July 18, 1944. L. A. RICHARDS 2,353,760

PRESSURE-MEMBRANE EXTRACTION APPARATUS

Filed July 16, 1941

Fig. 1.

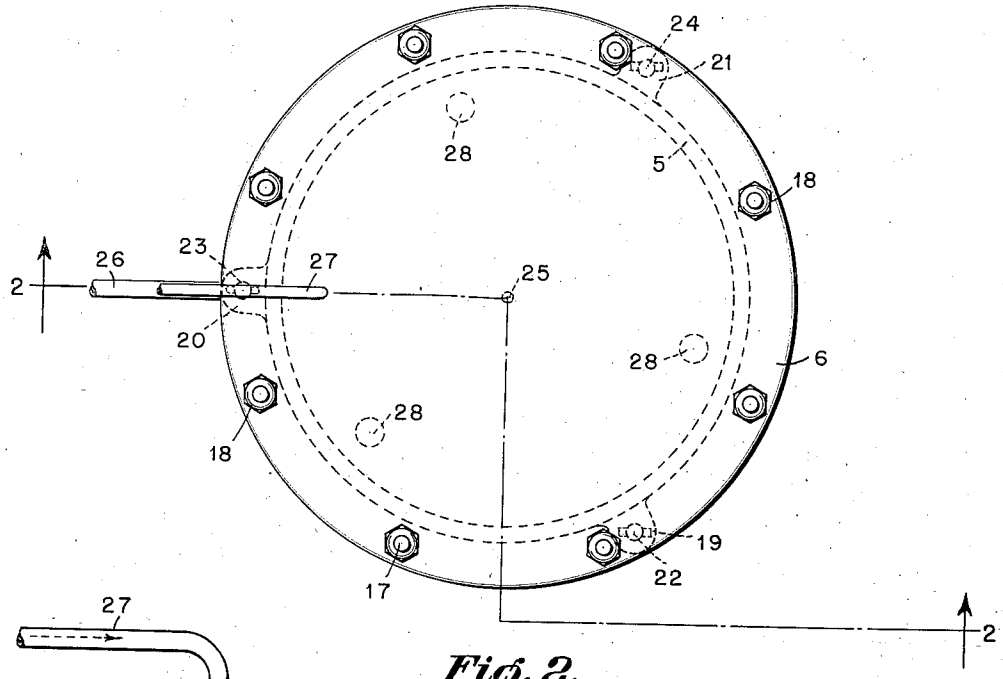
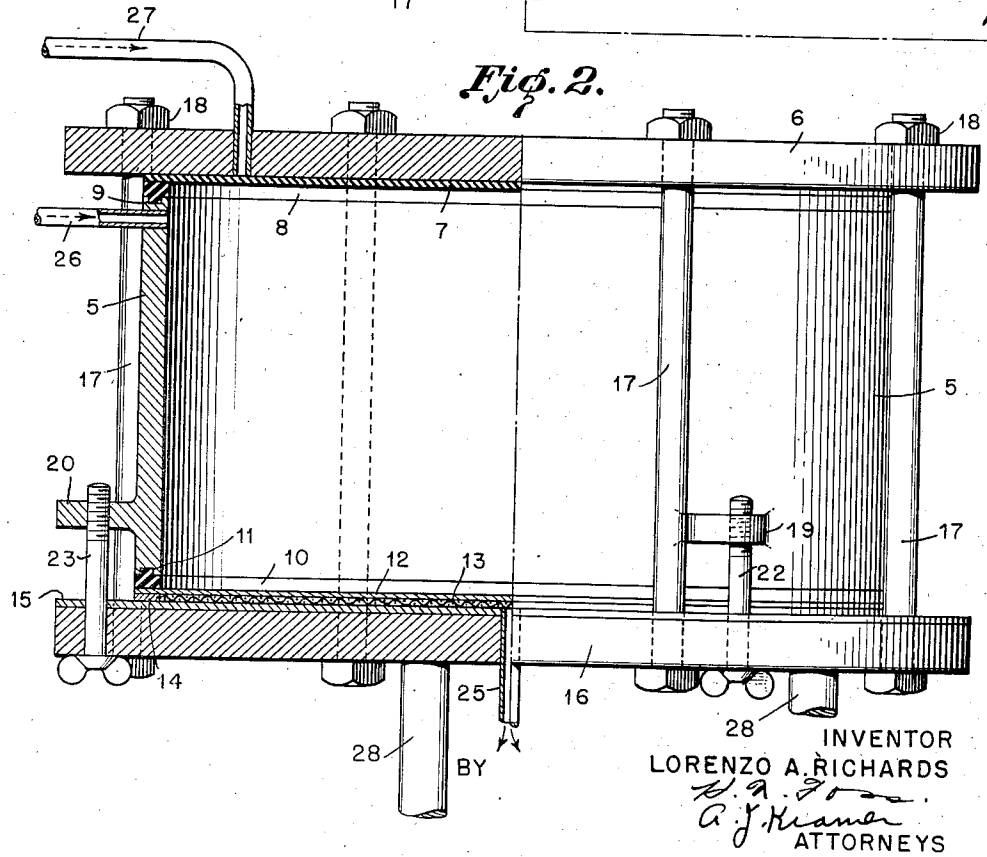


Fig. 2.



INVENTOR
LORENZO A. RICHARDS
BY
A. J. Kramer
ATTORNEYS

Patented July 18, 1944

2,353,760

UNITED STATES PATENT OFFICE

2,353,760

PRESSURE-MEMBRANE EXTRACTION APPARATUS

Lorenzo A. Richards, Riverside, Calif.; dedicated to the free use of the People in the territory of the United States

Application July 16, 1941, Serial No. 402,715
6 Claims. (Cl. 210—185)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This application is made under the act of March 3, 1883, as amended by the act of April 30, 1928, and the invention herein described and claimed, if patented, may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to me of any royalty thereon.

I hereby dedicate the invention herein described to the free use of the people in the territory of the United States to take effect on the granting of a patent to me.

This invention relates to liquid extraction and one of the objects is the provision of an apparatus for use in extracting liquids from materials which are porous, permeable or granular, such as soil.

In general, this invention comprises a pressure chamber having a membrane wall which, when wetted with a mixture of a liquid to be extracted and a gas used to maintain pressure in the pressure chamber, is permeable to the liquid, but impermeable to the gas.

In the accompanying drawing there is illustrated an embodiment of this invention in one of its preferred forms, in which drawing:

Figure 1 is a plan view of the embodiment; and

Figure 2 is a section along the line 2—2 of Figure 1.

Referring with more particularity to the drawing, in which like numerals designate like parts, the embodiment illustrated comprises a chamber composed of a cylinder 5 on top of which is removably disposed a cover plate 6. Beneath said cover plate there is disposed a flexible diaphragm 7 of soft rubber or other suitable material. An annular gasket 8 of rubber, or other suitable material, is disposed between the diaphragm 7 and the top rim of the cylinder 5. In order to provide a more effective seal, the top rim of the cylinder 5 is provided with a groove 9.

Against the bottom rim of the cylinder 5 there is disposed another gasket 10, like the gasket 8, the rim of the cylinder at this point having also a groove 11 to provide a better seal between the gasket and the cylinder. Against the bottom of the gasket 10, a membrane 12 of Cellophane, or other suitable material, is placed and against the bottom of the membrane 12 is a screen 13, preferably brass and of 120 mesh. The screen 13 is attached to the brass plate 15 by the annular rim of metal 14 which may be solder or tin or other suitable material. This rim is directly below the gasket 10. The screen 13 is supported by the plate 15 which may be of any suitable material, such as brass. The plate 15 rests on a bottom cover plate 16 which is connected by bolts 17 carrying nuts 18 to the top cover plate 6, whereby the entire assembly is held together.

Lugs 19, 20 and 21 project from the cylinder 5 and engage the threads of bolts 22, 23 and 24 disposed through the bottom cover plate 16. By these means, the assembly against the bottom rim of the cylinder 5 can be held in place while the top cover plate and diaphragm 7 are removed to charge the chamber with the material from which the liquid is to be extracted.

An outlet tube 25 is disposed through the bottom cover plate 16 and through the plate 15, the upper end of said tube being flush with the top of the plate 15.

Through the wall of the cylinder 5, near the upper rim thereof, a tube 26 is tapped and is adapted to be connected to a source of gas under pressure. Through the top cover plate 6 another tube 27 is tapped which is also adapted to be connected to a source of gas under pressure.

Suitable leg supports 28 are provided on the bottom cover plate 16.

To use the device, the nuts 18 are removed from the bolts 17 and the top cover plate 6, together with the diaphragm 7, is removed. The material to be treated is then placed in the chamber and the diaphragm 7 with the top cover plate 6 is replaced, after which the nuts 18 are tightened on the bolts 17.

Pressure inside of the chamber is then increased by introducing gas under pressure through the tube 26. Liquid from the material being treated touches the membrane 12 and passes through the pores thereof into the interstices of the screen 13 where it is drained through the outlet tube 25. As the material in the chamber becomes dehydrated, a continuous gas phase is established throughout the mass of material. When this continuous gas phase is established, the liquid in the pores of the membrane forms a meniscus with the gas and said meniscus prevents the flow of gas through these pores, the while permitting liquid from the material being treated to flow into the liquid phase of the meniscus. The meniscus will be maintained so long as liquid from the material being treated flows in to the water phase of the meniscus and so long as this meniscus is maintained, the flow of gas through the pores of the membrane will be prevented.

By maintaining the pressure in the chamber, there is established in the gas-liquid interface at the upper surface of the membrane an equivalent curvature determined by the pressure differential between the two sides of the membrane. The substantially free movement of water

through the membrane maintains this same curvature in the liquid interface at the contact points between the membrane and the material. Thus there is established a curvature gradient across the layer of material in contact with the membrane. The pressure gradient corresponding to this curvature gradient moves the liquid through the unsaturated material toward the membrane. When equilibrium is reached through loss of liquid, the interface curvature of the liquid throughout the material will be the same as at the membrane and passage of liquid through the membrane will cease.

As the liquid is extracted from the material and passes out of the chamber, the material will have a tendency to shrink out of contact with the membrane. In order to maintain a constant pressure of the material against the membrane, gas under pressure in excess of the pressure in the chamber is introduced through the tube **27** against the diaphragm **7**, which thereby is distended into contact with the material and forces it against the membrane.

Having thus described my invention, I claim:

1. A device of the character described comprising a chamber, a porous membrane forming one wall of said chamber, means for introducing gas under pressure into said chamber, and means for urging material in said chamber against said membrane when gas under pressure is in said chamber.

2. In a device of the character described having a chamber, one wall of which is a porous membrane, a screen against the outer side of said membrane. a plate against said screen, a drain-pipe through said plate to carry off liquid between said plate and membrane, and means for introducing gas under pressure into said chamber.

3. A device of the character described comprising a chamber having a removable cover plate on one side and a porous membrane on the other, a flexible diaphragm between said cover plate and the sides of the chamber, and means for introducing gas under pressure between said diaphragm and said cover plate so as to urge material in said chamber against said membrane.

4. The method of extracting liquid from an unsaturated porous solid material, comprising placing the material in contact with one face of a porous membrane and establishing and maintaining by gas pressure a continuous gas phase throughout said material and liquid-gas interfaces across the pores of the membrane.

5. An apparatus comprising a cylindrical shell, a rigid top cover member and a rigid bottom cover member on said shell, a flexible gas-tight diaphragm on said shell beneath said top cover member, a porous membrane below said shell over said bottom cover member, a foraminous sheet below said porous membrane to hold it offset from the bottom cover member, a drain pipe through said bottom cover member communicating with the interstices of said foraminous member, a tube through said shell communicating with the space between said diaphragm and said membrane, and a tube through the top cover member communicating with the upper surface of the diaphragm.

6. A device of the character described comprising a chamber having a removable cover plate on one side and a porous membrane on the other, a flexible diaphragm between said cover plate and the sides of the chamber, and means for introducing gas under pressure between said diaphragm and said cover plate so as to urge material in said chamber against said membrane, and means for introducing gas in said chamber between said diaphragm and said membrane.

LORENZO A. RICHARDS.