the MK IX. The second chart shows all modifications made to the wiring, all marked in blue, and any removed wires or components are grayed out.

Original Wiring Diagram



Wiring Diagram as modified for alternator and relays