Electric Ceramic Engine Preheater

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I was approached by a fellow Glastar Builder this winter with a problem starting his cold engine on his 180 hp Lycoming powered Glastar.

He had already tried the Silicone electric heating pad on the oil sump and it wasn't hot enough and didn't bring the engine oil temps up high enough or fast enough. Different solutions were discussed including things such as oil dip stick heaters, using a light bulb inside the cowling and gas flame engine pre heaters.

Each of these solutions had limitations and I was not too fond of using a flame sourced heater around the cowling of an airplane inside a hangar.

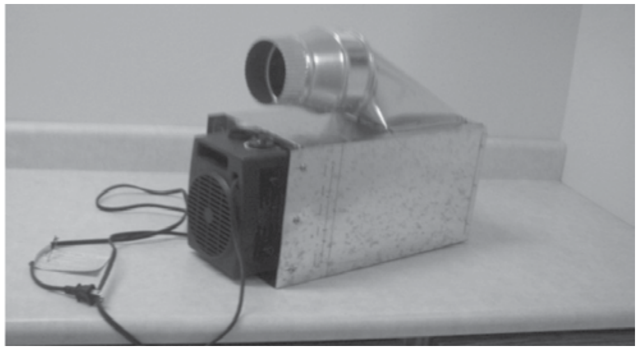
After I left the luncheon with my friends I drove to Rona lumber and browsed the Aviation Isle for a possible solution to the problem. First I hit the Aviation Isle for Ceramic Electric Heaters and found a suitable heater with a somewhat flat and rectangular shape that would fit inside some sort of an enclosure. The shape is important to simplify fabrication, sealing and fastening the heater to the unit.

Armed with this discovery I pushed my cart over to the Aviation/Furnace Ducting Isle and browsed through the various parts available off the shelf to make up the rest of the heater.

The Ceramic heater was roughly 5 1/2″ wide by just under 8″ high and I quickly decided to use an 8 inch square box for the design. Next I chose a piece of Galvanized sheet metal 16″ wide and 36″ long normally used in the heating industry for cold air returns by nailing them to the bottom of the floor joists. I selected one straight undamaged piece for my heater prototype.

The 16″ X 36 ″ piece of galvanized sheet metal was marked with 4 parallel lines spaced 8 inches apart starting from the unbent, flat 16 inch long edge. The other end the sheet has some funny bends that we don't need and I measured another line 1 inch past the last marked line and cut off this surplus piece of sheet metal approximately 3″ wide X 16 ″ long.

I bent the sheet metal on each of the marked lines up 90 degrees to form a square box tube. The 1″ X 16″ tab that is left over wraps around the straight edge of the 16″ long side that meets it's bend and holes are drilled through the mating edge of the box and the 1″ flange. (This is a good place to use your clecos to hold everything into alignment) The box is pop



Top: side view of heater with duct inserted into the cooling air outlet. Above, the Ceramic Heater modified for Engine preheater application on the author's Glastar . The duct insulation is removed for clarity of the ducting

riveted together along this 1″ wide overlap.

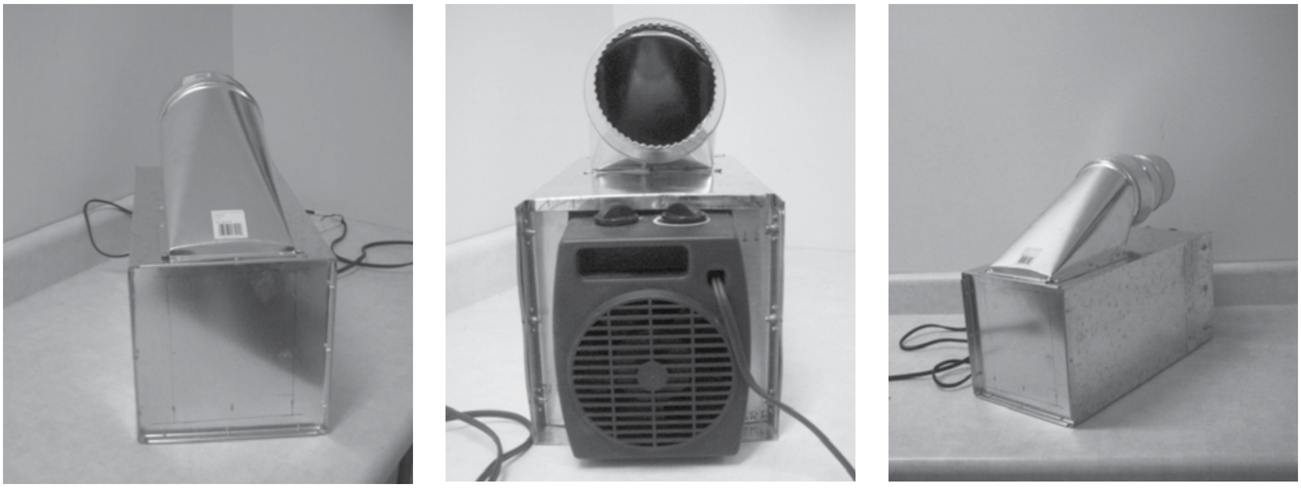
I searched through the bins for a suitable end closeout for the box. I found a standard 8″ X 8″ furnace duct close out prebent to slip onto the end of the 8 inch square ducting. This was perfect and only required minor bending to complete the closeout.

In fabricating the end cap for the box I used a standard heating 8″ X 8″ Closeout that you buy prefabricated from Rona. Two opposite side are totally shaped and the other two opposite edges will need to be bent to match the other two edges.

I bent these in a vice between two pieces of angle iron to 90 degrees and then completed the bends using standard flanging pliers.

Next place the end cap onto one end of the box. Note that by design it captures the edges of the end of the square tube between an inner and outer layer of sheet metal. Drill carefully through the outer layer of the cap, the end of the box and the inner layer of the end cap with a 1/8″ drill and Pop rivet the end on. I then had to decide how to get the hot air from my 1500 watt heater up into the engine to heat the oil sump.

I decided on using a top take-off used in the heating industry to run 5″ pipes from the top of the main heating trunk lines in your house to each individual room. I chose



Left: opposite end view showing the stock end cap. Centre, end view showing Facto Heater with left and right side retaining pop riveted to the end of the fabricated heaterbox. Angle Brackets Trimmed to fit side contour of the heater. Right, the view showing the end close-out and top take-off.

to use a 5″ diameter take-off to ensure good air flow. Install the take-off so that the round outlet faces the heater end of the box. (it is more compact this way)

By using this type of take-off it simplified the construction of my heater in that the boot was already fabricated with the rectangular side that would fasten to my fabricated box by simply cutting a rectangular hole with tin snips and inserting the provided tabs through this hole and bending them back over to firmly clamp the boot to the box. The Take-off Ducting is formed with a top flange around the rectangular perimeter of the hole and numerous tabs that are bent under once they are all passed through the hole.

The final step was to drill 1/8″ holes through the top flange of the boot, through the edge of the hole in the sheet metal box and through the tab that was bent back under to secure the boot to the box. This provides a strong attachment of the boot.

This top take-off comes fabricated with a round transition at the other end which was real convenient.

Next I had to come up with a solution to get the heat into the cowl and the simplest way was to use 2-90 degree elbows which are also standard fare in the heating industry. I was sure glad that their industry adheres to the same high standards we have in the aircraft industry and their parts were compatible with my project.

The advantage of using the standard heating industry 90 degree bends is that by rotating the various segments of the bends we can change the angle that the pipe leaves the heater and approaches the underside of the airplane cowling. Everything from

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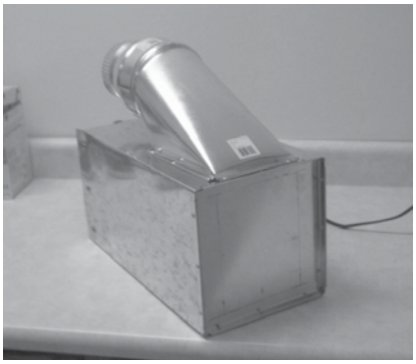
90 degrees vertical to 90 degrees horizontal is possible with most aircraft requiring something in between.

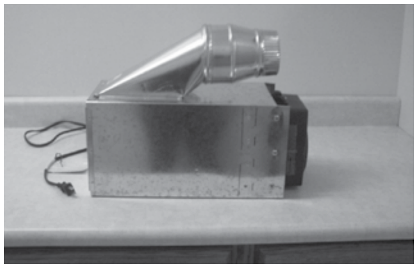
Stock heating fare elbows can be twisted to obtain the optimal angle to enable your pipe to enter the cowling on your particular application

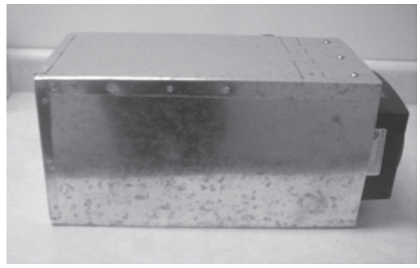
For the application on my Glastar I needed to reduce my pipe down to 4″ to fit into the cowling exit at the bottom juncture with the firewall. This was accomplished with a standard 5″ X 4″ reducer from Rona. On the unit I built for my friend that inspired all of this nonsense and his Glastar I was able to use the optimal 5″ duct and using 2 - 5″ 90 degree bends turned every-which-way so that the duct passed into the bottom of his cowling where the exhaust exited through a fairing he had around the exhaust which also acts as the exit for cooling air on his Glastar.

The best part of this design for our aircraft is that the heater can sit on the ground under the airplane and the Ducting placed directly into the lower cowling without flexible floppy tubing that could fall out.

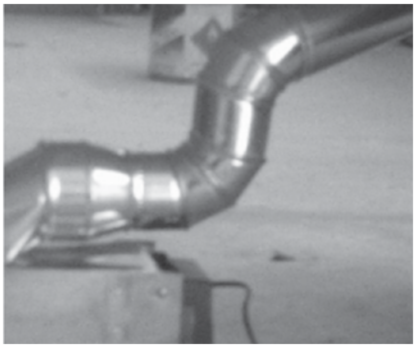
I fastened the heater into the other end of the square tube using bent angles pop riveted to the inside of the square box. I cut 4 pieces of 032″ aluminum 2 3/8″ wide X 7 7/8″ long. I trimmed them and deburred the edges. (Remember to cut these across the







Below left, stock heating fare elbows can be twisted to obtain the optimal angle for cowling ingress. Top left, the compact design of the box and top duct take-off. Above, side view with the forward facing take-off boot and 5 inch to 4 inch reducer. And finally, the bottom view (right) showing the one inch lap seam with pop rivets.



grain on the aluminum sheet). I marked a line at 1″ and bent each piece into a 90 degree angle using a 032″ piece of scrap wrapped around the nose of my bender to give a good radius for the aluminum so it wouldn't crack.

This gave me 4 equal angles 1″ X 1 3/8″ X 7 7/8″ long. I marked the box back on the two vertical sides 2 5/8″ on the inside with a felt marker and clamped the angles with the 1″ flange against the box facing in. This leaves the 1 3/8″ flange to act as a back support for the face of the heater. I repeated this for the left and right side. Drill 3 equally spaced 1/8″ holes on each angle through the box sides and pop rivet them to the box.

I then placed the face of the heater against these angles and slid first the right side angle in along the side of the heater with the 1″ flange against the box and the edge of the 1 3/8″ flange tight against the side of the heater. The 1″ wide flange should face out to make it easier to install. Clamp with side grip klekos or some type of similar small clamps. The heater I chose has a rectangular face on it but the aft side of the face has a curved edge of the heater body that meets with the edge of the aluminum retaining angle.

I took a felt marker and ran it along the curve of the heater body and marked a curved line on the angle clamped to the side of the box.

I removed this angle and cut along the line with a band saw and smoothed the cut. I placed the last remaining angle back to back with the completed angle and marked it with a felt marker to make a mirror imaged angle of the one I just completed and then cut and smoothed that retainer. I clamped the heater back in place and using the first bracket and side grip fasteners, I again clamped it to the heater box. I then test fit the last angle and trimmed it and the other opposite angle to fit. I clamped the last angle into place so that the heater was held firmly into place and drilled 3 – 1/8″ holes through both angles and the box they were attached to.

I removed the clamps and angle retainers marking them for sides and installed #10 plate nuts on the inside of each angle drilling up the holes in the angles and Box for the #10 screws.

I finished the box by fastening the heater to the box using the removable retainers and 6, #10 /32 screws.

The top of the box above the heater will need to be trimmed and bent down so that the heater controls can be seen and operated. I marked mine with a line that was lined up with the outside retaining angle and cut back from that line about 3/8″ and bent it down to stiffen the top edge.

When I tested the first prototype on my Glastar it was in the hangar and the EIS oil and engine temperatures at the start were 15 degrees Fahrenheit. I checked the progress and monitored

Pre-Heater Parts List

1. Facto 900 / 1500 watt ceramic heater from Rona $27.00, Model #97955006
2. 1- 16" X 36" sheet of Galvanized metal Cold air return ducting from Rona
3. I – 8" X 8" Galvanized metal Duct end closeout from Rona
4. 1 – Top Take–Off for 5" diameter pipe from Rona
5. 2- 5" – 90 degree elbows Galvanized from Rona
6. 6 - #10 Plate nuts and rivets. (could use bolts and nuts as well)
7. 1 piece of .032" aluminum 9 3/4" x 7 7/8" for retaining angles.
8. 26 - 1/8" pop rivets
9 6 – 3/8" long # 10/32 screws
10. Compressed fibre flat board heating duct insulation (optional)
Total cost per unit with heater is about $60.00

Above: view showing detail of the retaining angle trimmed to fit the curved side of the heater. Right, the end of the sheet metal box showing the stock end closeout riveted through the double folded end cap and the edges of the fabricated box

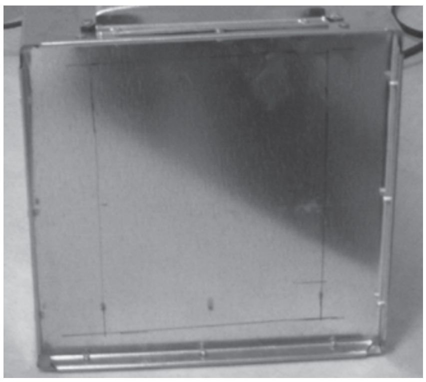
the temperatures during the test.

After the first hour the oil temperature was up to 58 degrees Fahrenheit and the CHT and EGT were all rising and were around 40 degrees F. I left it run for 1 hour and 45 minutes and checked again. The Oil temperature was at 78 degrees Fahrenheit and the

EGT were 54-68-55-82 (the egt of 82 reflects the Open exhaust valve on that cylinder) The Cylinder head temperatures were 42,50,44,59. (the 59 degree cylinder again reflects the cylinder with the open exhaust valve). On my airplane the heat was ducted in onto one side of the cowling due to the design of the dual exhaust pipes and the cooling air outlet on the bottom of my cowling.

I will refine a duct to put air into the cowling along both sides of the exhaust pipes rather than just the one as was done on this test.

This heater design has several advantages over some other methods. It should be safe because there is no open flame and the ceramic 1500 watt heaters have built in thermostats to shut them down should they overheat. I chose the Facto from Rona because of its shape, size and price (around $27.00) It has two heat settings 900 watts and 1500 watts) It is the type of heater that could be turned on and left to heat the engine while you went to the club for breakfast it could be hooked up through wireless to be turned on by a call from home before you leave for the airport and have your engine toasty when you arrive. A programmable timer could also be employed to turn it on at a given time of day and even day of the week.



Also the design was decided on based on several factors. I wanted to have a suitably sized box and ducting so that the heater would run at its full 1500 watt capacity and not trip off its internal thermostat. (Thus the 16″ box length) I also wanted it to be fairly compact and robust. The top take-off was installed facing towards the heater end to make a shorter package than facing it the other way around. I also chose the rigid ducting route so that I could place it flat on the floor or ground and push the rigid ducting up inside the cooling air outlets in a cowling.

On some applications one 90 degree elbow could be used to duct air in vertically from the bottom.

I use an insulated padded type moving blanket over my cowling to hold the heat in while heating it and this works well and is cheap.

I used it this winter to preheat our SE 5a replica and the Lycoming fired right up after the pre-heat. This was a major achievement given all of the openings on an SE 5a cowling.

I have provided this as one person's perspective on preheating an engine and don't guarantee the results however the little heater puts out a lot of heat (1500 Watts and is fan driven) and most of us know that even a simple 100 watt light bulb given time will preheat an engine. The unit could be improved by insulating the inside of the box with Duct insulation. There is a product called duct board which is used to fabricate insulated ducts and is available in thicknesses from 1″ to 2″. Home depot sells this as a plenum kit under the Master Flow name with enough material for a 24″ X 24″ X 24″ duct which will provide enough material for insulating 4 heaters. This Duct Board has a foil face on one side and is treated on the other surface. Larger sheets of duct board are also available from suppliers of furnace ducting materials. Place the insulation inside the box and fasten with a suitable adhesive or mechanical fasteners. There is also a sleeve type fiberglass duct insulation available to insulate the round duct from the heater to the cowling. If you decide to build one please use caution the metal box gets very hot and gloves should be worn when handling it or the heater be allowed to cool before touching it after use. All cautions pertaining to hot appliances should be followed.

Jim Anderson *is a member of the Flamborough chapter, flies out of Cetinski Field and spends his spare time hanging out at Rona Hardware.*