

April 6, 1937.

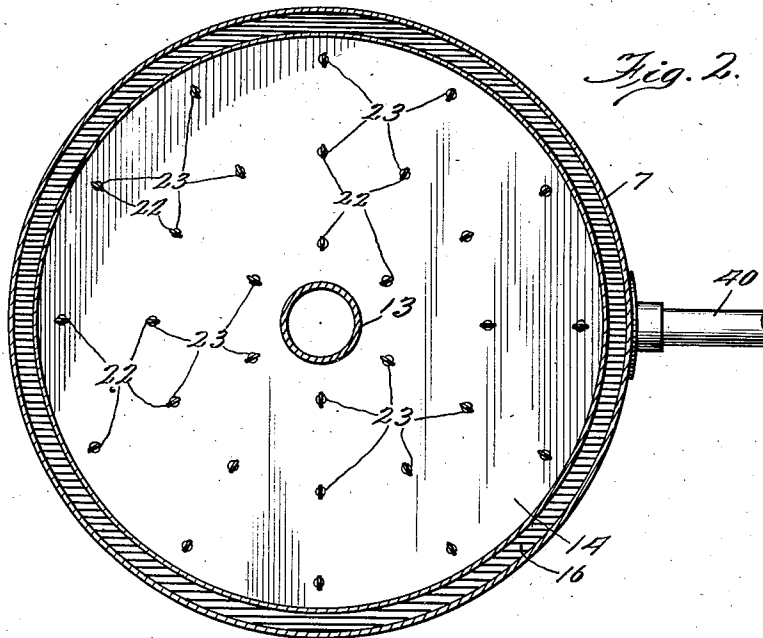
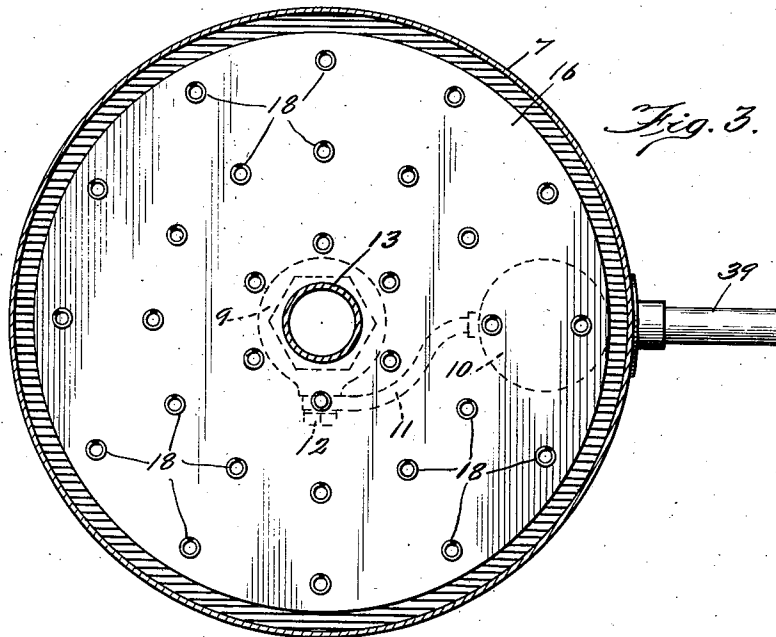
J. FARWELL

2,076,498

FILM FORMING MEANS IN VACUUM SYSTEM FOR REMOVING IMPURITIES FROM OILS

Filed Sept. 10, 1928

4 Sheets-Sheet 2



Inventor:
Joseph Farwell
By Messrs. Crane
Attorneys

April 6, 1937.

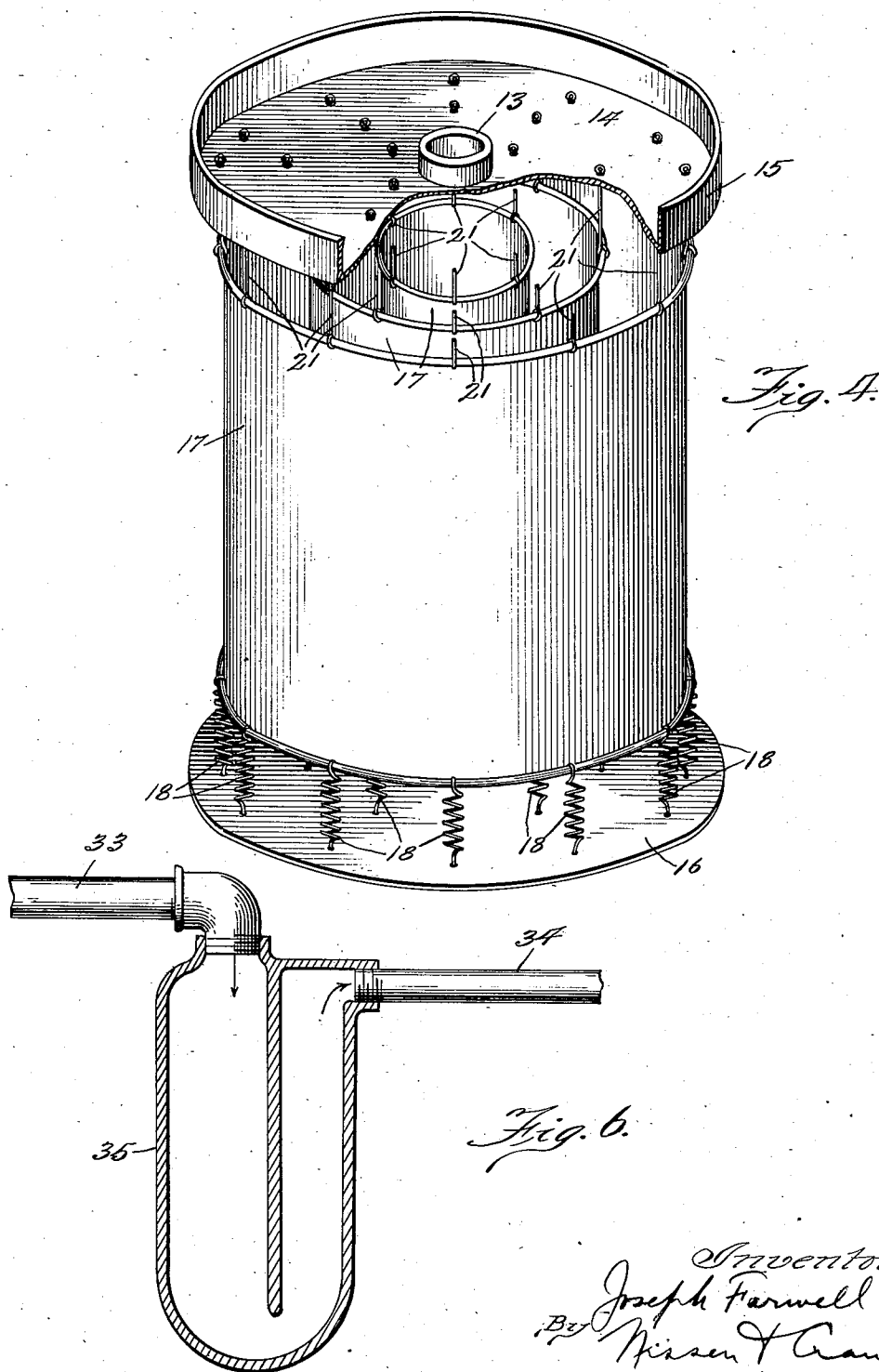
J. FARWELL

2,076,498

FILM FORMING MEANS IN VACUUM SYSTEM FOR REMOVING IMPURITIES FROM OILS

Filed Sept. 10, 1928

4 Sheets-Sheet 3



Inventor:
Joseph Farwell
By: Kissen & Crane
Attys.

April 6, 1937.

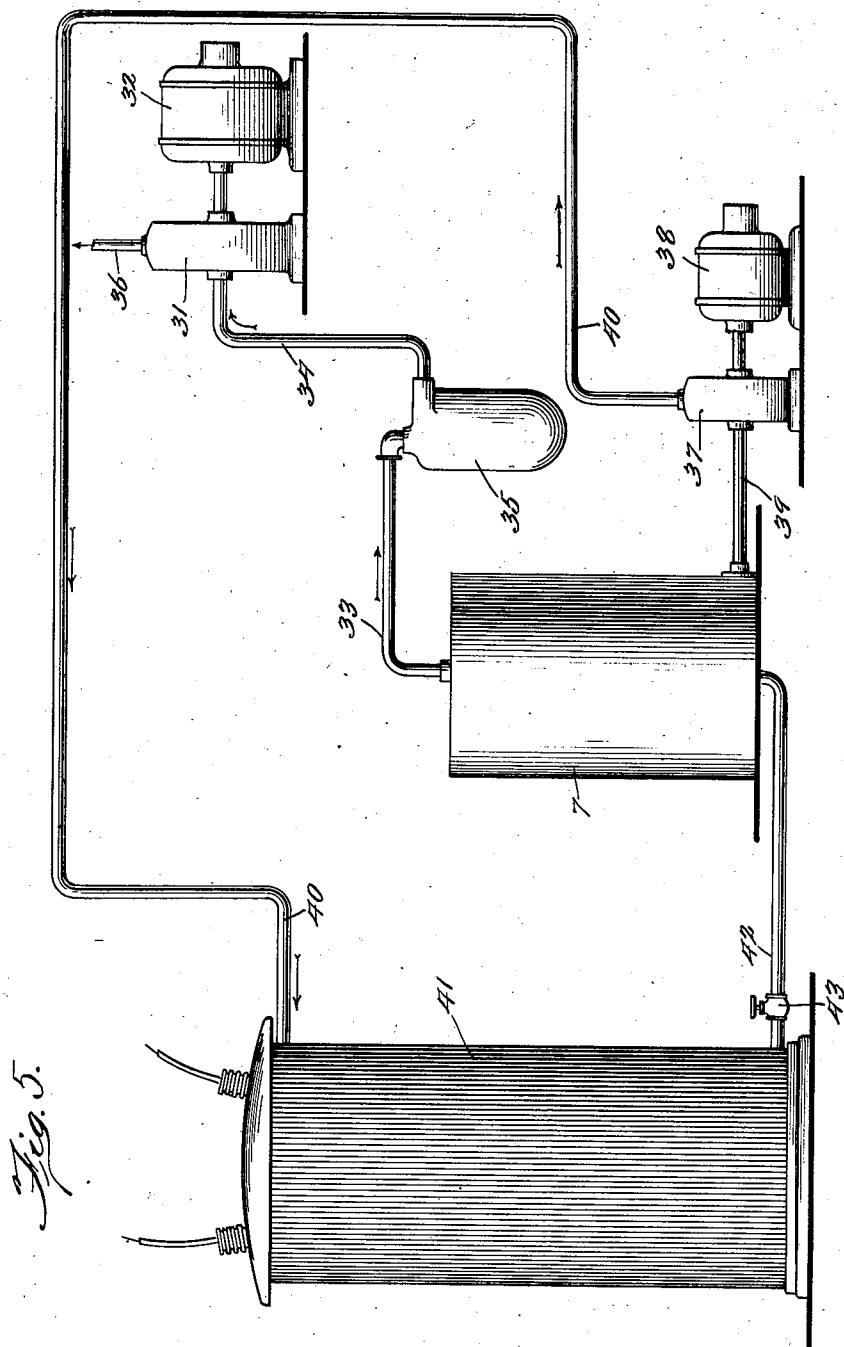
J. FARWELL

2,076,498

FILM FORMING MEANS IN VACUUM SYSTEM FOR REMOVING IMPURITIES FROM OILS

Filed Sept. 10, 1928

4 Sheets-Sheet 4



Inventor:
Joseph Farwell
By Messrs. T. A. Lane
Attys.

UNITED STATES PATENT OFFICE

2,076,498

FILM-FORMING MEANS IN VACUUM SYSTEM FOR REMOVING IMPURITIES FROM OILS

Joseph Farwell, Fort Wayne, Ind., assignor to
S. F. Bowser & Company, Inc., Fort Wayne,
Ind., a corporation of Indiana

Application September 10, 1928, Serial No. 304,981

11 Claims. (Cl. 196—16)

My invention relates to apparatus for removing impurities from oils and one of its objects is the provision of improved and efficient apparatus for removing moisture from electrical insulating oils, such as oils used in electrical transformers, in order to restore the dielectric strength of such insulating oil, although the invention may have a general application in removing from a mixture of oils the undesirable volatile ingredient.

Another object of the invention is the provision of concentric cylindrical surfaces for spreading thin films of the liquid in a vacuum chamber to effect the dehydration of the films of liquid.

Another object of the invention is the provision of concentric spaced-apart fabric cylinders with means for saturating such fabric cylinders with the liquid to be dehydrated.

A further object of the invention is the provision of concentric spaced-apart cylinders of cloth compactly arranged to secure film surfaces of large area in a vacuum chamber to increase the efficiency of dehydration of the films of liquid on the inner and outer surfaces of such cloth cylinders.

Another object of the invention is the provision of a multiplicity of thin liquid collectors for the purpose of having spread on the surfaces thereof thin films of liquid in a vacuum chamber to dehydrate the liquid while spread over a large area of such film surfaces.

Another object of the invention is the method of dehydrating transformer insulating oil by spreading the same over thin porous surfaces and applying a vacuum to the thin films of oils thus spread over such surfaces.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings—

Fig. 1 is a sectional elevation of my improved film-forming means comprising a plurality of concentric tubes or cylinders of thin porous material mounted in a vacuum chamber;

Fig. 2 is a sectional plan view taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional plan view taken on the line 3—3 of Fig. 1;

Fig. 4 is a perspective view, with a portion broken away, to show the structure of the film-forming means mounted in the vacuum chamber shown in Fig. 1;

Fig. 5 is a diagrammatic view of a circulating system embodying my invention and adapted to dehydrate transformer insulating oil; and

Fig. 6 is a cross-sectional elevation of the water-

absorbing chamber adapted to contain calcium chloride.

Referring to Fig. 1, I have shown a tank or oil reservoir 7 mounted on a supply pipe 8. At the lower portion of the tank 7 and connected to the upper end of the pipe 8 is a float-controlled valve 9. The float 10 is connected by a rod 11 to the stem 12 of the valve 9. On top of the valve 9 is rigidly mounted a standpipe 13 open at its upper end at a position near the upper end of the tank 7.

Secured to the pipe 13 at a short distance below its upper end is a horizontal flat circular plate 14 to the periphery of which is welded or otherwise secured a cylindrical band 15 to form a shallow cup having a depth somewhat greater than the height to which the pipe 13 projects upwardly into the pan 14, 15. If desired, the cylindrical wall 15 of the pan may be integral with the bottom 14.

Secured to the lower portion of the pipe 13 above the valve 9 is a flat circular plate or disc 16. Between the plates 14 and 16 are mounted a plurality of spaced-apart concentric cylinders of fabric 17, such as cloth or canvas, although various other materials may be used, according to the nature of the liquid to be purified. For instance, cylinders of thin sheets of glass, celluloid or metal may be used for some mixtures of oils and, if desired, such sheets may be flat and mounted in spaced-apart relation closely adjacent each other.

The concentric cylinders are in reality stretched between the plates 14 and 16, because although suspended from the plate 14, springs 18 are connected to the bottoms thereof. At the upper end of each cloth cylinder 17 is a wire ring 19 and at the lower end of each cloth cylinder is a wire hoop or ring 20. The open ends of the cylinders of cloth are secured to the wire hoops 19 and 20 to form cloth covered end rims to more effectively support the cloth cylinders and stretch them taut without wrinkling thereof.

The upper wire hoops 19 are suspended from the plate 14 by the vertical rods 21 and to the lower wire hoops 20 are connected the springs 18. The suspensions 21 pass through perforations 23 in the bottom of the plate 14 and are provided at their upper ends with eyes 22 to serve as abutments for the rods 21 to keep them from dropping through such perforations. That is to say, the eyes 22 at the upper ends of the suspending rods 21 are sufficiently large to prevent the suspending rods from dropping through the perforations 23, but the latter should be of sufficient size to permit the liquid in the pan 14, 15 to flow freely through

the perforations 23 along the rods 21 to the upper rims 24 of the cloth cylinders 17 so that the liquid may be directed to the upper edges of the cloth cylinders and spread out on the latter in thin films over a total large surface in a comparatively very small space.

By referring to Fig. 2 it will be seen that the perforations 23 and the eyes 22 at such perforations are spaced apart circularly and radially so that the oil received on the bottom 14 of the pan will be distributed over the upper rims 24 at a multiplicity of points. I have shown only three concentric cylinders of cloth for the sake of clearness in illustration, but it should be understood that the spaces between the cylinders shown may be occupied by many additional spaced-apart cylinders of cloth so that in the aggregate a very large total surface for the oil to spread out on, will be provided. The concentric nesting of the cloth tubes or cylinders enables a large number of them to be used in a very small space and they may all be held out of contact with each other. Each tube or cylinder 17 is preferably composed of fabric or some other porous material so as to obtain a double film-forming surface on both sides of each cylinder of thin material.

The springs 18 are connected at their upper ends to the wire hoops 20 so as to hold the lower rims 25 of the cylinders down in their lowermost positions. The lower ends of the springs pass through perforations in the plate 16 and are provided with eyes 26 to bear against the bottom of the plate 16 and hold the springs 18 stretched out to a limited extent, thereby holding the cloth cylinders stretched out without permitting any wrinkling thereof. Such stretching of the cloth cylinders enables them to be placed closer together without coming in contact with each other and therefore a larger number of such spaced-apart cylinders may be placed in a given space. In the same manner, plane sheets of fabric may be stretched between upper and lower straight rods and mounted closely adjacent each other, but in spaced-apart relation.

The oil to be treated passes upwardly into the pipe 8, as indicated by the arrow 27, and when the valve 9 is open the oil will pass upwardly into the pan 14, 15, as indicated by the arrows 28. The oil will spread over the bottom 14 of the pan and enter the perforations 23, as indicated by the arrows 29, 29. The oil runs down the suspension rods and the upper rims 24 and then spreads out on the cloth cylinders 17 flowing in a downward direction and form thin films on both sides of each cylinder of cloth, the object being to expose to the vacuum in the tank 7 thin films of oil over as large an area as possible so as to enable the water in the oil to escape upon being vaporized or evaporated by reason of the high vacuum produced in the tank 7.

The amount of solid impurities in transformer insulating oil, such as carbon, dust, etc., is very small, but such solid impurities as may occur in such oil will adhere to the cloth cylinders and thus be removed from the oil, the dehydrated and cleaned oil passing to the lower rims 25 of the cloth cylinders and thence to the upper surface of the plate 16 and over the peripheral edge thereof, as indicated by the arrows 30, to the bottom of the tank 7. The tank 7 may have a detachable cover normally hermetically sealed thereon. When such cover is removed the pipe 13, together with the film-forming cylinders, may be removed for the purpose of cleaning solid im-

purities which may have become deposited thereon after long continued use.

In Fig. 5 I have shown a vacuum pump 31 operated by an electric motor 32. The vacuum pump 31 may be connected to the top of the tank 7 by means of the pipes 33 and 34, between which is located the calcium chloride holder 35, as shown in elevation in Fig. 5 and in section in Fig. 6. As indicated by the arrows in Figs. 1, 5 and 6, the water vapor extracted from the films of oil in the tank 7 is directed through the calcium chloride bed in the container 35 and then sent out to the atmosphere by means of the pipe 36.

A pump 37 operated by an electric motor 38 is adapted to pump the oil from the bottom of the tank 7 through the pipe 39 into the pipe 40 and thence to the upper portion of the transformer 41, as indicated by the arrows in Fig. 5.

The tank 7 may be so located with respect to the transformer 41 that the oil will flow from the bottom of the transformer into the pipe 42 by gravity when the valve 43 is open and thence upwardly along the pipe 13 into the pan 14, 15, as shown in Fig. 1. In other words, the casing of the transformer 41 containing the transformer oil having a greater head than the height of the tank 7 will be sufficient to cause the oil to flow by gravity from the transformer into the pan 14, 15. When, however, the pump 37 does not withdraw the purified oil from the tank 7 as fast as it is being supplied through the tube 13 to the film-forming means the increasing depth of the oil in the tank 7 will cause the float 10 to rise and gradually close the valve 9. It will thus be seen that the system is entirely automatic and self-protective even when the valve 43 is left open indefinitely. If the pump 37 is shut down or does not operate at sufficient speed, the float-controlled valve in the tank 7 will prevent too much oil from flowing from the transformer 41 into the tank 7. Only after the predetermined maximum of the oil in the tank 7 is decreased sufficiently by the pumping of the oil through the pipes 39 and 40 to the upper portion of the transformer 41 will the oil again flow by gravity through the pipe 41 up along the tube 13 into the pan 14, 15. It will thus be evident that the oil in the transformer may be treated continuously and automatically without shutting down the transformer or interfering with its operation, because at all times sufficient filling of the transformer 41 with insulating oil is assured and after some oil has been taken from the transformer it is immediately dehydrated and the solid impurities removed therefrom by adhesion to the cloth cylinders and then the purified oil is at once pumped into the upper portion of the transformer 41 to take the place of that which has been withdrawn from the lower portion thereof.

While the shape of the suspended cloth sheets may be varied as desired, for instance, to flat sheets spaced apart and stretched out by resilient holding means, I prefer cylindrical sheets of cloth for the film-forming means, because the cylindrical shape is the best for the containing tank 7 to withstand mechanical strains when operating under high vacuum conditions produced by the vacuum pump 31 through the calcium chloride bed in the container 35.

When the vacuum pump is operated to apply a vacuum to the interior of the tank 7 and the valve 43 is opened, the suction at the upper end of the pipe 13 may be sufficient to withdraw the oil from the bottom of the trans-

former 41 even though the tank 7 is at a higher elevation than the transformer 41, so that irrespective of the relative elevation of the tank 7 an excessive amount of oil cannot flow into the tank 7, because the float-operated valve 9 will be shut off or closed when the depth of the oil in the tank 7 exceeds a predetermined amount.

When the vacuum is applied in the tank 7 and oil flows into the pan 14, 15 the vacuum on the oil first causes the cloth itself to become impregnated with the oil which flows very slowly and forms a sort of core or liquid mat. This flow is very slow because of the friction of the oil against the substance of the porous cloth or material of which the cylinders are constructed. The continued flow of the oil is effected over the surface of the core or liquid mat contained in the porous structure and being on the outer and inner surfaces of the entire liquid mass, thin films of untreated liquid are continually exposed to the vacuum, a condition which increases the speed and effectiveness of the process. The action of the vacuum takes place on both sides of each cylinder of cloth simultaneously, thereby doubling the capacity of film-forming means where there is only opportunity to act on one side. In other words, the porous structure of the film-forming means by becoming saturated with a layer of oil at its center flows more slowly than the remainder of the flowing sheets of oil due to the resistance of its flow by the meshes and fibrous structure of the cloth, but after the porous structure once becomes impregnated with the slow moving oil sheet the successive flow of the oil will be rapid over the outer and inner surfaces of the oil impregnated sheets. A comparatively large volume of oil will therefore flow from the shallow cup 14, 15 to the upper rims 24 of the cloth cylinders and thence to the two surface layers or very thin films which are in immediate contact with the high vacuum conditions in the tank. The removal of the water from such very thin films then becomes unusually rapid. For the same reasons, when the solid impurities are removed from the oil by adhesion with the fibrous structure the formation of the films will not be interfered with, because the fibrous body of the cylinders, together with the oil impregnating the same and the solid impurities clinging to the fibrous structure, form sheets having on opposite sides thereof the comparatively rapid flowing films of oil for action thereon of the vacuum to dehydrate such films.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended and I wish therefore not to be restricted to the precise construction herein disclosed.

Having thus fully disclosed an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In film-forming apparatus, the combination with an enclosure, of a plurality of cylindrical sheets of flexible material, a pan above said sheets provided with a plurality of openings in the bottom thereof, mechanism for introducing oil into said pan for flow therefrom through the openings in the bottom thereof, a plurality of wires extending through the openings in the bottom of said pan to the tops of said cylindrical sheets to suspend the latter from the bottom of said pan, a horizontal plate below the bottom of said sheets, and means connecting the bottoms of said

sheets to said lower plate to hold the sheets taut while oil flows from said pan through the holes in the bottom thereof along said suspension wires to said sheets.

2. In film-forming means, the combination with a hoop, of a sheet in tubular form corresponding to said hoop and suspended therefrom, means for supporting said hoop to permit said sheet to hang therefrom, and means for directing liquid by gravity to flow and spread over the surfaces of said sheet to expose the liquid in thin films over a wide area.

3. In film-forming means, the combination with a pair of hoops, of a sheet of flexible absorbent material between said hoops and corresponding in shape thereto, and means for directing liquid over said sheet to spread the same by gravity in thin films thereon over a wide area.

4. In apparatus for dehydrating oils, the combination with spaced-apart concentric cylinders of sheet material each with circular wire hoops at the top and bottom, of a perforated pan for receiving the oil, wire suspensions for the upper hoops from said perforations to direct the oil from the pan through said perforations and along said suspensions to the upper edges of said hoops to spread out in thin films over the surfaces of said cylinders, a plurality of springs connected to the bottom hoops to hold the cloth cylinders stretched down and taut, means for directing oil into said pan, an enclosure for the aforesaid parts, and means for producing a vacuum in said enclosure to act on the oil spread over said cylinders to extract and remove the moisture from said oil.

5. In apparatus for removing impurities from oils, the combination with a plurality of spaced-apart concentric cylinders of sheet material, of an oil receiving pan above said cylinders, a plurality of suspensions for suspending from holes in the bottom of said pan the cylinders in vertical positions to cause the oil to flow from the holes over said suspensions to the upper edges of said cylinders and thence over the surfaces thereof, and means comprising a plurality of springs connected to the bottom of said cylinders to hold the same taut.

6. In film-forming means, the combination with a pipe open at its upper end, of a plate mounted on the upper end of said pipe in position to receive liquid from said upper end, a sheet for receiving liquid, and means comprising a plurality of vertical suspensions extending through perforations in said plate to support said sheet at its upper end spaced below the bottom of said plate.

7. In a film-forming apparatus, the combination of an enclosure, a liquid container at the top thereof and provided with concentric rows of spaced-apart holes in its bottom, rod-like elements mounted in each hole and depending into said enclosure, there being sufficient space between each element and the adjacent walls of the surrounding opening to permit the passage of liquid from the container through the hole and thence down the rod-like element, and a plurality of circular sheets concentrically arranged in spaced-apart relation, within said enclosure, said sheets being connected to said rod-like elements whereby the liquid in descending is distributed in film-like form thereover.

8. In a film-forming apparatus, the combination of an enclosure, a liquid container at the top thereof and provided with concentric rows of spaced-apart holes in its bottom, rod-like ele-

ments mounted in each hole and depending into said enclosure, there being sufficient space between each element and the adjacent walls of the surrounding opening to permit the passage of liquid from the container through the hole and thence down the rod-like element, and a plurality of circular sheets concentrically arranged in spaced-apart relation within said enclosure, said sheets being connected to said rod-like elements whereby the liquid in descending is distributed in film-like form thereover, and means for creating a vacuum in said enclosure.

9. In an apparatus for rendering electrical insulating oils anhydrous, the combination of means forming a vacuum chamber constructed to exclude outside air and moisture therefrom, means for maintaining the chamber under a vacuum, and film forming means disposed wholly within said chamber comprising a container mounted at the upper portion of said chamber, means for feeding oil to be treated into said container, the bottom of said container having a plurality of relatively minute oil exit openings, a suspension member, a plurality of tenuous members suspended thereby beneath said container and each arranged to receive the flow of

oil from one of said exits, a plurality of sheets of relatively thin material suspended by said tenuous members and arranged to receive the flow of oil from said members so that said oil will flow over the opposed faces of said sheets in relatively fine, thin liquid films while being subjected to the action of the constantly maintained vacuum.

10. The process of rendering anhydrous electrical insulating oils containing relatively small amounts of moisture comprising continuously flowing thin films of the oil simultaneously over opposed faces of relatively thin, porous material having a large superficial area, and while under the influence of a maintained vacuum and to the exclusion of outside air and moisture.

11. The herein described process of rendering anhydrous such electrical insulating oils as contain relatively small amounts of moisture which comprises flowing thin liquid films of the oil by gravity across the opposed faces of a relatively thin sheet of relatively porous fabric, while subjecting the films of liquid oil to the action of a maintained vacuum and to the exclusion of external air and moisture.

JOSEPH FARWELL.