such a Kendall tube for the production of oxygen-free nitrogen from regular tank nitrogen of reputed 99.44 per cent. purity. Our experience with this original design is quantitatively summarized in Fig. 1, where

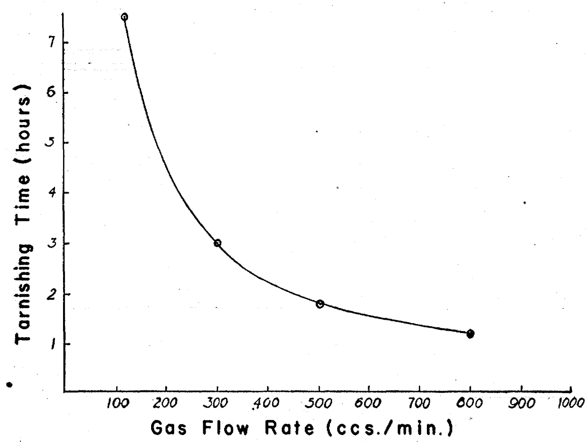

FIG. 1

the time at which tarnishing of all the gauze is complete is plotted against corresponding rates of gas flow.

It is the purpose of this paper to describe a slight modification in design of tube, providing for increased capacity. Both the original design and the new design are shown in cross section in Fig. 2.

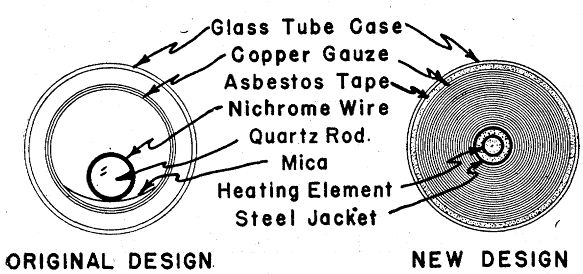

FIG. 2

If a Calrod[3] heating element is used as a source of heat, the copper gauze may be tightly wrapped around the heating element to a thickness just below the inside diameter of the glass case. The heating element which we find satisfactory draws 500 watts at 115 volts, is $23\frac{3}{4}$ in. in length, and has 17-inch effective heating surface. One-inch asbestos tape is wrapped tightly about the copper gauze bundle at several points about four inches apart to provide a snug fit of the bundle in the glass case, and to prevent channeling of the gas through the tube. It is essential that this asbestos packing be very tight. Care should be taken that the materials entering the tube do not become greasy from handling, as this grease will distil off the materials on heating, and condense on the inside of the tube.

[3] Manufactured by General Electric Company.

The new design has two advantages over the original. (1) The capacity for oxygen removal is considerably increased, the new having 10 to 12 times the capacity of the original. (2) Provision is made for more intimate contact between gases and the hot gauze. If the Reynolds number[4] is calculated for gas flow in the original tube according to the equation, Reynolds number $= \frac{D u \rho}{\mu}$, it is found that at a gas flow of 100 cc/min, the Reynolds number is 1.5. Since u, the velocity of flow, is directly proportional to the Reynolds number, this number for any flow velocity can easily be computed from this one calculation; *e.g.*, at 1,000 cc/min, the Reynolds number is 15. When the Reynolds number is less than 2,100, viscous flow obtains. Therefore flow in the original tube is of the viscous type whenever the gas flow rate is below 100,000 cc per minute. It may be possible, therefore, for oxygen molecules to pass from one end of the tube to the other through the open central portion of the tube without coming into contact with the hot copper. Removal of oxygen should therefore be more complete with the new design. This point must be settled, however, by further experimental work. At the same time, gas flow is unrestricted. Calculations of Reynolds numbers for the new design would be without meaning, since the circuitous path imposed upon the gas insures turbulent flow.

Our tube was constructed by the Central Shops of the University of Minnesota.

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COLD EXTRACTION APPARATUS

OFTENTIMES one wishes to extract a solute from solution without the use of heat. In biological chemistry, especially, there are many substances which are easily destroyed by boiling solvents.

The author has designed and built a special cold extraction apparatus which is schematically shown in Fig. 1. The apparatus works on the principle that two immiscible liquids, such as water and benzene, for example, will not mix, but will rise and separate on the top of the heavier one similar to oil on water. The long column A is half filled with the aqueous solution to be extracted. Benzene or any other immiscible liquid which is lighter than water is allowed to run down the inner tube C, passing through a porous glass filter at the bottom. The latter disperses the organic solvent into many small bubbles which extract as they rise through the water and separate at the top. The upper liquid containing the extracted

[4] Badger and McCabe, "Elements of Chemical Engineering." Second Edition. McGraw-Hill Book Company, 1936.

substances flows off into the syphon chamber and eventually into the reservoir. In so doing the organic liquid flows up the tube D due to suction created by the liquid sealing the end of same tube. The liquid flows up to the suction chamber on top to a level of about half. The weight of the liquid delivered in suction chamber trips the balance arm above and thus allows the left-hand side to be lowered a few inches and the right side to be raised by the same amount. This latter side is fastened to a wire E, which is connected to tube D. This above action lifts the tube D up out of the liquid, breaking the seal and allowing air up the same tube and releasing the suction in the suction chamber above. By releasing the suction on the system, the float valve rises and allows the liquid to flow out into storage chamber F. From here it flows down at a speed governed by means of flow control valve through the inner tube G through a porous glass filter into another aqueous solution, which reextracts the dissolved solute back into the aqueous phase again. The organic liquid rises in many small bubbles, separates at the interface and flows over to storage chamber H. From here the whole process repeats itself, going on continuously.

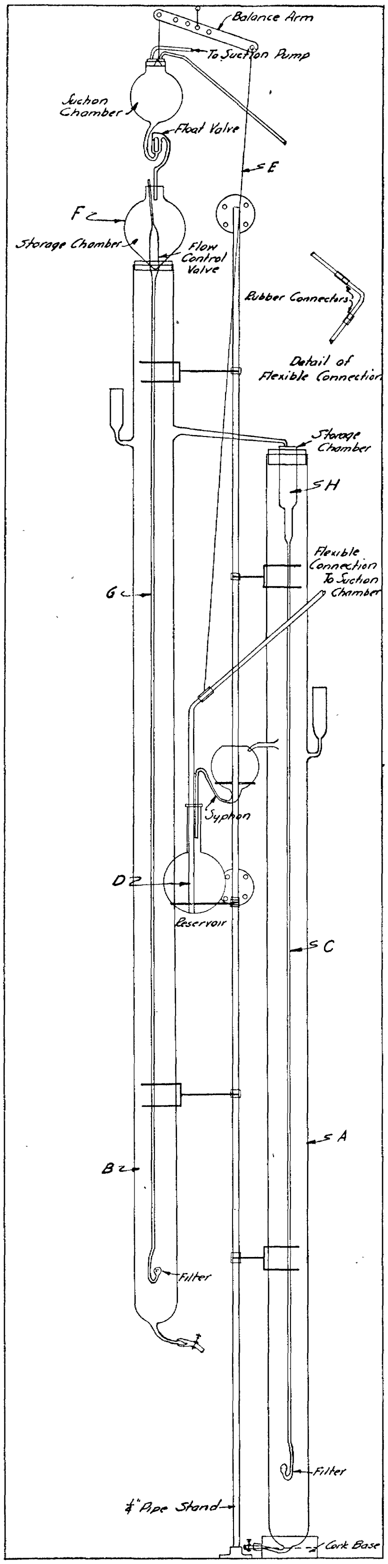

FIG. 1

The apparatus could be built of any desired size, and it may be used for a variety of problems by simply using different solvents.

The writer is greatly indebted to Dr. S. J. Thannhauser, whose laboratory supported the building of the above apparatus, and also to E. Perkins, who helped overcome one of the mechanical difficulties. The glass blowing was done by J. Rossetti.

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