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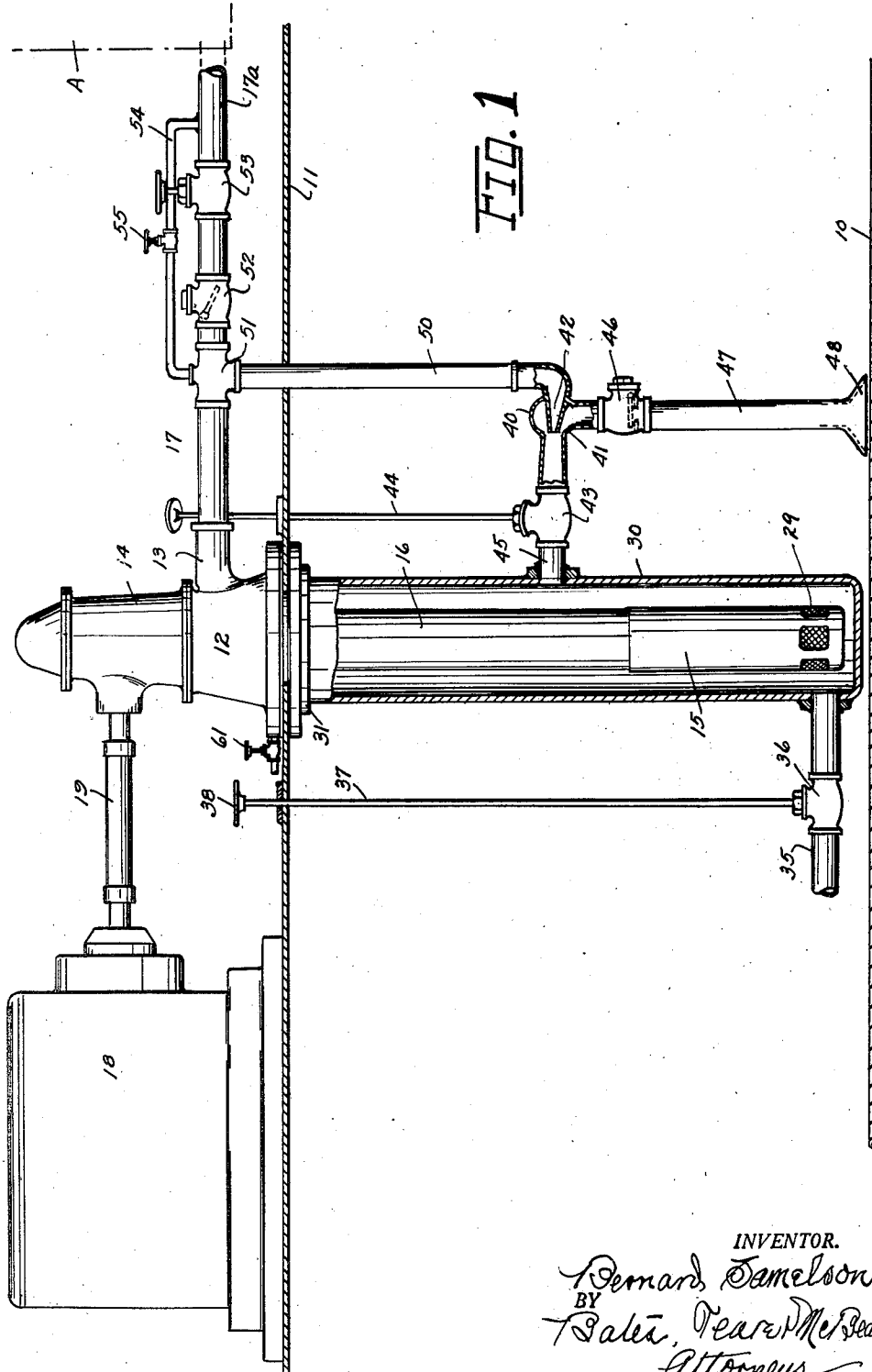
B. SAMELSON

2,425,957

PUMPING SYSTEM FOR EVACUATING CONTAINERS OF LIQUID

Filed Jan. 24, 1945

2 Sheets-Sheet 1



INVENTOR.

Bernard Samelson,
BY
Salem, Pease & McBean
Attorneys

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B. SAMELSON

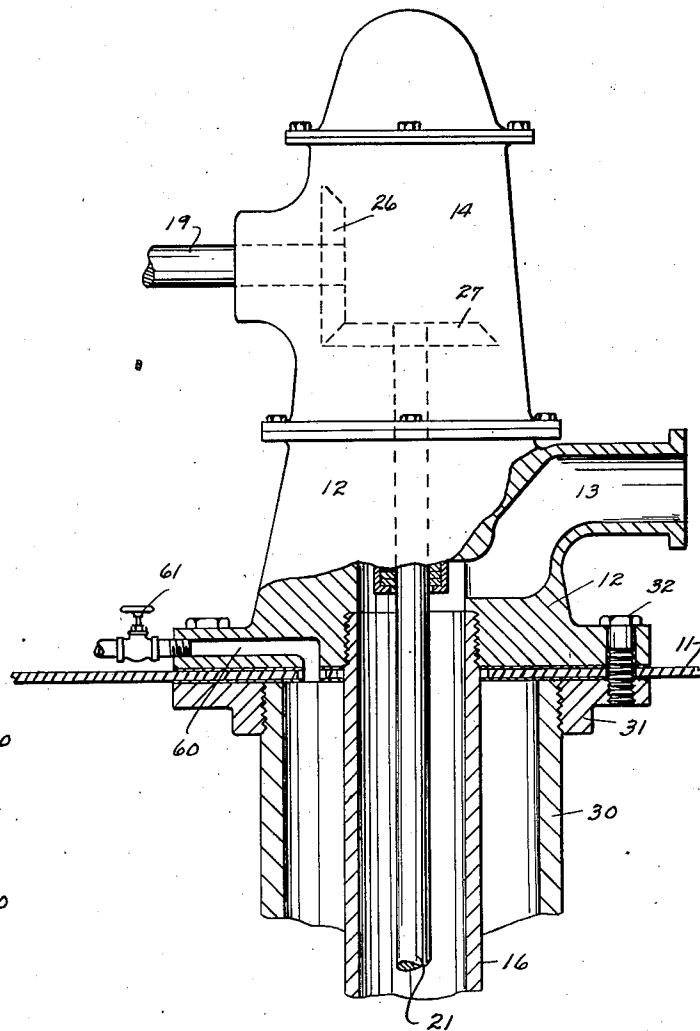
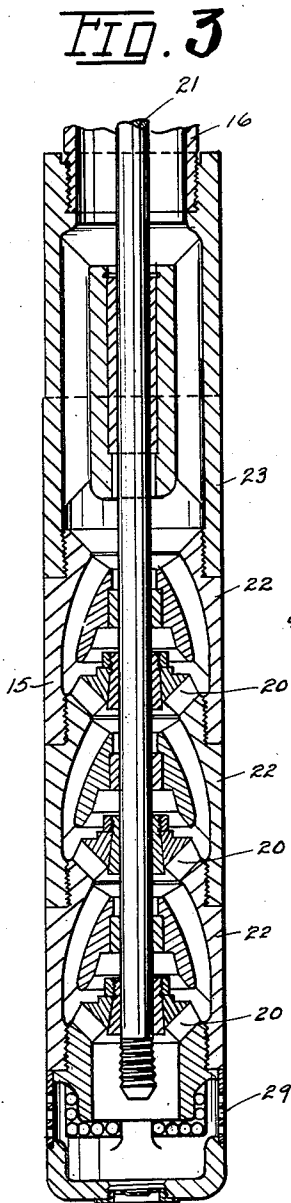
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PUMPING SYSTEM FOR EVACUATING CONTAINERS OF LIQUID

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2 Sheets-Sheet 2

FIG. 2



INVENTOR.

Bernard Samelson
BY
Paul, Pearl & McDevitt
Attorneys

UNITED STATES PATENT OFFICE

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PUMPING SYSTEM FOR EVACUATING CONTAINERS OF LIQUID

Bernard Samelson, Salem, Ohio, assignor to The Deming Company, Salem, Ohio, a corporation of Ohio

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20 Claims. (Cl. 222-263)

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This invention relates to a pumping system for removing the contents of comparatively large tanks, such for instance as those used underground for storage or in barges or vessels for delivery. An object of the invention is to provide an efficient system for pumping out the contents of such tanks and delivering it against a comparatively high pressure.

Another object of the invention is to provide means for removing substantially all of the liquid from the tank. When a comparatively large pump is employed, there is ordinarily a comparatively large suction pipe lying substantially along the bottom of the tank but unavailable to maintain suction when the liquid in the tank falls to a level where it uncovers the mouth of the suction pipe, though there is still a considerable quantity of liquid remaining in the tank. My invention strips the tank of the remaining liquid below the region which can be pumped out by the regular pumping system, and it is a feature of my invention that I accomplish this stripping by the same driving mechanism and the same general pumping mechanism as causes the normal action. I thus provide for the stripping by means of a minimum amount of additional mechanism and at a small increase in cost.

My invention is illustrated in the accompanying drawings and is hereinafter more fully explained and its essential novel features are set out in the claims.

In the drawings, Fig. 1 is a somewhat diagrammatic sectional elevation of my pumping system installed in a suitable tank; Fig. 2 is a sectional elevation on a larger scale of the pumping head and adjacent parts; Fig. 3 is a sectional elevation of the pumping unit and parts which form a continuation of parts shown in Fig. 2, with the intermediate portion broken away.

In Fig. 1, I have illustrated at 10 and 11 respectively, the top and bottom of a container for liquid to be removed by my pumping system. This container may be a tank in the ground or in a vessel or may be the vessel itself or other receptacle. Mounted on top of the tank is a suitable base 12 having a delivery passageway 13 and carrying a head 14 housing driving mechanism.

A pumping unit 15 within the tank discharges into a delivery pipe 16 and is operatively connected with the driving mechanism within the head. In Fig. 1, I have indicated a motor or other engine 18 having a driven shaft 19 which leads into the head and operates the pumping mechanism.

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The pumping unit 15 is preferably a vertical multi-stage centrifugal pump and may be of the type known as a deep well turbine, or other form may be used if desired. As shown the pumping unit comprises a series of impellers 20, Fig. 3, mounted on a rotary shaft 21. Each of these impellers is of a conical form and has annular row of veins on its conical surface coacting with a mating surface provided by a series of connected tubular members 22 forming a continuous housing connected by a top section 23 to the delivery pipe 16, the upper end of which is shown as threaded into the base portion 12 of the pump head.

I have shown the motor shaft 19 as carrying a bevel gear 26 meshing with a bevel gear 27 on the pump shaft 21. The rotation of the latter shaft causes the lowermost impeller to draw in liquid through an entrance orifice (indicated as screened openings 29) and causes each impeller in the whole pumping unit to discharge upwardly each to the one above it and the uppermost one to the delivery pipe.

The pumping unit 15 with its delivery pipe 16 is housed within a comparatively large vertical well 30, which may be a cylindrical tubular member closed at the bottom and secured at its upper end to the top of the tank. As shown the well wall is threaded into a collar 31 and suitable bolts (as 32 in Fig. 2) may secure both the collar and the lower portion of the pump base 12 to the tank top.

The main suction pipe 35 lies near the bottom of the tank and is connected to the well 30 near the bottom thereof. A valve 36 in this suction pipe is adapted to close it when required. The valve is shown as operated by a rod 37 leading upwardly above the tank and provided with an operating handle 38.

When the valve 36 is open and the motor 18 operated, the result is to establish suction in the pumping unit 15, and draw liquid through the suction pipe, the pumping unit and the delivery pipe and pump it out through a discharge pipe 17 communicating with the base passageway and deliver it to any suitable container (as indicated by the broken lines A in Fig. 1), where it may exert pressure against the contents of the delivery pipe.

The pumping system, as so far described, is effective in pumping the liquid from the tank until the liquid descends to a level sufficient to uncover the entrance to the suction pipe 35, whereupon the admission of air to that pipe would prevent further drawing of liquid from the

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tank by the pumping mechanism described. At this stage, the mechanism I have devised for withdrawing the liquid from the region below the mouth of the suction pipe comes into play. The operation of this mechanism will be best understood after I have described the construction itself.

In Fig. 1, 40 indicates an ejector comprising an elbow-like chambered member 41 and an inner nozzle 42 discharging into it. The outer member 41 is connected through a control valve 43 (which may conveniently be operated by a rotatable rod 44 extending through the top of the tank) with the well 30 at a point preferably above the pumping unit 15, the connection being shown at 45. The chamber 41 extends downwardly to a check valve 46, from which a pipe 47 leads downwardly to an open flaring receiving mouth 48 standing close to the bottom 10 of the tank.

A pipe 50 leads upwardly from the nozzle 42 and is connected to a T-fitting 51 in the delivery pipe 17. Beyond the T-fitting is a check valve 52 opening away from the pump, and beyond this check valve is a control valve 53 to open to a variable extent the discharge pipe to the section 17a therefor leading to the ultimate receiver. A suitable by-pass 54 leads from the delivery pipe portion 17a to the T-fitting 51, this by-pass being controlled by a shut-off valve 55.

I provide a valve-controlled vent from the top of the well 30. A passage for this vent is shown in Fig. 2 at 60 and extends through the base portion 12 of the pump head and the exit from the passage 60 is controlled by a hand valve 61, Figs. 1 and 2.

The operation of the stripping system described is as follows: After the liquid has been withdrawn in the normal manner by operating the pump by its motor, until the liquid has descended to the top of the suction pipe mouth, I shut off the suction pipe by closing the valve 36 and I open the stripping valve 43 and the vent valve 61. Now the pump continuing to operate with liquid in the well above the pump entrance 29, will continue to cause liquid under pressure in the pipe 17 which will force the liquid in the pipe 50 effectively in a jet through the nozzle 42 which causes suction up the pipe 47 through the stripping mouth 48. This feeds liquid from the tank through the entrance 45 into the well. This liquid forces out the air in the well above the liquid therein through the vent 60. As soon as liquid begins to pass through the discharge 60 the valve 61 is closed, so that the well is full of liquid about the pumping unit and the pumping unit continues to operate to draw liquid through the pipe 47 and discharge it into the pipe 17. Some of such discharged liquid passes down the pipe 50 and operates the ejector to strip liquid from the bottom of the tank.

At the start of the stripping operation, the valve 55 in the by-pass 54 is opened and thus the pressure of liquid in the discharge portion 17a of the pipe through the by-pass furnishes pressure in the pipe 50. With the control valve 53 entirely closed the pump will circulate liquid through the ejector nozzle from the by-pass 54 and will cause an operation of the stripping line. If the valve 53 is entirely open it might pass more liquid than the ejector could strip, so that the level in the well would drop and in the extreme case the pump would draw air and reduce pressure. I, therefore, set the control valve 53 partially open to choke the discharge through it and insure a sufficient amount of discharged liq-

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uid being diverted into the pipe 50 to operate the ejector effectively. The gate valve therefore can be used to maintain the level in the well until the stripping is finished.

It will be seen that by my system I can remove substantially the entire contents of the tank into the regular discharge line notwithstanding the regular suction inlet is some distance above the bottom of the tank. Moreover it should be noted that if the pump in its regular operation with the liquid level near the bottom draws air into the pump chamber and ceases to function, this will cause no trouble in my system because the fluid operated ejector has a powerful air suction and will immediately supply liquid to the pump. With my system it is possible to use satisfactorily a comparatively large pump with a large suction line, leading if desired from different tanks to be discharged selectively, without the necessity of sacrificing convenience in location of the suction line or requiring its mouth or mouths to be as near the bottom as possible, because whatever liquid is left in the tank after a suction mouth is uncovered is evacuated through the stripping connection to the pump.

I claim:

1. In a pumping system for evacuating containers of liquid, the combination of a pump having a suction opening in the container and a discharge passageway outside of the container, mechanism for operating the pump, and means operated by the liquid delivered by the same pump to strip liquid in the container below the suction orifice and deliver it into position to be discharged by the pump.

2. The combination with a container for liquid, of a pump submerged therein and having a suction orifice within the container and a discharge orifice outside of the container, and an ejector operated by fluid discharged by the pump and adapted to strip liquid in the tank below the suction orifice and deliver it to the pump.

3. The combination with a container for liquid, of a pump having a suction orifice in the container and a discharge orifice outside of the container, and an ejector operated by the liquid discharged to strip liquid in the tank below the suction orifice.

4. The combination of a container for liquid, a submerged pump in the container, a casing about the pump provided with a suction orifice above the bottom of the tank, mechanism for operating the pump, and means actuated by the liquid delivered by said pump for stripping liquid from the container below the suction orifice discharging it into said casing.

5. The combination of a container for liquid, a submerged pump therein, a casing about the pump having a suction orifice, a stripping conduit provided with an ejector and leading from a region lower than said suction orifice to the casing, and means for operating the ejector by fluid discharged by the pump.

6. The combination of a container for liquid, a submerged pump therein, a casing about the pump having a suction orifice, a stripping conduit leading from a region lower than the suction orifice to the casing, an ejector operated by the liquid discharged by the pump and communicating with the stripping conduit and the casing.

7. The combination of a container for liquid, a submerged pump therein, a casing about the pump having a suction orifice, a stripping conduit leading from a region lower than the suction orifice to the casing, an ejector communicating

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with the stripping conduit and the casing, a shut-off valve in the suction line from the casing, and a shut-off valve in the passageway from the ejector to the casing.

8. The combination, with a container for liquid, of a submerged centrifugal pump therein having a chamber housing a centrifugal member and communicating by a delivery pipe with a discharge conduit, a shaft in the delivery pipe operating said centrifugal member, a casing about the pumping unit having a suction orifice, a stripping conduit, and an ejector connecting the stripping conduit with the casing and having an operating conduit connected with said discharge conduit.

9. The combination with a container for liquid, of a submerged pump therein having an upwardly extending delivery pipe and having an operating shaft for the pump within the delivery pipe, a discharge conduit connected with the delivery pipe, a casing in the container surrounding the pump and delivery pipe, a suction pipe communicating with the casing and equipped with a shut-off valve, a stripping conduit leading from a lower portion of the container and provided with an ejector leading from the stripping conduit to the casing, means for operating the ejector, and a valve controlling the discharge from the ejector into the casing.

10. The combination with a container for liquid, of a submerged centrifugal pump therein having a chamber communicating by a delivery pipe with a discharge conduit, a shaft in the delivery pipe operating a centrifugal member in said chamber, a casing about the pumping unit, a suction conduit to said casing, a stripping conduit having a mouth in the lower part of the container, an ejector adapted to connect the stripping conduit with the casing and having an operating conduit connected with the discharge conduit on the pump, a valve-controlled vent from the upper portion of the casing, and valves for shutting off the suction conduit to the casing and the ejector.

11. The combination with a pump adapted to be submerged in a body of liquid and mechanism for operating it of a submerged casing about the pump having a suction orifice, a discharge conduit from the pump, a stripping conduit having a suction orifice at a lower level than the orifice first mentioned, means including an ejector for connecting said stripping conduit to the casing, a downwardly extending conduit from the discharge line communicating with the ejector for operating it, a control valve in the discharge line, and a by-pass conduit from the discharge line beyond the control valve to the ejector.

12. The combination with a tank having a top and bottom and adapted to contain liquid, of a submerged pumping unit in the tank, a pump head above the tank connected with the pumping unit by a delivery pipe, a discharge conduit in communication with the delivery pipe, an operating shaft within the delivery pipe, a power mechanism above the tank extending into the head and connected with the shaft, a casing in the tank surrounding the pumping unit and delivery pipe and leading upwardly to the top of the tank, a valve-controlled vent from said casing above the tank, a suction conduit communicating with a lower portion of the tank and having a shut-off valve, a stripping conduit having a mouth a short distance above the bottom of the tank and leading upwardly, means providing an ejector chamber connecting said stripping conduit with

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the casing and having a shut-off valve, an ejector nozzle extending into said chamber, an ejector conduit extending downwardly from the discharge conduit to the ejector nozzle, a control valve in the discharge conduit beyond said downwardly extending ejector conduit, and a valve-controlled by-pass between the delivery conduit beyond the control valve and the ejector conduit.

13. In a pumping system, the combination of a pump having a suction opening in communication with a source of liquid and a discharge passageway, mechanism for operating the pump and means operated by the liquid delivered by the pump to draw liquid from a region from the same source below the top of the suction intake and deliver it into position to be received by the pump.

14. The combination with a pump having a suction intake in a source of liquid and having a discharge orifice and an ejector operated by the liquid discharged and adapted to force liquid from the same source to the pump from a region below the top of the suction intake.

15. The combination of a pump, a casing about the pump having a suction orifice adapted to be in communication with liquid to be discharged, a conduit leading from the same source of liquid to the casing, an ejector discharging into said conduit, and a conduit connecting said ejector with the discharge passageway from the pump.

16. The combination of a pump adapted to be submerged in a body of liquid, a pump head connected with the pumping unit by a delivery pipe, a discharge conduit receiving the flow from the delivery pipe, an operating shaft within the delivery pipe, a power mechanism extending into the head and connected with the shaft, a casing surrounding the pumping unit and delivery pipe, a valve controlled vent from said casing, a suction conduit communicating with a lower portion of the casing and having a shut-off valve, a stripping conduit having a mouth at a level below the top of the suction conduit, an ejector chamber connecting said conduit with the casing, an ejector nozzle extending into said chamber, a conduit extending from the discharge conduit to the ejector nozzle, a control valve in said discharge conduit beyond the conduit to the ejector, and a valve controlled by-pass between the discharge conduit beyond the control valve and the ejector conduit.

17. The combination of a container for liquid, a submerged pump therein, a casing about the pump having a suction orifice, a stripping conduit leading from a region in the container lower than the suction orifice to the casing, an ejector operated by the liquid discharged by the pump and communicating with the stripping conduit and the casing, a shut-off valve in the suction line from the casing, and means for operating the shut-off valve from a region outside of the container.

18. The combination with a container for liquid, of a submerged pump therein having an upwardly extending delivery pipe and having an operating shaft for the pump within the delivery pipe, a pump head above the container having mechanism for operating the shaft and having a discharge conduit connected with the delivery pipe, a casing in the container surrounding the pump and delivery pipe, said casing having a suction opening, a stripping conduit leading from a lower portion of the container and provided with an ejector leading from the stripping conduit to the casing, an operating conduit for the

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ejector leading downwardly from said discharge conduit and a valve controlled vent from the upper portion of the casing.

19. The combination with a container for liquid of a submerged pump therein, a casing surrounding the pump, said casing extending upwardly to the top of the container, a suction orifice to the lower portion of the casing, a discharge conduit from the pump, a stripping conduit having a suction orifice at a lower level than the orifice first mentioned, means including an ejector for connecting said stripping conduit to the casing, a downwardly extending conduit from the discharge line communicating with the ejector for operating it, a control valve in the discharge line, and a by-pass conduit from the discharge line beyond the control valve to the ejector.

20. The combination of a centrifugal pump having a chamber housing the centrifugal member and communicating by a delivery pipe with a discharge conduit, a shaft in the delivery pipe for operating said centrifugal member, a casing about the pumping unit having a suction orifice, a stripping conduit extending to a lower level

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than the top of the suction orifice, and an ejector connecting the stripping conduit with the casing and having an operating conduit connected with the discharge conduit.

BERNARD SAMELSON.

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