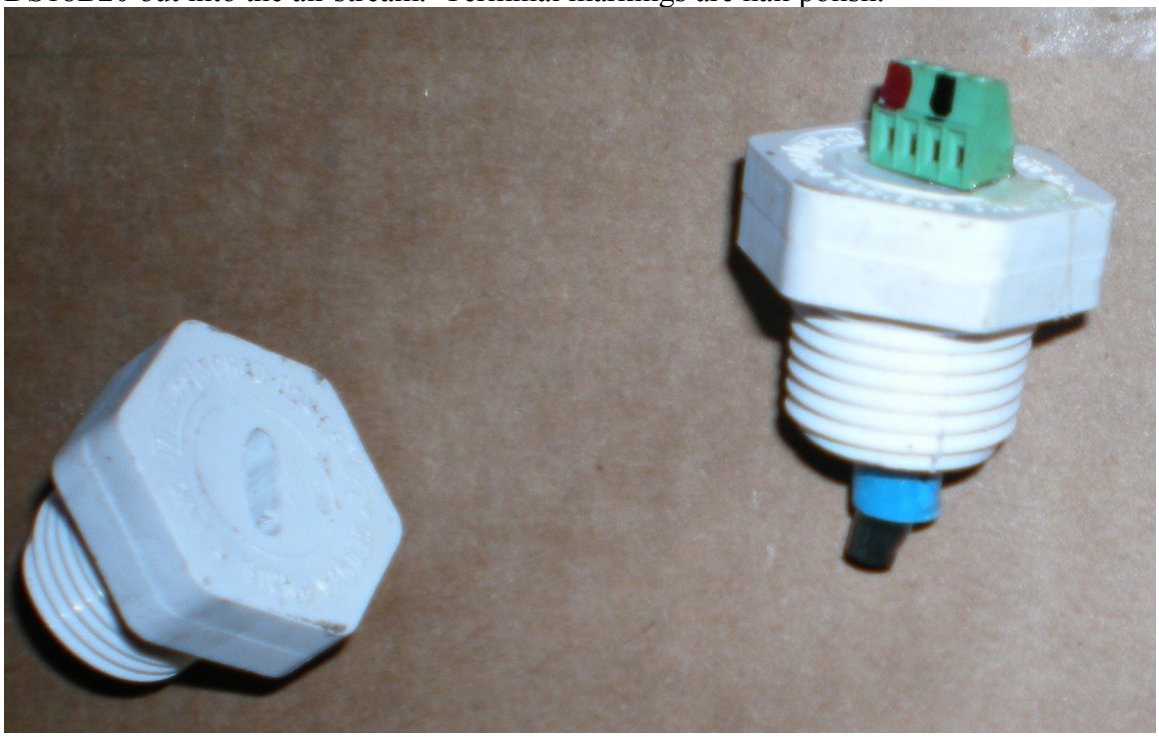
A 1-Wire Aspirated Thermometer

It's tough to get a good temperature reading in a greenhouse. The sun heats everything up, and sufficient shading may stop the needed air flow. The best answer is probably to use an aspirated thermometer. A small fan draws air through the instrument, over the temperature sensor, and the surrounding body provides some shade. In a greenhouse environment adequate water resistance and ruggedness are also considerations. And it doesn't hurt if the whole thing is cheap and easy to build and maintain.

My first attempt involved a foot of 2" PVC pipe, a 2" to 3" DWV bushing, and a 3" to 4" mushroom cap. I drilled and tapped a hole for a 3/8" PVC bushing in the center of the pipe. I soldered some wires on a DS18B20 1-wire temperature sensor and potted it into the 3/8" bushing with 5-minute epoxy and a piece of heat-shrink tubing. I attached a surface mount box with 2 RJ45 connectors to the pipe, and screwed a 60mm 12V ball-bearing fan to the top of the 2" to 3" bushing. The result works, but isn't as water resistant or rugged as I wanted. Also, the wires glued to the 3/8" bushing prevent actually swapping out the temperature sensor, and I'm not really that thrilled with the RJ45 connectors. Here is what it looks like, plus detail of the junction box.

I thought I had gotten a few things right. The choice of 2” diameter pipe seemed good, and the 12” length prevented recirculation. The mushroom cap looked a little funny, but probably couldn't be improved upon. The 2” to 3” bushing worked with the mushroom cap, and fit the fan OK. But I didn't like the exposed fan and sensor wires, the junction box that clearly was not water resistant, and the hardware store where I bought the 3/8” bushing didn't have enough parts for the 6 thermometers I needed. And I had to isolate the 12V power and ground for the fan from the 1-wire signal and ground, and added a 47 uF capacitor across the fan wires to suppress the electrical noise from the fan.

I decided to switch to a 1/2” PVC plug to hold the DS18B20. I found a 1/2” NPT tap at a local flea market for $1. I don't know if it is in good enough shape to thread steel, but PVC is no problem. I bought some small Phoenix screw connectors (2.54mm centers) for use on the back of the plug. You need a really small screwdriver, but they hold OK. Here is the resulting sensor assembly, and a view of another plug drilled for the wires and Phoenix connector pins. Note the blue heat-shrink tubing full of epoxy that extends the DS18B20 out into the air stream. Terminal markings are nail polish.



Drilling the 2” to 3” bushing was the hardest part of construction. The inside top of the bushing is tapered toward the center so it is very hard to drill a hole straight enough to go through the fan mounting holes. I wound up building a simple jig to do this on the drill press. It consisted of a small piece of plywood with a piece of 1-1/2” PVC pipe epoxied in place and thickened with electrical tape so it would center in the bushing, and with the fan hole pattern drilled in the plywood to guide the holes drilled in the bushing.

The “saddle” is a piece of pipe cut off with a 2-3/8” hole saw, and about 1-1/4” long at the shortest point, to make a small junction box. I drilled a full 3/8” hole in the top for the fan wire tube, and a slightly incomplete 3/8” hole in the bottom for the 1-wire cables.

I attached the saddle to the pipe with PVC cement, then strengthened the joint with epoxy after the cement cured.

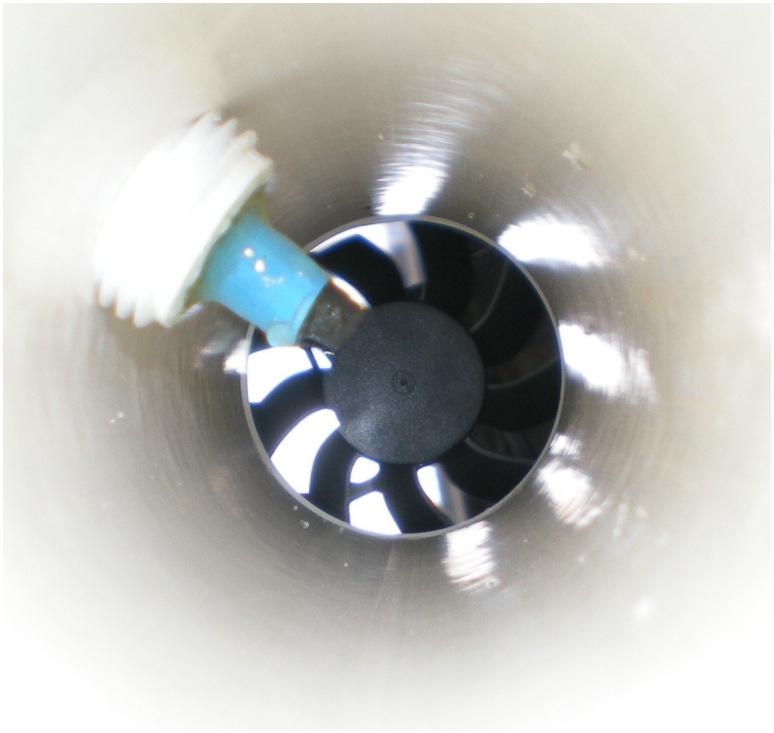
The exposed fan wires had to go, too. I drilled a hole in the bushing and saddle, and epoxied a piece of clear vinyl tubing (3/8” OD, 1/4” ID) in place to protect the fan wires. I sprayed this area with white Krylon Fusion paint.

The mushroom cap came in gray so I spray painted it white to try to reduce the solar heat gain. Again, the Krylon Fusion seems to be the best paint choice.

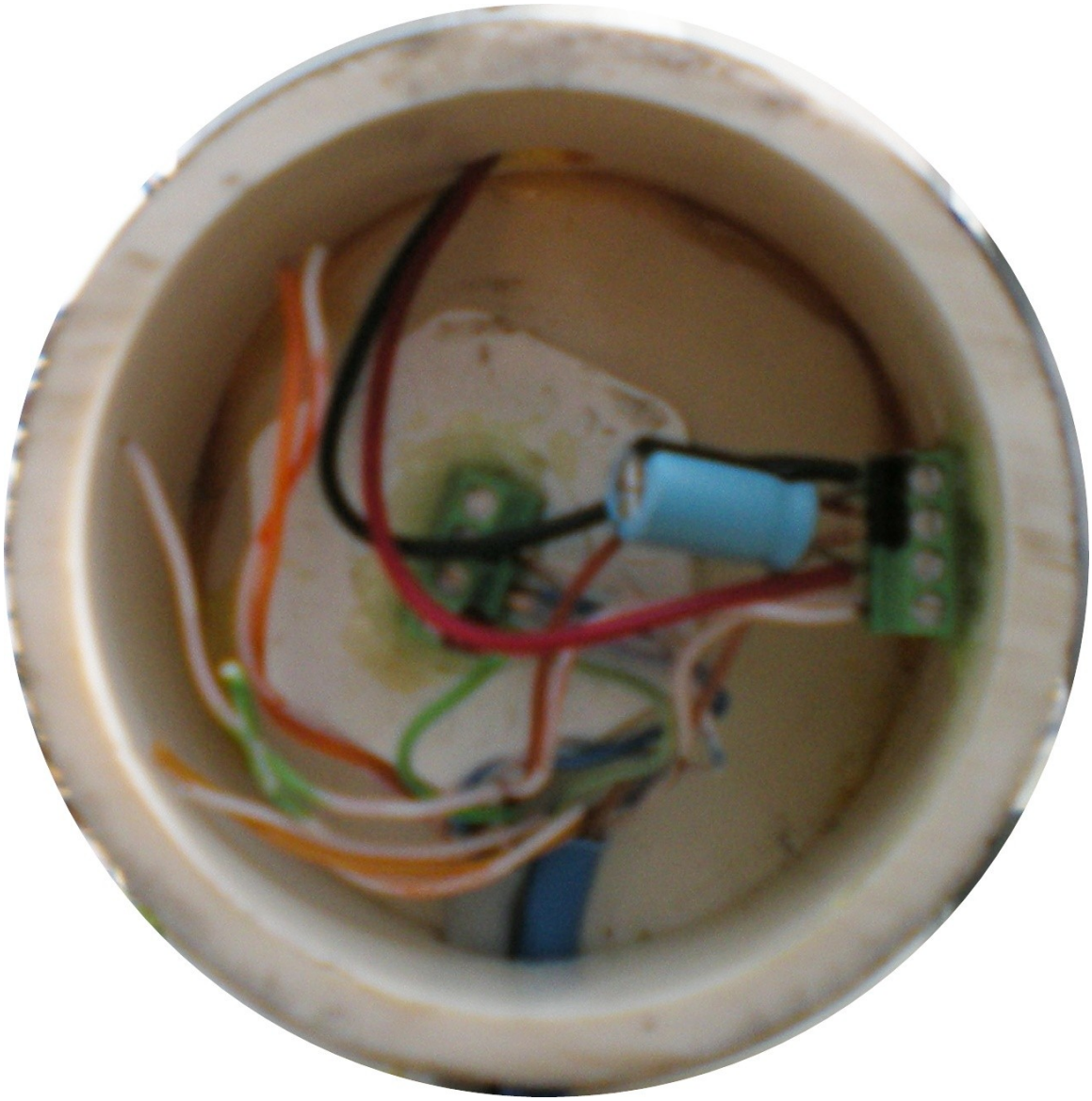
Another view of the saddle showing the Phoenix connector used to connect the fan wires and capacitor. Note that the tapped hole for the temperature sensor assembly is offset to one side so that you can get a 1-1/8” deep socket over the PVC plug without hitting the Phoenix connector glued to the side of the junction box.

This view shows the cable hole in the bottom of the saddle, which also doubles to allow any water that might get in to weep out of the bottom of the junction box.

This view shows the penetration of the DS18B20 into the air stream in the pipe.



Here is an example all wired up. Green is 5V, Blue is 1-wire data, White/Blue is the ground for the 1-wire data and 5V. White/Brown is 12V, Brown is the 12V power return. The Orange pair and White/Green are unused. The 47 uF capacitor suppresses electrical noise from the fan.



I lubed the inside of the 2” PVC cap with Lock-Ease (graphite spray in a solvent used to lubricate locks) so I can hopefully get them off if I need to. Here is a finished thermometer hanging in one of the greenhouses.