Sept. 2, 1958 M. M. FINK 2,850,167

LIQUID THERMAL DIFFUSION APPARATUS

Filed May 14, 1956

FIG. 1

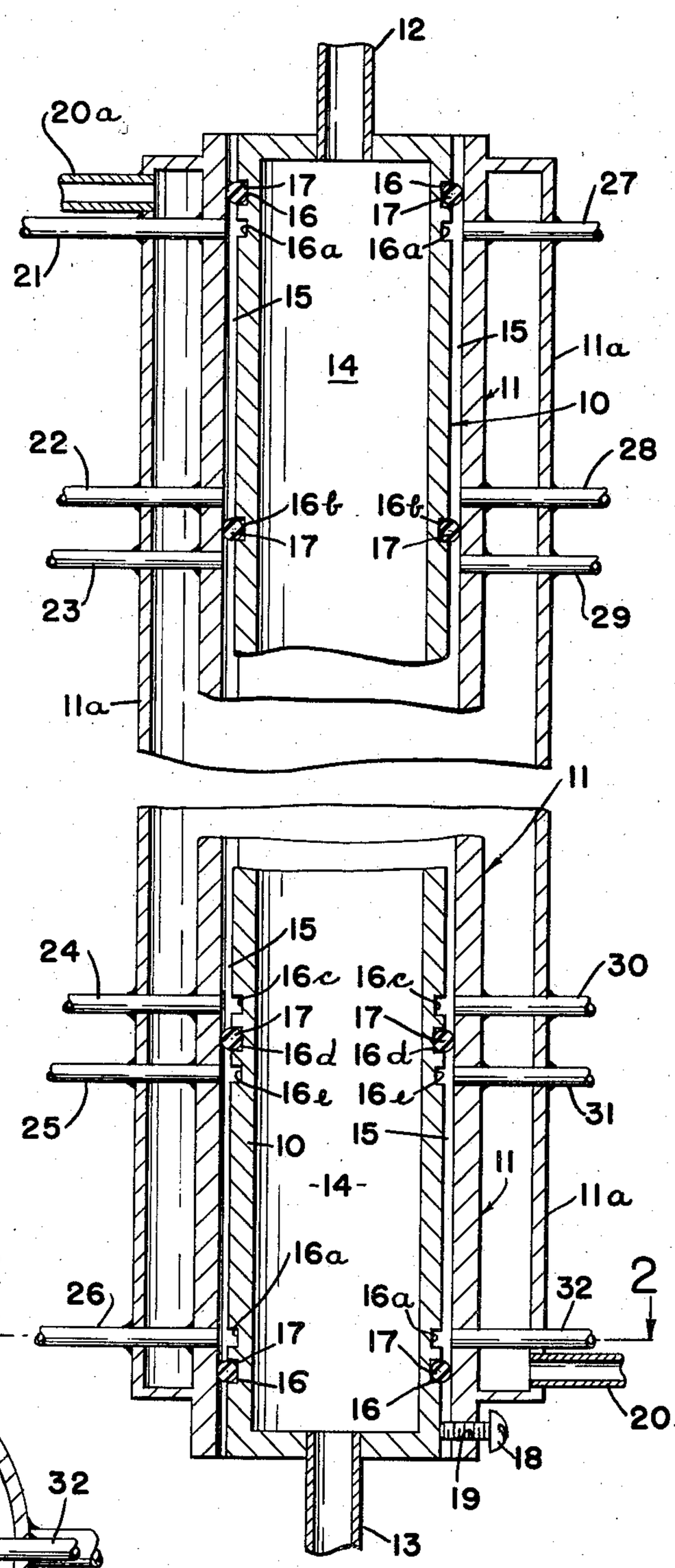
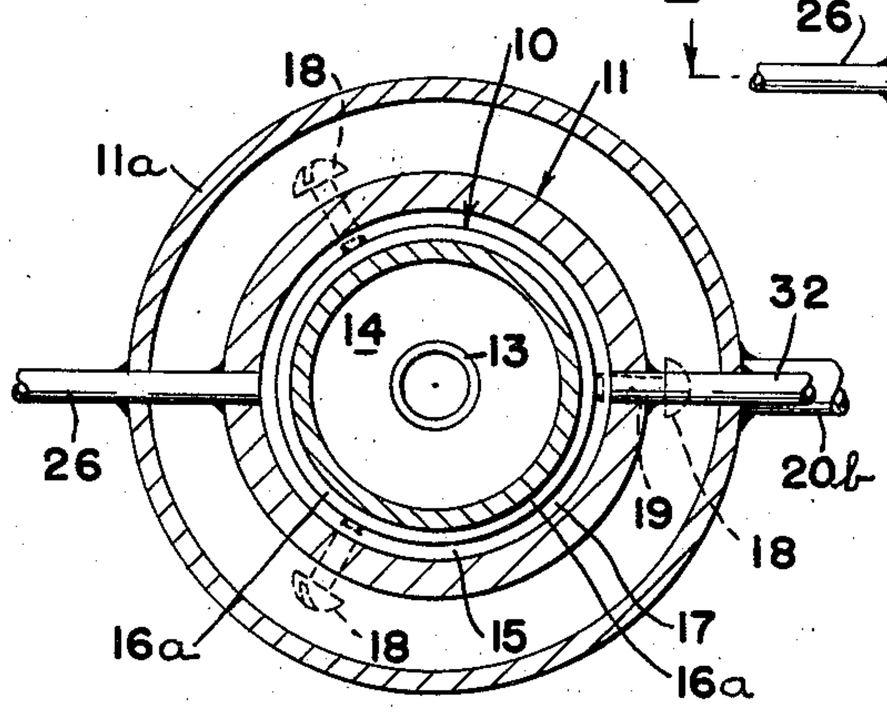


FIG. 2



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2,850,167

Patented Sept. 2, 1958

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LIQUID THERMAL DIFFUSION APPARATUS

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Application May 14, 1956, Serial No. 584,576

4 Claims. (Cl. 210—176)

The present invention relates to an improved liquid thermal diffusion apparatus. More particularly, this invention relates to a unitary tubular type thermal diffusion apparatus containing a plurality of discrete separation chambers.

Liquid thermal diffusion is a process by means of which the components of a liquid mixture may be concentrated and separated. The process is carried out by subjecting a thin film of the liquid to be separated to a temperature gradient and the separation is accomplished by means of the resultant thermal forces within the liquid.

Apparatus which may be employed in carrying out a liquid thermal diffusion operation has been described in U. S. Patent No. 2,541,069 to Jones et al. Figure 1 of that patent illustrates a typical tubular-type apparatus for carrying out the thermal diffusion operation. In such an apparatus, concentric tubes are employed to form a narrow annular space of uniform width which serves as the separation chamber. The width of the separation chamber is necessarily quite narrow, less than 0.15 inch and preferably 0.02 to 0.06 inch. Means are provided for feeding a liquid to the separation chamber and for withdrawing products therefrom. Separation of a liquid mixture is effected in such an apparatus by impressing a temperature gradient across the liquid which is confined in the annular space between the concentric tubes and means are provided for this purpose.

Heretofore, if a number of different liquids were to be thermally diffused, it was necessary to employ a separate apparatus of the type described in the Jones et al. patent referred to above for each liquid to be separated. The same conditions obtained if it was desired to subject the products of the thermal diffusion process to further refinement by thermal diffusion. Accordingly, one of the objects of this invention is to provide a tubular type thermal diffusion apparatus in which a single pair of concentric tubes is employed to form a plurality of discrete separation chambers which may be simultaneously employed to effect the separation of different liquids. Such an apparatus has the advantage of requiring a minimum of piping and other connections which are employed to supply the heat transfer mediums to the apparatus since the means for impressing the temperature gradient across the various liquids to be separated are common to all of the separation chambers.

In view of the criticality of the width of the separation chamber in a thermal diffusion apparatus, it is important that the surfaces forming the separation chamber be maintained relatively free from obstructions or deposits. It is well known that certain materials will foul the separation chamber under the high temperatures which they may be subjected to in the thermal diffusion process. Consequently, the time required to clean the apparatus becomes an important consideration in determining the economics of subjecting such materials to the thermal diffusion process. Accordingly, it is another object of this invention to provide a tubular type apparatus which may be readily

disassembled to facilitate cleaning operations on the apparatus.

In brief, my invention comprises a pair of concentric tubes which are spaced apart so as to form a uniformly narrow thermal diffusion separation chamber. Means are provided at certain predetermined spaced distances along the length of the concentric tubes to seal the annular space between the tubes so as to form a number of discrete separation chambers therebetween. Means are provided for feeding liquids to and withdrawing products from each of the discrete separation chambers. Means are also provided for impressing a temperature gradient across each of the discrete separation chambers, but such means are common to all of the separation chambers.

A better understanding of the apparatus of this invention may be had by reference to the attached patent drawing wherein similar figures denote similar parts throughout and where:

Figure 1 is a cross-sectional side view; and

Figure 2 is a top view of the apparatus looking down from the plane **2—2**.

Referring now particularly to Figure 1, the basic elements of the apparatus are the hollow cylinder **10** and the jacketed tube **11**. The cylinder **10** is inserted in the tube **11** so as to provide a uniform annular space **15** therebetween. The cylinder **10** and the tube **11** may be formed of any heat-transmitting solid such as glass or metal. The cylinder **10** is provided with a plurality of grooves **16** in its outer wall at spaced points along its length. The grooves occur at intervals along the length of the cylinder **10**. The grooves **16** may be in pairs, **16** and **16*a***, as shown at the top and bottom of Figure 1, or there may be a single groove **16*b*** as shown in the upper part of Figure 1, or in sets of three, **16*c***, **16*d*** and **16*e***, as shown at the bottom part of Figure 1. The grooves are adapted to receive a sealing means such as a resilient O-ring gasket **17** which serves to seal the annular space **15**. The gasket may be of natural or silicone rubber or a plastic, for example. The arrangement of the cylinder **10** and the tube **11** is also shown in Figure 2. One or more set screws **18** may be provided in openings such as **19** in the jacketed tube **11** to assure a uniform spacing between the cylinder **10** and the tube **11**. The conduit means **12** and **13** communicate with the interior **14** of the cylinder **10** whereby a heat transfer medium such as steam or water may be admitted to the interior **14**.

The jacket **11*a*** which surrounds tube **11** is provided to accommodate a similar heat transfer medium. The heat transfer medium enters and leaves jacket **11*a*** by means of the conduits **20*a*** and **20*b***.

Suitable provisions are made in the tube **11** and the tube jacket **11*a*** for the entry of conduits **21—32**, inclusive, which communicate with the exterior of the apparatus and the separation chamber **15**. The conduits **21—32** communicate with the separation chamber, and may be opposite a groove, as shown at **16*a***, **16*c*** and **16*e***, in the outer wall of cylinder **10**. Accordingly, such grooves **16** function as liquid reservoirs. In this manner, a unitary apparatus is provided in which a plurality of discrete separation chambers are provided by means of the sealing means **17** which effectively divides the separation chamber **15** into a number of discrete sections.

In one method of employing the apparatus of this invention, a liquid to be separated could be admitted to the separation chamber **15** through the conduits **21** and **22**. In such an operation, enriched products of the thermal diffusion process would be withdrawn through conduits **27** and **28**. Another liquid similarly could be fed through conduits **23** and **24** and withdrawn from conduits **29** and **30**. Alternatively, the enriched liquid from either conduits **27** or **28** could be fed to conduits **23** and **24**.

One of the principal advantages of my invention is that

the apparatus may be easily disassembled. In order to disassemble the apparatus of this invention, it is only necessary to loosen the set screws **18** and pull the cylinder **10** out of the tube **11**. Since the sealing means **17** are resilient, they furnish no obstruction to the removal of the cylinder **10** from the tube **11** and they are the only elements of this apparatus which contact both the cylinder **10** and tube **11**, as can be seen from Figures 1 and 2 of the patent drawing.

Another advantage of my invention arises from the use of O-ring gaskets as the sealing means, since these gaskets, due to their resilient nature, will inherently serve also as spacing means and maintain the uniformity of the annular space **15**. This feature of the apparatus eliminates the need for separate spacing means.

I claim:

1. A thermal diffusion apparatus comprising a first tubular member secured within a second tubular member so as to form a narrow uniform annular space between the said tubular members, means for sealing said annular space at a plurality of points along the length of said tubular members so as to form a plurality of discrete separation chambers, means for impressing a temperature gradient upon said separation chambers, means for feeding liquids to and withdrawing products from said separation chambers.

2. The apparatus of claim 1 in which said sealing means are resilient O-ring gaskets.

3. The apparatus of claim 2 in which the resilient

O-ring gaskets are sealed within grooves in said first tubular member.

4. A thermal diffusion apparatus comprising a first tubular member secured within a second tubular member so as to form a narrow uniform annular space between said tubular members, said second tubular member having openings at intervals therein and a jacket surrounding the entire member and a plurality of conduits communicating with said openings and the outside of said jacket whereby liquids may be introduced and withdrawn from said separation chambers, means for sealing said annular space at a plurality of points along the length of said tubular members comprising a plurality of recesses in the wall of said first tubular member having a resilient O-ring gasket disposed therein whereby a plurality of discrete separation chambers are formed, means for impressing a temperature gradient upon said separation chambers and reservoir means comprising a recess in said first tubular member forming a groove therein disposed immediately adjacent to each of the ends of each separation chamber.

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