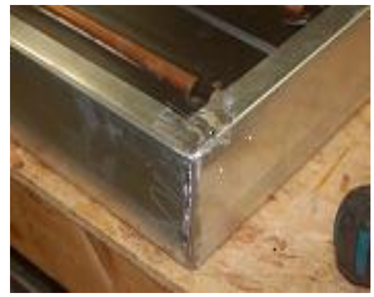
My name is Matt, I live in Indianapolis, Indiana and this is my version of Gary's $1K solar hot water system. I would like to start by saying thanks to Gary not only for all that he has posted on the internet but also for answering all of my questions.

Tank being installed

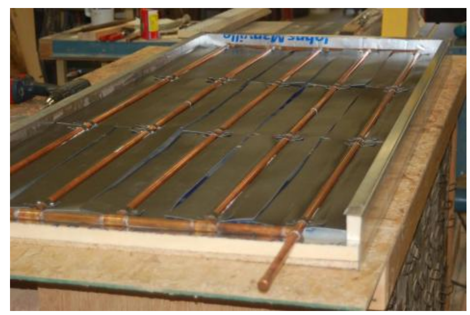
I will start with the tank. I was fortunate to find an old 100 gallon pool sand filter. This was just about perfect for my use. It has a 1 ¼" pipe thread on both the top and on the side at the bottom. It also has an oval shaped lid that can be sealed.

Because this tank is steel and I did not have to use the EPDM that Gary used I didn't feel I needed to limit my temperature. I am also concerned about the effects of high temperature and moisture on the wood in the panels. Therefore one of the changes I made to the original design was to use the track for steel studs for the frame of the panels instead of wood.



Welded corner of solar panel

The first panel I made used 20 gauge steel, the other two I used 18 gauge. For the 20 gauge I used sheet metal screws to put it together. The 18 gauge was heavy enough I could weld two corners. After I had two sides and one end put together I was able to put the pipes, insulation and OSB in from the open end, I then installed the other end.

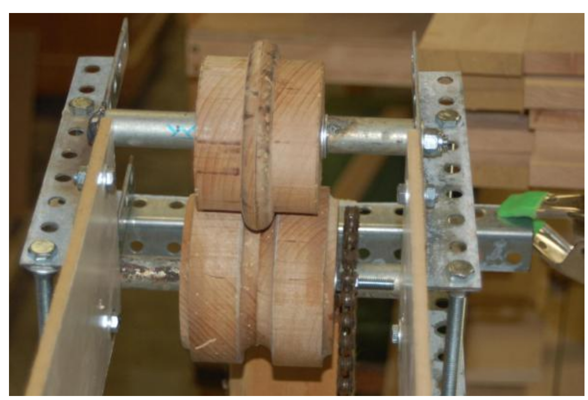


Panel assembly ready for end cap

On both gauges of steel I attached the other end with screws. I did this for two reasons. One, in case I needed to take it apart for some reason. And two, I was afraid of burning the insulation and wood backer board if I welded the other end.

For my aluminum fins I used the same thing that Woodsy used. I bought a coil of pre-painted black aluminum coil stock. This is 2'x50'. I have an aluminum break with a tool for cutting aluminum. Using this I was able to cut pieces of aluminum 6"x2'.

Cutting aluminum on break



Molding wheels in frame

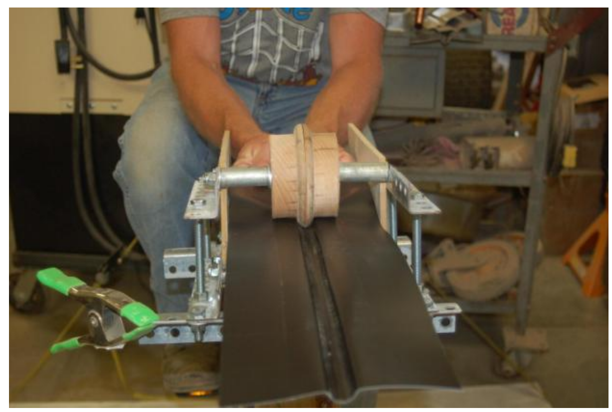
I didn't like the idea of forming the aluminum with a sledge hammer that Gary used. So I took four pieces of hardwood and cut them into 4" circles 1 ½" thick. On two of them I cut a 5/16" round over with my router. On the other two I cut a 3/8" concave. By placing each half together I made two wheels, one with a 5/8" half round and the other with a 3/4" grove. I then bolted a sprocket from the back wheel of a coaster brake bicycle to one of the wheels.

Feeding aluminum into wheels

I then made a frame holding these two wooden wheels together so that they were mated. This assembly was mounted onto the gooseneck of an old bicycle that I had. Then I lengthened the chain and ran it from the pedals up to my new forming tool. By putting a piece of aluminum into the wheels while I peddled I could form the groove in just a few seconds. Without much effort I could do two to three pieces a minute.

Final assembly of molding machine

This whole system took much longer to make than I thought it would because I had to keep stopping and figure out the next step. If I had to repeat it I feel I could make it in about 8 hours. Not sure if it was worth it if I was only making a couple of panels. But if I were going to make several panels, such as for multiple systems, I think I would do it again.

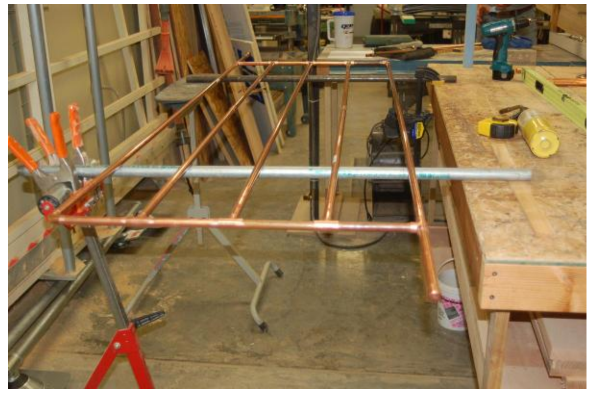


Aluminum leaving wheels

One unexpected advantage of making the fins this way was it put a slight curve in the fin lengthwise. I soldered my copper pipes the same arrangement that Gary did having the inlet in the opposite corner of the discharge. I was careful to lay two ¾" pipes so that they were level. Placing the copper pipes onto these ¾" pipes made sure that the copper assembly was flat when it was soldered.

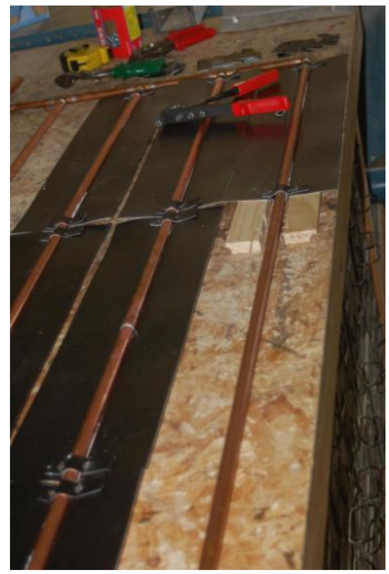
Slight curve in aluminum fin

Because I am concerned about exposing wood to the heat of the panel I chose not to staple the aluminum to the OSB. Instead I used small pieces of the black aluminum cut into strips about 1"x4" and riveted the straps around the pipe to the fins with one strap at each end of the fin. The slight curve I mentioned earlier helped because when placed against the pipe the ends of the fin pulled away from the pipe. When one end is riveted it pulls the other end further away. By pulling this end tight when you rivet the other strap on it causes the whole fin to be tight to the pipe. Like a lot of other people I have trouble believing that silicone helps conduct heat to the pipes. Gary's test results convinced me to go ahead and use it. This method finishes with the top side of the pipes exposed. I had completed this before I saw how Woodsy made his. I thought it interesting that we both decided to do the same thing without ever knowing about each other.



Copper pipes on level 3/4 pipes

After I had all of the fins riveted onto the pipes I put all of the pieces into the frame. First a piece of OSB cut to the size of the frame. Then a piece of 1" foil covered foam the same size as the OSB. 2" wide pieces of the 1" foam were placed around the perimeter to insulate the sides. Then the pipes and fins were slid in and the other end of the frame was attached. I then turned it over and screwed the frame to the OSB. When done the whole frame felt rigid and secure. After all of the panels were assembled to this point I painted the frame and the backside of the OSB. Also the exposed side of the pipes was painted with high temperature paint that is made for painting grills.



Fins being attached to pipes

Not sure if the 18 gauge was enough of an improvement to justify using it. I do like having welded corners instead of just using screws. It added about $4-$5, and 8lbs per panel. I would probably use the 18 again only because I have a tendency to overbuild.

Another thing I did differently was since I had several old sliding glass doors lying around; I cut them apart and used glass instead of plastic on the panels. This required making the panels 3'x6' so I made three instead of two panels for a total of 54' square feet of panels.

Glass attached to frame

I simply placed a large bead of silicone around the edge of the panel frame and placed the glass onto the frame. Then I ripped a 25 gauge track in half and screwed this L shaped piece of metal onto the fame so it would hold the glass down. I left the bottom end of the panel without this hold down piece so that water could run off.

For a heat exchanger I chose to copy Kris De Voecht's method. I made a manifold using several ¾" tees and bushings to get down to six 3/8" copper coils. Each coil is 30' long. I formed the coils by hand, first by eye and then putting them around a piece of 6" duct and then reforming them.

Ripping steel track in half

The lid for my tank was not big enough to solder everything together outside of the tank first. So I had to place the bottom manifold in first, then one coil at a time, and finally the top manifold

Forming soft copper into coils

My reason for changing to copper from Gary's idea of plastic was because I felt the copper would have much higher heat transfer. Even though the copper cost more per foot I could use less to get the same effect. I talked to Gary about this and he felt it was not worth the effort. Gary had not yet posted his heat exchanger test results when I made mine. If I had seen this I might have gone ahead with the plastic as Gary was correct about the time and effort to make the copper exchanger. At this time I have only been able to run my system a short time but it looks like I am going to have very efficient heat transfer. So it may be worth the effort, not yet sure.

Wrapping coil around 6" duct

I don't have a perfect spot to place my panels. The south side of my house has trees that block the sun certain times of the year. During the summer my roof is in the sun, but during the winter the area below my deck gets more sun. I could put the panels out in the yard away from the house but that would require burying the water lines about 125' and I didn't want to do that.

Finished coils waiting to be installed

I chose to put my panels on the roof. I hope to eventuially connect my wood stove to my system so I can heat the water with it in the winter. One problem I did not anticipate this causing was I had to buy a much more expensive pump than Gary did so that I could get the water up to the roof. I choose to use the Taco 009.

Manifold in bottom of tank

The pump is fed by a pipe that comes out of the bottom 1 ¼" connection. It is below the water line by about 2'. When it was first hooked up the inlet and discharge were in a horizontal line. If it sat for a long time the pump would have a prime and work just fine. But if it was short cycled air would be inside of the pump and it would not prime.

Top of tank looking at finished exchanger

I am unable to express the frustration that followed. After much thought, trial and error I realized that the pump needed to be reoriented so that the discharge and inlet were in a vertical line with the discharge up. Such a simple thing caused an amazing amount of lost time.

When I mounted the panels I was concerned that if the discharge from one panel were lower than the others it would be the only one to flow water. I used a level to be sure that all three discharges were the same height. The supply line was hooked up before the discharge so I simply turned on the pump and waited for the water to come out of the panels onto the roof to see if they flowed evenly.

Trees on south side of house

Not only did they flow evenly, but since it was a sunny afternoon when I did this, just before the water started coming out a cloud of steam came out of each collector. This was a real confidence builder.

Panels mounted on roof

Like Gary, I titled my collectors so that the supply corner was the lowest part. One surprise of this system is that as soon as the pump shuts off I expected the water to drain back both from the supply, and return lines. Instead what happens is a siphon is formed in the supply line and sucks all of the water out of the collectors and what is still in the return line and pulls it back down the supply line.

For the roof rack I used 1 1/4" galvanized pipe. I don't really feel this big of pipe was necessary but it was the smallest size of roof flashing I could find. I didn't realize until I started adding up my receipts how much this rack cost. Not sure what I could have done differentially but just by putting my panels on the roof cost me about $300 between the larger pump and roof rack.

I used ½" PEX to connect the tank and panels. It was all wrapped in insulation and to give a little more protection, I ran the insulated pipe through 1 ½" PVC drain pipe. After the system was up and running a box was built around the tank using 2" Styrofoam. The box is large enough so that at least a 2" gap exists between the tank and foam. I am thinking about putting foam packing peanuts inside the box to fill this void. I suppose I could do it as I receive some of them in packages rather than going out and buying some.

After much thought and talking with Gary I still ordered a Tekmar 157 a controller. This will allow me to make my pump a variable speed pump. Gary didn't think the additional money was worth this feature but we get a lot of cloudy days here. I am hoping this will allow me to get more out of my collectors.

Just like Woodsy, I was not able to keep the price under $1K. But I also agree that this was more than just an attempt to save money. It has proven to be both enjoyable and addictive to reduce my footprint. I have attached a spreadsheet showing the cost of each section. As you can see had I stuck with Gary's original heat exchanger, and kept the panels off of the roof I believe it would have been under $1K.

Lessons learned, don't forget KISS, keep it simple stupid.

Materials	qt	Price	Tax	Total	Materials	qt	Price	Tax	Total
Panels					**rack**				
1/2 tee 25 pack	1	$11.00	$0.77	$11.77	1 1/4x5' nipple	4	$20.83	$1.46	$89.15
Coil stock	1	$33.00	$2.31	$35.31	1 1/4 floor flange	6	$5.49	$0.38	$35.25
silicone	3	$4.97	$0.35	$15.95	Roof flashing	8	$4.99	$0.35	$42.71
20 gauge studs	2	$5.83	$0.41	$12.48	1 1/4 x 4" nipple	6	$2.48	$0.17	$15.92
18 gauge studs	4	$6.20	$0.43	$26.54	1 1/4 el	4	$3.09	$0.22	$13.23
1 1/4 screws	3	$1.79	$0.13	$5.75	1 1/4 tee	4	$4.53	$0.32	$19.39
7 16 osb	3	$5.57	$0.39	$17.88	1 1/2 straps	12	$0.34	$0.02	$4.37
1" foil insulation	3	$13.38	$0.94	$42.95	misc bolts & nuts	1	$10.00	$0.70	$10.70
1/2 copper pipe	11	$6.49	$0.45	$76.39					$230.71
black spray paint	3	$4.00	$0.28	$12.84	**supply & return**				
Primer	1	$15.97	$1.12	$17.09	1/2" pex	1	$23.37	$1.64	$25.01
25 gauge studs	3	$3.49	$0.24	$11.20	pipe foam insulation	15	$3.97	$0.28	$63.72
				$286.14	1/2 copper x pex	2	$1.99	$0.14	$4.26
					1 1/2 coupling	2	$0.38	$0.03	$0.81
Misc. plumbing					1 1/2 el pvc	5	$2.19	$0.15	$11.72
Temp gauge	1	$13.99	$0.98	$14.97	Pex support el	5	$2.19	$0.15	$11.72
Mixing valve	1	$69.99	$4.90	$74.89	1 1/2x10 pvc pipe	4	$2.79	$0.20	$11.94
1 1/4x3/4 bushing	2	$2.49	$0.17	$5.33	2" pvc cap	2	$0.87	$0.06	$1.86
3/4x1/2 bushing	2	$1.29	$0.09	$2.76					$131.03
1x3 nipple	2	$1.65	$0.12	$3.53	**heat exchanger**				
1 1/4x1 bushing	2	$2.49	$0.17	$5.33	1/2 x3/8 bushing	12	$1.19	$0.08	$15.28
1 dialectric union	2	$5.49	$0.38	$11.75	1/2 street el	12	$0.68	$0.05	$8.73
1x3/4 bushing	2	$3.49	$0.24	$7.47	2" foam insulation	2	$19.82	$1.39	$42.41
1/2"shutoffs	2	$11.00	$0.77	$23.54	3/4 tee 10 pack	1	$17.99	$1.26	$19.25
pump	1	$150.00	$10.50	$160.50	3/4x1/2 tee	2	$2.99	$0.21	$6.40
Controller	1	$215.00	$15.05	$230.05	3/4 copper street el	4	$1.95	$0.14	$8.35
				$540.11	3/8 copper tubing	3	$69.99	$4.90	$224.67
				$1,513.09					$325.09