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Handling of liquids under weighlessness

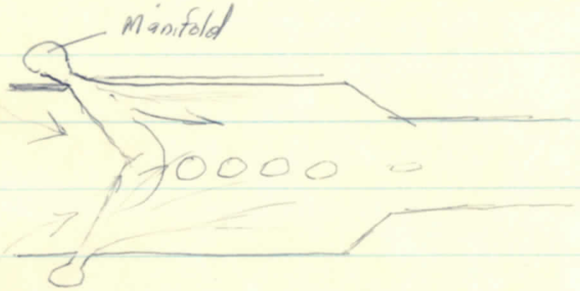
There are now and will continue to be a number of situations in $\varnothing \overline{w}$ in which a liquid must be collected, separated into a single phase i.e. unmixed c̄ ~~air~~ gas, measuremed volumetrically, sampled, & placed in containers or circulated or transferred. Three such examples are urine collection, washing either personal or mechanical objects and a shower bath. In spite of numerous studies and some experimentation there are presently no workable systems. Worse still the problem has not been approached systematically.

The urine collection problem has probably had more talk and money spent on it than the others. Some of the efforts to date include programs by Whirlpool, and G.E. These will be examined in detail later. Although an infinite variety of combinations are possible and a goodly number will work the basic operations will be described, several possibilities considered and the most promising examined in detail.

1) ~~Generally the~~ Entrapment. a stream or droplets, usually moving c̄ some velocity must be restricted to some desired area and

then picked up and carried into a conduit-

The function of restriction + pick up may be performed by gas flow. This gas flow arrangement will depend upon the situation. For example in urine collection ~~an~~ annular nozzle producing an inverted conical 'shield' might be used. In this case the flow is unidirectional or at worst zero. The problem is simply that of ~~at~~ maintaining or achieving sufficient velocity to adequately transfer the liquid ~~to~~ through the conduit to a separator. The worst case is a dribble which has insufficient initial velocity to separate from the body and by surface tension forms a globule. This could be broken + removed by a sufficient air flow however shaking plus a lower flow will accomplish the same result. ~~The p~~



~~The present~~ $V \propto r^3$

$A \propto r^2$

~~At~~ A small additional air flow from outside the collector will aid in odor control, further control backflow and possibly provide a measure of of drying. It seems unlikely that any mechanical curtain to prevent backsplash will be required. This is supported by Apollo experience ~~of~~ in which capillary action ~~or~~ plus a very low air flow has provided adequate collection.

Previous experience: the ~~earliest collection system wa~~ Mercury collection system had a number of shortcomings ~~including~~ the most serious of which was its being a dirty system -

The Appolla system is apparently proven

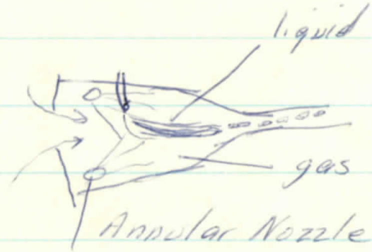
* Check on " " air flows dirt etc.

+ acceptable. Zero G flights tests have apparently been successful ē ~~the~~ the simple air ~~ent~~ entrapment system of the Fairchild-Hiller ~~system~~ device.

Air flows rates must be determined + tested here. Apparently the can be quite low to judge from th F.H. and Appola collectors -

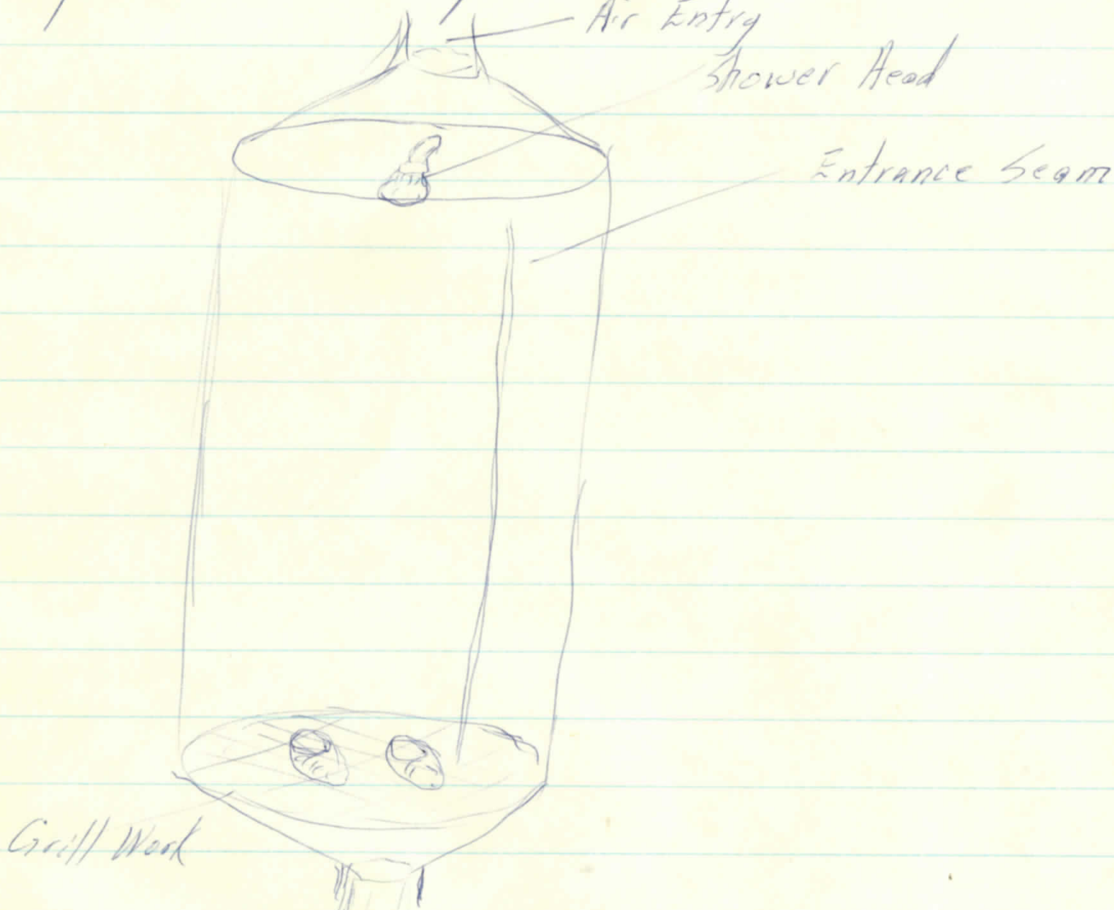
Wash Collect. ~~Another example~~ This is another more complex example of the collection function. ~~There~~ ~~Bas~~ A ~~stream~~ continuous stream of water impinges upon the object to be washed, hand, cloth etc.

~~Th~~ To perform vigorous of scrubbing etc - it seems likely that relatively high velocity water drops may be back scattered. This may well required a mechanical as well as a gas curtain. One possible arrangement is shown below -

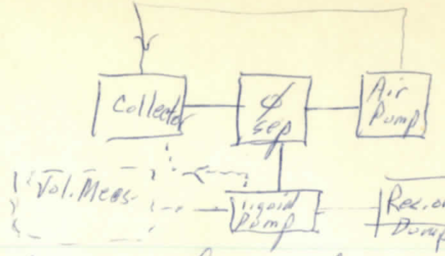


~~The hands become~~ ~~This~~ Both hands may be used to mechanically manipulate any item being washed. In addition a wash cloth may be ~~squeezed~~ as under 1 G conditions. The low velocity solvent ~~stream~~ (water is assumed) stream may either flow continuously or be controlled by foot or knee or other pressure, It's assumed there will be water droplets on the rubber dam but a simple stretch + release would snap these into the air stream for simple hand washing a rapid dry cycle could be incorporated by heating the air stream -

In the case of a shower the same principles could be used on a larger scale. As in conventional showers a surrounding curtain would be used. In this case the curtain would be continuous and cover the top as well to prevent back splash.

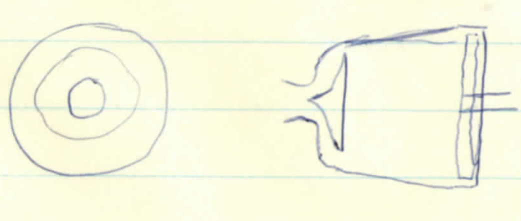


The difference here is that large volumes of air + water will be required. In all of these collectors the air should ~~prove~~ be used after accomplishment of the collection proper to sweep away any large droplets + to dry any small droplets or



films. All contact surfaces should be non-wetting.

Phase separator – This is the heart of the system. No one acquainted c̄ elementary physical & mechanical principles doubts that a centrifugal separator ~~It is only~~ will function. It is ~~in~~ the details that cause difficulty. These however are only details. In essence a centrifugal separator need only impart sufficient radial velocity to the smallest droplets to sling ~~slight~~ them to the ~~outside of~~ periphery of a rotating cup. How to keep them there is another important decision. There are two possible ways exemplified by the Whirlpool and G.E. devices. In the Whirlpool centrifuge ~~the~~ a mixed air liquid stream enters centrally and strikes a



rotating slinger plate which imparts radial velocity to the mix. The greater momentum of the liquid droplets carry them to the walls of the cup which also rotates. ~~At the Opposit~~ This will very effectively separate water & gas c̄ the

liquid ~~remaining in firm contact c̄ the walls~~
forming a homogenous lamina against the
wall.