March 15, 1932. E. HEIBIG 1,849,622

DIALYZER FRAME

Filed June 13, 1928

FIG: 1

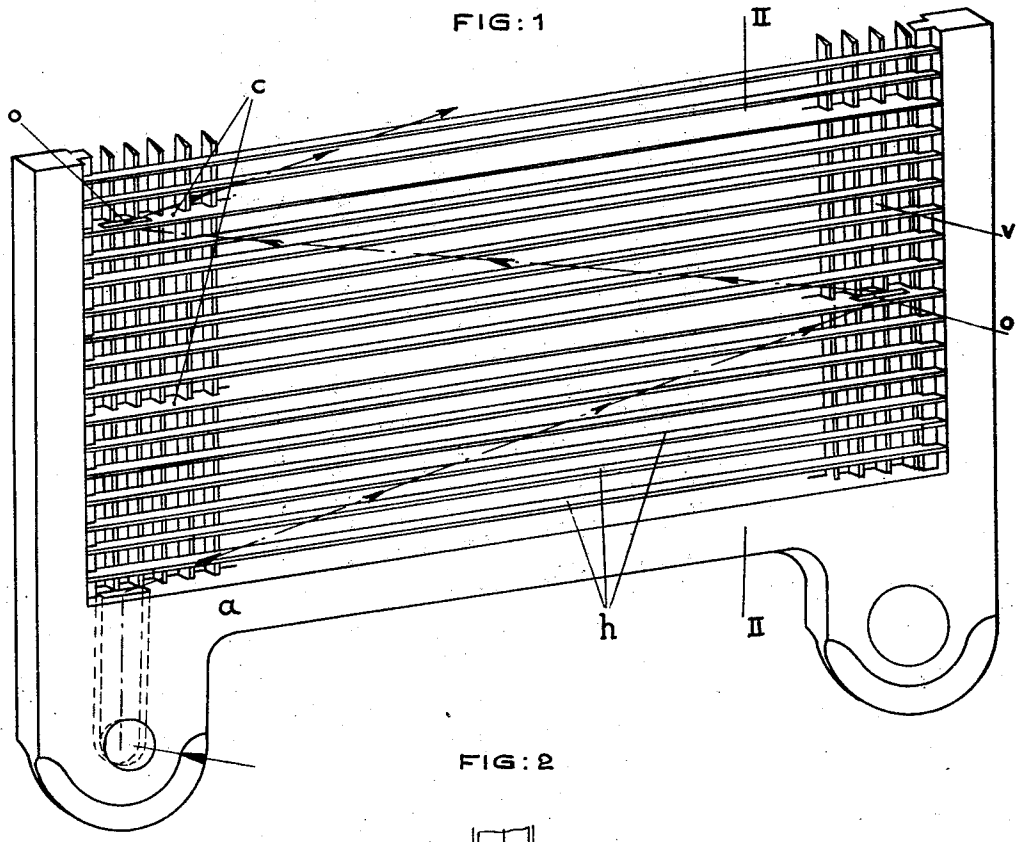
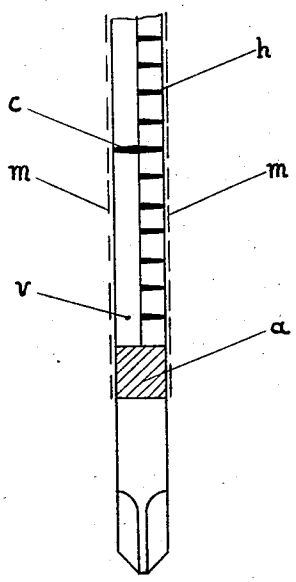



FIG: 2

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# UNITED STATES PATENT OFFICE

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## DIALYZER FRAME

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The present invention relates to an improvement in the devices employed in dialysis. In general, these consist of two series of chambers separated by interposed diaphragms through which the liquids of which the constituents are to be exchanged pass in counter-current. The invention relates more particularly to the construction of these compartments. According to the type of dialyzer employed, the improvements according to the invention may be applied to all, or only to some of the chambers, for example to only one of the two series.

Thus, a plurality of cells or frames, provided with a diaphragm on both sides, may form one series, whilst the other series consists of troughs formed by subdividing a long trough by cross partitions.

In other devices a number of rectangular or circular frames forming chambers for the liquids are separated by diaphragms prepared from special materials, for example parchment, etc., and supported by lattice work or perforated sheet metal. These chambers are then secured together, usually as in the chambers of a filter press, the odd-numbered chambers and the even-numbered chambers being, respectively, connected in series and the liquid to be dialyzed, flowing through the one series of chambers, being admitted at one end of the device, and the lixiviating liquid, which traverses the other series of chambers, being admitted at the other end of the device. The frames may be provided with apertures in the corners so that the liquid in each frame flows from one corner to the corner diagonally opposite. The chambers therefore form an alternating series of hollow spaces which, when in use, are filled, with the one or the other of the two liquids. The capacity of the chambers is determined by the area of the surfaces covered by the diaphragms and by the thickness of the frames.

The study of osmosis (dialysis) reveals that the capacity of these chambers has a great influence on the efficiency of the device; and this also applies to the manner and method of the flow of liquid through the chambers. The osmotic action is, in fact, restricted to the immediate vicinity of the diaphragms, the portions of the liquid at a little distance from the diaphragms taking no part in it. Since there is only a slow diffusion of the layers of liquid towards and away from the centre of the chambers, the mean change in the concentration of the liquid which has traversed a chamber is far less than that in the layers in contact with the diaphragm.

In the chambers hitherto employed, the rate of flow in the central portion is somewhat greater than in the vicinity of the diaphragms, because the liquid in this latter position encounters a certain resistance at the surface of the lattices, woven material or perforated sheet metal usually employed to support the diaphragms, and this resistance is absent in the centre of the chamber. Consequently, the amount of liquid which flows through the chamber without undergoing dialysis is still further increased.

Moreover, it is a well-known fact that the rate at which dialysis proceeds increases with the osmotic pressure, that is to say with the difference in the concentration of the liquids on the two sides of the diaphragm.

Considering a single chamber, for example one in which there is an increasing concentration, it will be evident that the concentration in the vicinity of the diaphragms will be greater than in the portion of the liquid in the chamber which is further from the diaphragms, since a uniform distribution of the dissolved substance throughout the entire contents of the chambers only slowly takes place.

The converse conditions will, of course, exist in the chambers which give up the dissolved substance, and in which, therefore, the concentration decreases.

It follows that the osmotic pressure in the vicinity of the diaphragms, that is, where the dialysis occurs, is less than the pressure between the two mean values of the concentrations in the chambers on either side of a diaphragm.

Both causes, therefore, act together to lessen the osmotic action. This action could be improved by making the frames very thin, since a larger proportion of the circulating liquid would then pass in the immediate vi-

cinity of the diaphragms. For constructional reasons, however, limits are imposed in practice on the thickness of the frames.

With regard to the influence of the rate of flow through the chambers, it may happen, if the liquid flowing slowly through a chamber changes in concentration and density, especially when the concentration decreases in the case of a downward current and increases in the case of an upward current, that the incoming liquid passes directly to the outlet without being uniformly distributed over the whole frame, with the result that dead, or at least less active, corners are formed within the chamber.

The problem on which the invention is based consists in removing the aforesaid drawbacks and in facilitating the circulation and diffusion, so as more especially to promote the osmosis action.

According to the invention, the chamber formed by each frame is provided with two relatively crossing systems, each comprising a number of parallel plates or blades occupying one half of the chamber. The blades are preferably in contact in the middle of the chamber and are thinner towards the outside. The diaphragms are supported by the outer edges of the blades and, if the blades taper to a thin edge, only a very small portion of the effective area of the diaphragms will be wasted, certainly not more than with the usual lattices, woven fabrics or perforated plates.

Preferably, one set of plates or blades is disposed horizontally and the other vertically.

This arrangement of the blades has the following advantages:

In the first place, the capacity of the chamber is reduced by the space occupied by the blades, and secondly the blades serve to support the diaphragms. The greatest advantage, however, is to be found in the circumstance that the blades compel the circulating liquid to change its direction every time and to flow from the outside of the chamber to the middle and then back towards the outside, so that the diffusion of the liquid inside the chamber is energetically facilitated.

In order to assist the circulation, some of the blades may extend over the whole thickness of the chamber. These plates have only a single opening at one of their ends, the openings lying in a zigzag line relatively to each other and to the openings for admitting and discharging the liquid flowing through the chamber. Each chamber is consequently divided into compartments and the diffusion of the layers of liquid is still further facilitated by the longer path traversed by the liquid.

It is also advisable to dispose the various frames in such a way that each diaphragm is supported by vertical blades on the one side and horizontal blades on the other. Another important advantage is that the frames and blades may be cast as an integral unit. Consequently, the frames can be supplied in the rough, the skin being left untouched, so that, in many cases, the material offers increased resistance to the liquids, for example caustic soda solution, with which it comes in contact.

The invention can also be applied to dialyzing apparatus of other than the filter-press type, provided they possess compartments in which the crossing blades can be disposed, and diaphragms are in contact with the edges of the blades.

An embodiment of the invention is illustrated by way of example in the accompanying drawings.

Fig. 1 is a perspective view of part of a frame.

Fig. 2 is a vertical cross-section on the line II—II of Fig. 1.

In the frame $a$ are disposed horizontal blades $h$ and vertical blades $v$, each of which has a width approximating half the thickness of the chamber, the two sets of plates being in contact along their rear edges.

A few of the horizontal blades $c$ extend across the entire width of the chamber, and thereby divide it into different compartments. These blades are provided with openings $o$.

As shown in Fig. 2, the blades are of tapered or wedge section, and the diaphragms $m$ rest against their outer edges.

The general course of the liquid through the frame is indicated by a dot-and-dash line and arrows. In reality, however, the liquid does not travel along this line, but is diverted, by the horizontal and vertical blades, so as to move in a series of steps, alternately vertical and horizontal, and always from the interior outwards or vice-versa.

If the horizontal blades are situated on the front side of the frame and the vertical plates on the rear side, the liquid can only move horizontally on the front side of the frame and vertically on the rear side. Consequently, the liquid is also compelled to travel in a direction at right angles to the diaphragm, so that the largest possible number of particles of liquid are brought into contact with the diaphragms. On the other hand, the particles which have taken part in the dialysis are moved away from the diaphragms and consequently the osmotic pressure on the two sides of a diaphragm is approximately equal to the mean pressure between the contents of the two chambers separated by the diaphragm.

It has been proved that this arrangement of the plates increase the yield by 10–15 per cent., for the same diaphragm area. This result was obtained in the dialysis of caustic soda lye contaminated with hemi-cellulose obtained as a waste product in the production of artificial silk.

What I claim is:—

1. A dialyzer frame, comprising a skeleton frame proper defining an internal chamber adapted to be closed at opposite sides by flexible diaphragms, and two intersecting sets of thin flat blades disposed within the confines of such chamber with their inner edges in abutting contact at the medial vertical plane of the chamber; one set of blades being arranged horizontally and the other set vertically, some of the blades of the horizontal set extending across the full width of the chamber, while the blades of the vertical set and the remaining blades of the horizontal set have a width equal approximately to only half the width of said chamber.

2. A dialyzer frame, comprising a skeleton frame proper defining an internal chamber adapted to be closed at opposite sides by flexible diaphragms and having inlet and outlet openings for the liquid flowing through such chamber, and two intersecting sets of thin flat blades disposed within the confines of said chamber; certain blades of one set extending across the full width of the chamber while the remaining blades of that set and the blades of the other set have a width approximately equal to half the width of the chamber; said full-width blades having each a single opening, said openings being disposed in a zig-zag line relatively to one another and to said inlet and outlet openings.

In testimony whereof I affix my signature.

EDOUARD HEIBIG.