Frank Lee's Thoughts on Homemade Oil Diffusion Pumps

Frank Lee and I had a fairly extensive correspondence in the 1992 timeframe regarding homemade metal diffusion pumps. In this collection I have included what I think are the more relevant notes, pretty much all in his hand.

We never brought this project to completion although I do have a chimney for the described 1 inch 2-stage pump.

If I were to continue this, I would make a glass pump body with a 25mm Ace Thred fitting on the inlet. This would have the advantage of making the innards visible (wonderful for educational purposes) and it would avoid all of the metal fabrication issues that are associated with sealed metal structures.

This collection begins with Frank's remarks on the Edwards EO1 diffusion pump, upon which this design is based. It concludes with a related correspondence on an alternate design using copper plumbing tubing and fittings for the pump body.

Steve Hansen
January 1, 2009

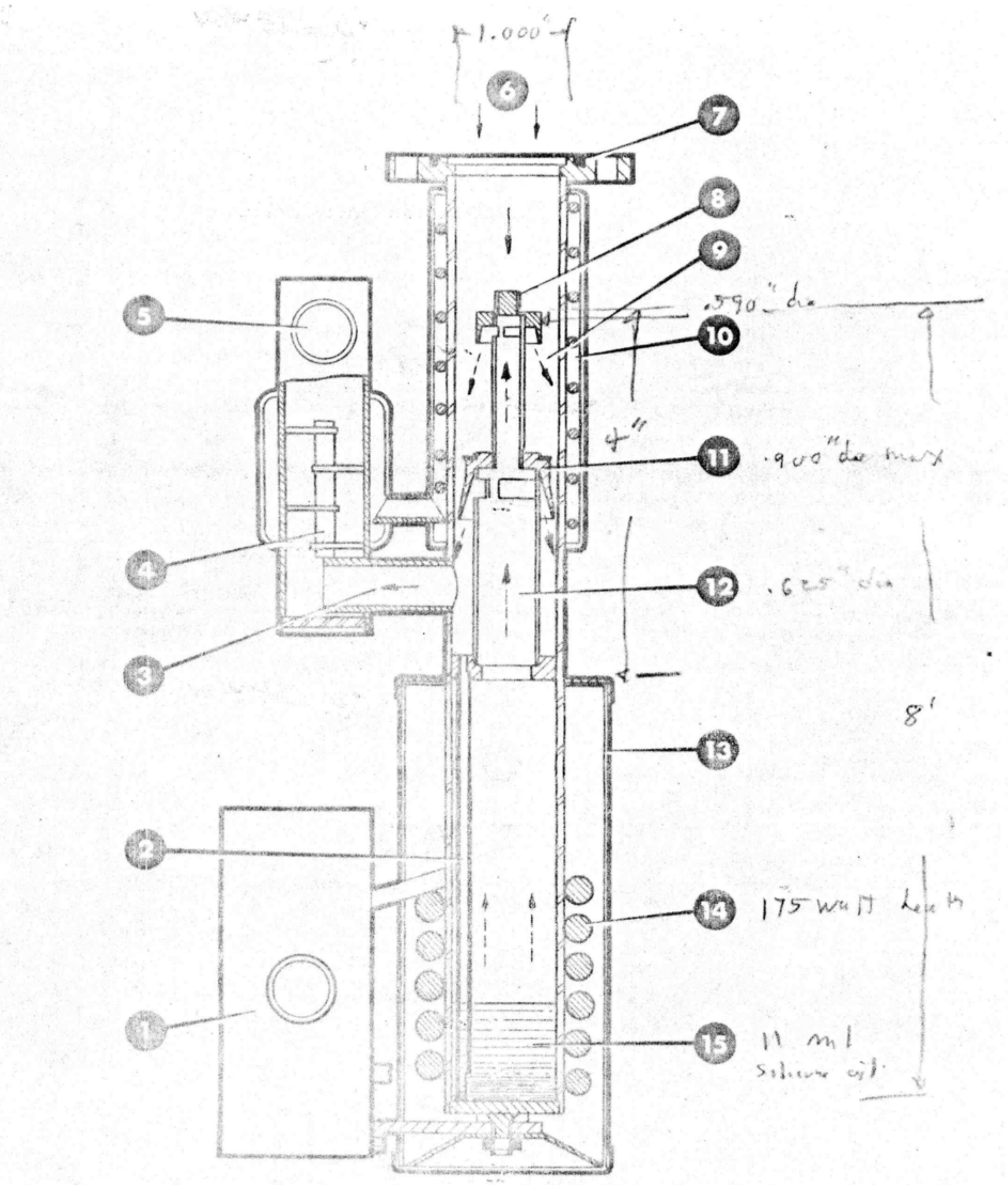
OIL VAPOUR DIFFUSION PUMPS

SERIES EO1

(Water and air-cooled versions)

M05624/2
Mar 1965

I think this pump sells for $700 now which is absurd. any machinist could make one in a day if materials were at hand (about $10). I made one once for somebody. It worked OK so he said but I have no data. I could provide the material and drawings if you could find someone interested in making another one. I'd like a report on the ultimate vacuum obtained.



1. Terminal box
2. Fluid return tube
3. Backing tube
4. Baffle
5. Backing connection
6. Gas from system
7. 'O' ring VOR0218
8. Top jet
9. Vapour plus gas
10. Cooling water jacket
11. Lower jet
12. Vapour stream
13. Radiation shield
14. Heater
15. Fluid charge

Fig. 1. Model EO1 Vapour Pump

SPECIFICATION

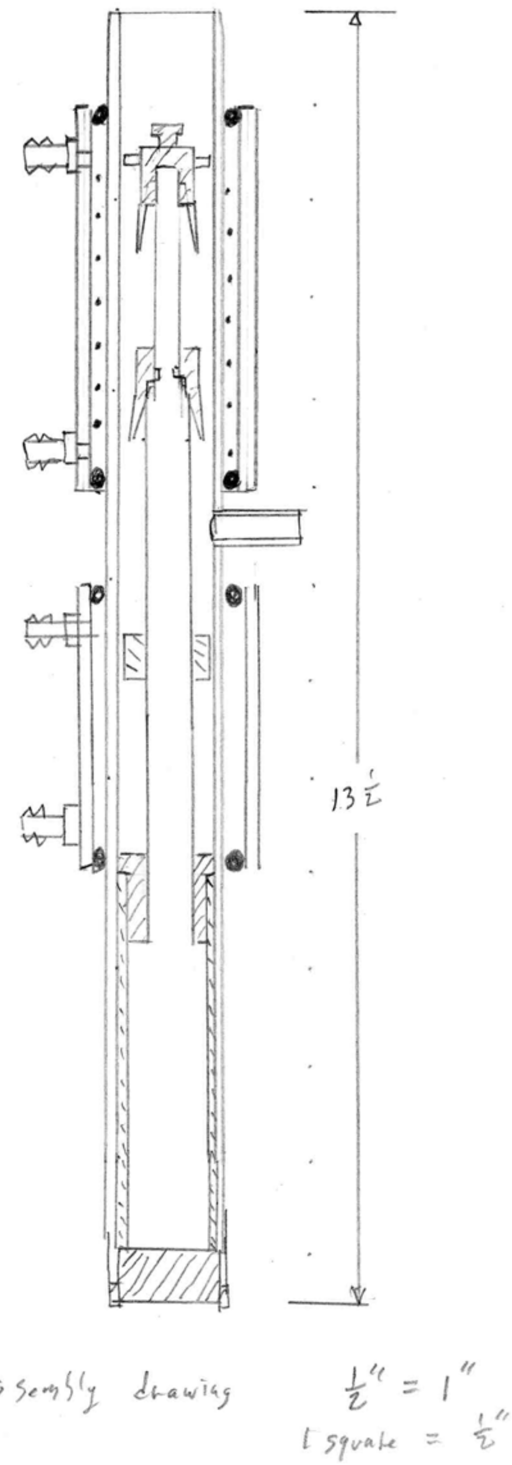
Construction	stainless steel body
Number of stages	2
Mouth diameter	1 inch
Peak air speed (unbaffled)	9 to 10 litres/second
Ultimate vacuum, better than	5×10^{-6} torr
Critical backing pressure:	
Using Silicone 702	0.5 torr
Backstreaming rate	less than 0.05 mg/cm^2/min
Recommended backing pump:	
Minimum Displacement	30 litres/minute
"Speedivac" Model	ES35
Backing connection	5/8 inch o.d. tube
Fluid charge	11 ml
Heater loading	175 watts
Cooling: Minimum water flow	0.3 litres/minute at 15°C
Connections	¼in o.d. tube
or:	air cooled by fan
Overall height (approx)	10 inches (25.4 cm)
Weight (approx) air cooled pump	8lb (3.6 kg)
water cooled pump	3¼lb (1.5 kg)

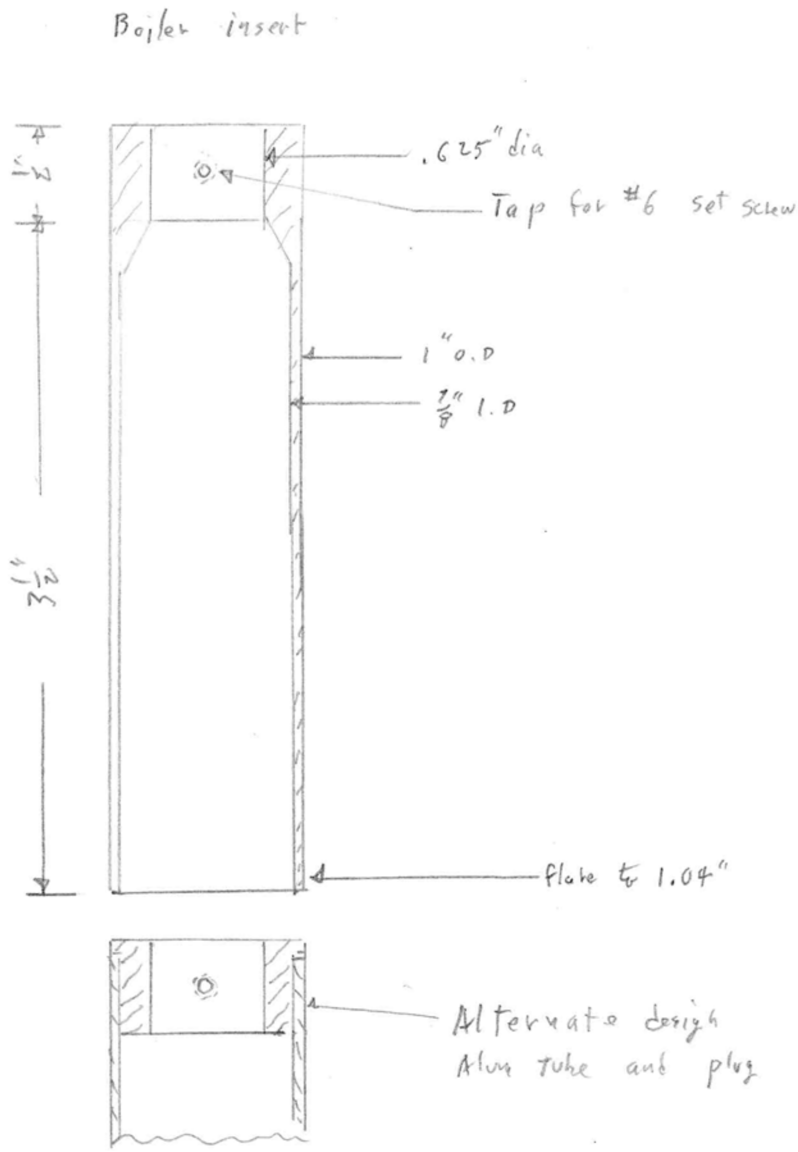
Here is the assembly drawing for Frank's version of the Edwards EO1. The chimney is machined from aluminum rod and tube stock. His approach to the water jacket is to use pvc pipe with the inside diameter just a bit larger than the pump body diameter. The pipe is drilled and tapped for the inlet/outlet hose barbs and the seal between the pipe and the pump body is made by o-rings at each end, sized to have a press fit in the gap.

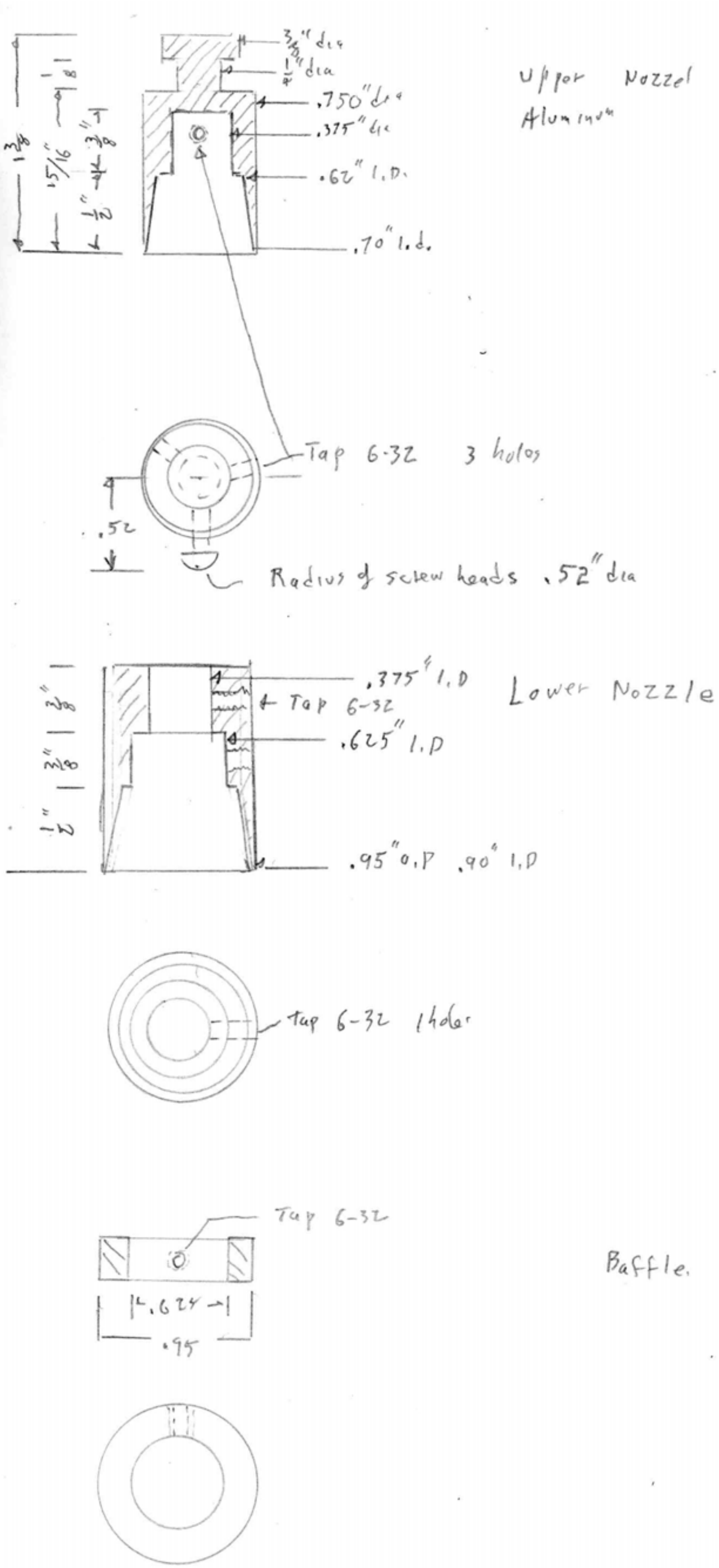
There are two water jackets: one for the upper part of the column and the other in for the area below the pump's outlet.

The heater (not shown) is a resistance wire that is wrapped around the boiler.

Drawings of the individual chimney parts are on the following two pages.




Boiler insert
.625" dia
Tap for #6 set screw
1" O.D
7/8" I.D
Flare to 1.04"
Alternate design
Alum tube and plug


Upper Nozzle
Aluminum
.750" dia
.375" dia
.62" I.D.
.70" I.d.
Tap 6-32 3 holes
.52
Radius of screw heads .52" dia
.375" I.D
Tap 6-32
Lower Nozzle
.625" I.D
.95" O.D .90" I.D
tap 6-32 1 hole
Tap 6-32
Baffle.
.624
.95

230 Hampton Pkwy
Kenmore NY 14217

Dear Mr Hansen:

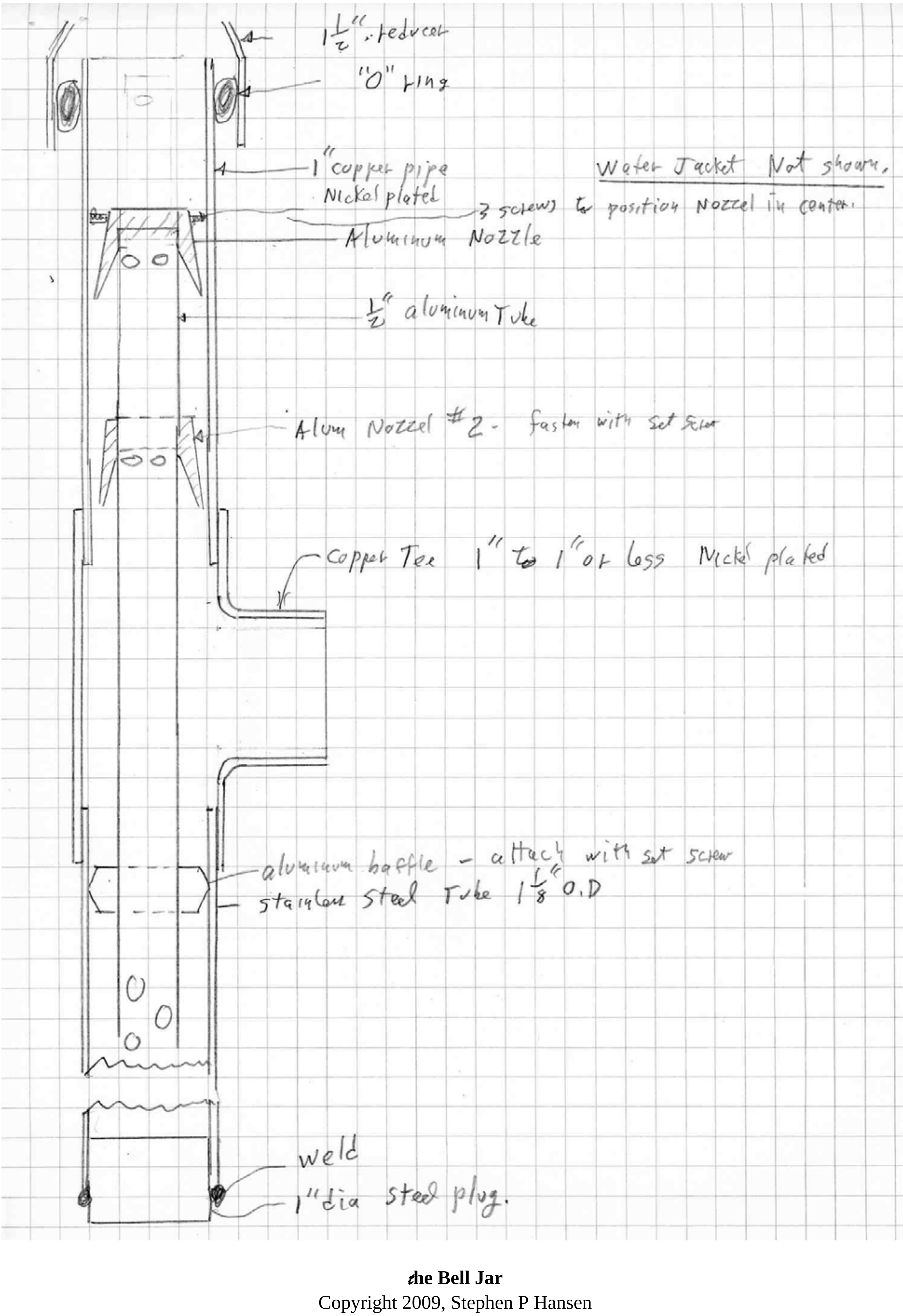
I'm offering another design which I think might be simpler. I would use copper water pipe which comes in diameters of .875, (3/4) 1.125 (1") 1.625 (1 1/2") and get stainless tubing of the same size. You could offer a kit for the stainless steel, nickel plated pipe, nozzels and aluminum parts which would save hours of work. These nozzles could be made for less than $3 each by any machine shop having a turret lathe. I'll make the first batch to get started.

Stainless steel requires a special flux to solder and is not easy to do. I would not solder the bottom plug as the operating temperature is close to the melting point. I would sell the stainless with an iron plug inert gas welded to it. I would also have the copper pipe pieces nickle plated.

Perhaps I could make a model and you could test it. I'll either make a copy of the nozzle in the pump I have or yours. The only critical dimensions of the nozzle is the diameter. Since copper is a good heat conductor, the water cooling might only have to cover the section above the Tee. This section could easily be made longer to allow more cooling area and would permit a simple jacket of pvc pipe and O rings.

My observations of a diffusion pump indicate that the oil is largely heated from the top. This smooths the evaporation and stops bubbling and boiling that would occur from bottom heating. The cold oil running down the inside of the top section must pass thru the baffle yet the opening must be small to prevent vapor coming up. Perhaps it would be good to make a separate trap thru the baffle or let the oil go down a down spout made from 3/16" diameter aluminum tube. Have you any data on the vapor pressure of the oil at operating temperature? It would have to be on the order of .1 mm Hg or less to prevent the vapor from forcing its way thru the oil film between baffle and boiler body.

Sincerely
Frank Lee


1 1/2" reducer
"O" ring
1" copper pipe Nickel plated
Water Jacket Not shown.
3 screws to position Nozzel in center.
Aluminum Nozzle
1/2" aluminum Tube
Alum Nozzel #2 - fasten with set screw
Copper Tee 1" to 1" or less Nickel plated
aluminum baffle - attach with set screw
stainless steel Tube 1 1/8" O.D
weld
1" dia steel plug.