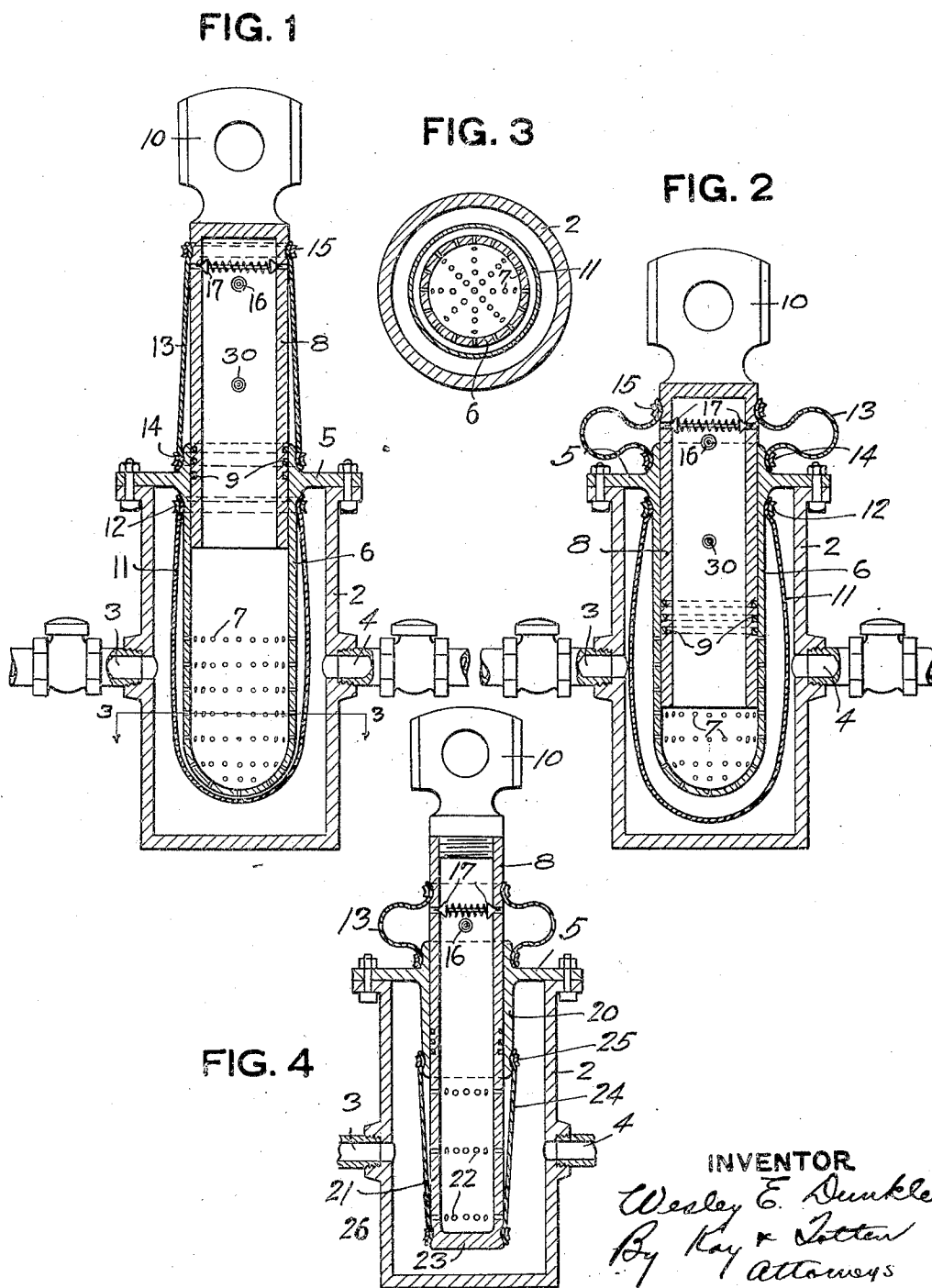


W. E. DUNKLE.
DIAPHRAGM PUMP.
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DIAPHRAGM-PUMP.

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To all whom it may concern:

Be it known that I, WESLEY E. DUNKLE, a citizen of the United States, and resident of Contact, in the county of Elko and State of Nevada, have invented a new and useful Improvement in Diaphragm-Pumps; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to diaphragm pumps, and it has for its object to provide a pump of the character indicated in which communication between the interior of the pump and the outer air is effectively provided, in which an annular diaphragm is alternately distended and collapsed by forcing fluid into and out of the diaphragm and in which these results are produced by a simple and effective arrangement of parts.

In the accompanying drawing, Figure 1 is a vertical sectional view showing a pump constructed in accordance with my invention with the piston at the limit of its outward movement; Fig. 2 is a vertical sectional view similar to Fig. 1 showing the piston at the limit of its inward movement; Fig. 3 is a transverse sectional view of the same structure, the section being taken substantially along the line 3—3, Fig. 1; and Fig. 4 is a vertical sectional view showing a modified form of plunger and diaphragm construction.

Referring first to Figs. 1 and 2 of the drawing, the pump therein shown comprises a cylinder or casing 2 provided with suitable 5 valved inlet and outlet connections 3 and 4. The cover 5 of the cylinder 2 is provided with a central circular opening around which is disposed a tubular member 6 that extends into the casing and is provided with 0 small perforations 7 upon its side walls and upon its closed inner end. A hollow plunger 8 provided with the usual expansive piston rings 9, is adapted to reciprocate within the tubular member 6 and is attached at its outer 5 end to a cross-head 10.

Surrounding the tubular member 6 is an annular diaphragm 11 of rubber or other flexible sheet material, the open end of which is securely attached by means of a 0 band 12 or otherwise to the tubular member 6 near the cover 5. A second annular diaphragm 13 surrounds the plunger 8 outside

of the casing 12, and has its ends attached, respectively, to the casing and to the plunger by means of bands 14 and 15. 55

The plunger 8 and the perforated tubular member 6 are filled with a liquid preferably an oil which is not injurious to the rubber or other material of which the diaphragms 11 and 13 are composed. The amount of 60 liquid is preferably such that when the plunger is withdrawn to the limit of its outward movement, as shown in Fig. 1, the diaphragm 11 will not quite touch the tubular member 6. The reciprocation of the plun- 65 ger 8 causes a small amount of oil to work up outside of the plunger and enter the space between the plunger and the outside diaphragm 13, and in order to permit such oil to reenter the plunger on the suction stroke 70 of the pump, I provide suitable check valves 16 and 17 in the plunger. The holes leading to these check valves are so small that the rubber diaphragm 13 will not be drawn into them. The diaphragm may, if desired, be 75 made with an insertion of cloth or other non-elastic sheet material opposite the valve ports, in order to prevent stretching and rubbing of the diaphragm at this point.

The modified device shown in Fig. 4 is 80 similar in its general construction to the pump shown in Figs. 1, 2 and 3 and the corresponding parts are correspondingly numbered. In the device of Fig. 4, however, the tubular member 6 is omitted and the plun- 85 ger 8 reciprocates within an annular bearing 20 formed on or attached to the cover 5 of the casing 2, and extending either into the casing or above it, as desired. The plunger is provided with an inwardly extending portion 90 21 having lateral perforations 22 and having its inner end closed, as shown at 23. An annular diaphragm 24 surrounds the inner portion 21 of the plunger and has its ends attached respectively to the bearing 20 95 and to the inner end of the plunger by means of bands 25 and 26.

The operation of my diaphragm pump will be evident from an inspection of Figs. 1 and 2. When the plunger is moved into 100 the cylinder, as shown in Fig. 2, oil is forced through the perforations 7 and distends the diaphragm 11, thereby forcing the liquid that is being pumped through the outlet con-

nection 4. When the plunger is withdrawn as shown in Fig. 1, the diaphragm 11 is collapsed and liquid is thereby drawn into the cylinder through the inlet connection 3.

5 The pump of Fig. 4 operated similarly, except that the displacement of liquid within the casing is effected by the plunger itself, and not by the simple distention of the inner diaphragm.

10 If it should happen that pumping conditions are such as to produce a greater pressure on the upper diaphragm than on the lower diaphragm, the oil in the upper space may eventually be forced past the plunger
15 into the lower space, which would leave the upper part of the plunger without lubrication. It may therefore be desirable to provide another check-valve 30 below the valves 16—17 at a point that will come above the
20 upper edge of the casing at an intermediate point in the stroke, and to set this lower check valve to open on the pulsion stroke, so as to insure a circulation of oil. The port to this valve should be of less capacity than
25 the ports draining the upper space through the valves 16—17.

My diaphragm pump is of special advantage in pumping liquids which are corrosive or gritty and which give off poisonous or
30 otherwise injurious fumes which might leak through ordinary pump packing. Packing friction and air leakage at the gland is entirely eliminated in my device and the efficiency of the pump is thereby increased.

35 While I have herein shown certain preferred embodiments of my invention, it is obvious that numerous changes in the construction and arrangement of parts may be made without departing from the principles
40 of my invention. I, therefore, desire that no limitations be imposed on my invention except such as are indicated in the appended claims.

What I claim is:

45 1. A pump comprising a reciprocable plunger and a tubular, radially distensible working diaphragm surrounding the said plunger.

2. A pump comprising a reciprocable
50 plunger, a bearing therefor, and a tubular, radially distensible working diaphragm surrounding the said plunger.

3. A pump comprising a casing, a tubular diaphragm disposed therein, and means for
55 intermittently and radially distending the said diaphragm by forcing fluid thereinto.

4. A pump comprising a casing, a plunger adapted to enter the said casing, and a flexible radially distensible working diaphragm
60 surrounding the said plunger within the said casing.

5. A pump comprising a casing, a hollow fluid-filled plunger adapted to enter the said casing, and a flexible working diaphragm
65 surrounding the said plunger within the

said casing and adapted to be distended when the said plunger moves into the said casing.

6. A pump comprising a casing, a plunger adapted to enter the said casing, and a flexible radially distensible diaphragm surrounding the said plunger within the said casing, the said diaphragm having one of its ends attached to the said casing. 70

7. A pump comprising a casing, a plunger adapted to enter the said casing, a flexible diaphragm disposed within the said casing and surrounding the said plunger, and a second flexible diaphragm surrounding the said plunger outside of the said casing. 75

8. A pump comprising a casing, a hollow, liquid-filled plunger adapted to enter the said casing, a flexible diaphragm disposed within the said casing and surrounding the said plunger, a second flexible diaphragm surrounding the said plunger outside of the said casing and a check-valve in the said plunger permitting the entrance of liquid into the said plunger from the space enclosed by the said outside diaphragm. 80

9. A pump comprising a casing, a plunger adapted to enter the said casing, and a tubular flexible diaphragm surrounding the said plunger within the said casing, the said diaphragm having one of its ends attached to the said casing and having its other end closed. 85

10. A pump comprising a casing, a perforated tubular member disposed therein, a plunger adapted to enter the said tubular member, and a flexible diaphragm surrounding the said tubular member. 90

11. A pump comprising a casing, a perforated tubular member disposed therein, a liquid-filled plunger adapted to enter the said tubular member, and a flexible diaphragm surrounding the said tubular member and adapted to be distended by liquid forced by the said plunger through the perforations of the said tubular member. 95

12. A pump comprising a casing, a tubular member extending into the said casing and provided with a closed inner end and with perforations formed in its side and end walls, a plunger adapted to enter the said tubular member and a flexible diaphragm surrounding the said tubular member, the said diaphragm having one of its ends attached to the said tubular member and having its other end closed to surround the closed end of the said tubular member. 100

13. A pump comprising a casing, a tubular member extending into the said casing and provided with a closed inner end and with perforations formed in its side and end walls, a hollow liquid-filled plunger adapted to reciprocate within the said tubular member, a flexible diaphragm surrounding the said tubular member, the said diaphragm having one of its ends attached to the said 105

tubular member and having its other end closed to surround the closed end of the said tubular member, a second flexible diaphragm surrounding the said plunger 5 outside of the said casing, and having its ends secured respectively, to the said casing and to the said plunger and a check-valve in the said plunger permitting the entrance of liquid into the said plunger from the space inclosed by the said outside diaphragm. 10

In testimony whereof, I, the said WESLEY E. DUNKLE, have hereunto set my hand.

WESLEY E. DUNKLE.

Witnesses:

FLORENCE H. DUNKLE,
W. A. KENT.