

May 18, 1943.

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2,319,730

PUMP

Filed Sept. 26, 1941

2 Sheets-Sheet 2

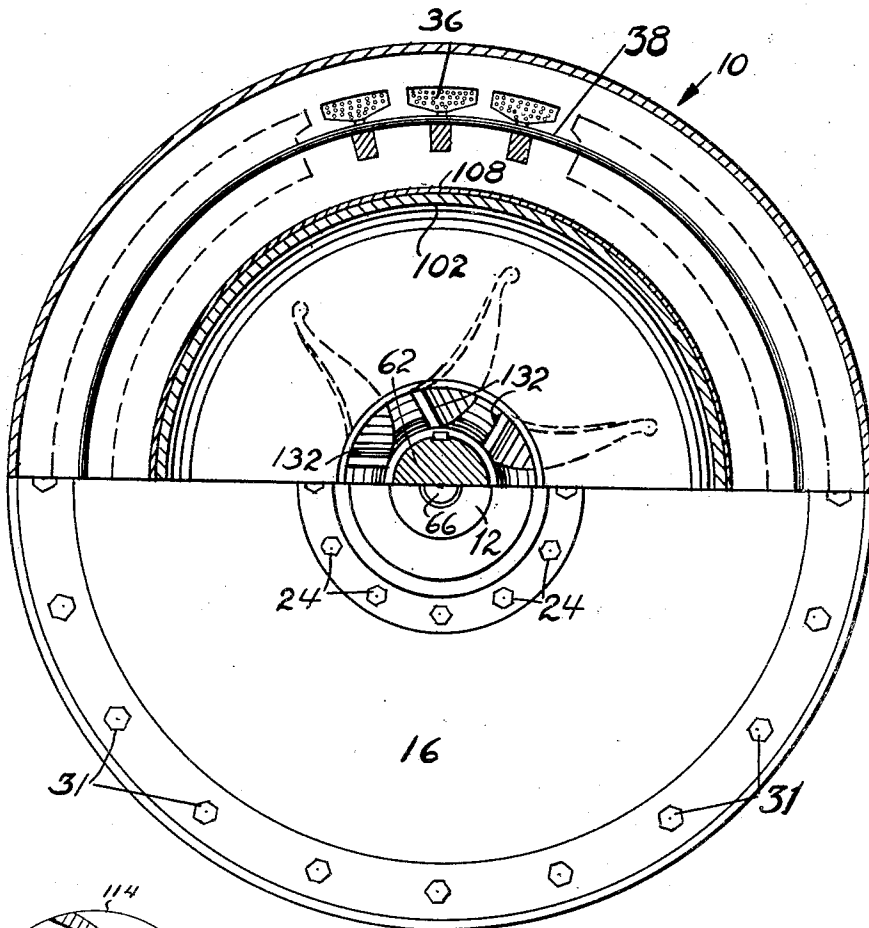


FIG. - 2

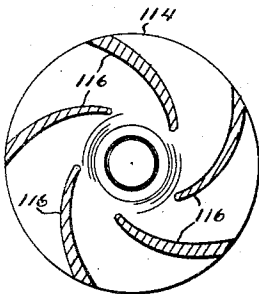


FIG-3

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UNITED STATES PATENT OFFICE

2,319,730

PUMP

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Application September 26, 1941, Serial No. 412,359

2 Claims. (Cl. 103—87)

This invention relates to pumps and more particularly relates to centrifugal pumps adapted for pumping volatile fluids.

In centrifugal pumps, leakage from the stuffing boxes is a frequent source of trouble. Also, it is dangerous when light inflammable products are pumped due to the escape of such products through the stuffing boxes. It is especially difficult to prevent leakage when pumping volatile liquids such as liquid propane and butane because of the high pressures encountered.

Centrifugal pumps have been made without stuffing boxes but where they are used to pump volatile liquids they are made to operate in a well or a hole in the ground as they are quite long and must be set vertically. These pumps also require elaborate seals for the rotors.

A centrifugal pump made according to my invention has no stuffing boxes through which the fluid handled may leak. The pump is integrally built with a motor for driving the pump. It is compact and may be used in a horizontal or a vertical position. The pump impellers or pumping elements are supported from the inside of the rotor instead of from a rotatable shaft and the diffuser members are stationary and secured to a stationary central shaft. Radial bearing liners and thrust bearings are provided for the ends of the rotating unit. A plurality of impellers is used in combination with a plurality of diffuser members to provide a multiple stage pump whereby high pressures may be obtained while retaining the compactness of the device.

Hydraulic balance of the rotatable unit or rotor is maintained by balancing the flow of fluid through the radial thrust bearing at the discharge end of the pump with the pressure at the suction end of the pump. Some of the fluid which escapes around the bearing at the discharge end of the pump is utilized to cool the laminations on the stator and rotor and also serves to cool and/or lubricate the bearing at the suction end.

In the drawings:

Figure 1 represents a longitudinal section with parts broken away to facilitate the disclosure;

Figure 2 represents a transverse vertical section taken substantially on line II—II of Figure 1; and

Figure 3 represents a detail of an impeller member with the cover broken away to show the vanes in the impeller member.

Referring now to the drawings, the reference character 10 generally designates the pump having an inlet or suction nozzle 12 and an outlet or discharge nozzle 14. The front end of the

pump is formed by a dished front cover 16. A similar dished back or rear end cover 18 is provided. The front cover has a flanged central opening 20. The inlet 12 comprises a sleeve 21 provided with a flange 22 at its outer end to which is attached the flanged opening 20 of the front cover 16 by bolts 24. The front cover 16 also has a flanged outer periphery 26 which is secured to the annular stator shell 28 by means of bolts 31.

The stator shell 28 has vertical sides 33 which extend inwardly and stator laminations 34 and windings 36 are held in the stator shell in the channel formed by sides 33. A stator sealing and insulating lining 38 is provided for the stator windings and laminations to protect them from the action of the fluid being pumped. The lining 38 is very thin to keep the gap between the stator and rotor laminations at an efficient minimum.

The back cover 18 has a flanged central opening 42 which is secured to flange 44 on outlet member 14 by bolts 46.

The inner end of the inlet member 12 is provided with a hub 54 provided with radial arms or webs 56 to provide openings 58. The openings 58 are streamlined to reduce the resistance of the inlet to the incoming fluid. A stationary shaft 62 is provided for the pump and the shaft is arranged substantially centrally of the pump. At the inlet end, the shaft 62 has a reduced cylindrical extension 64 which extends through the opening 65 in hub 54. The outer or free end of the extension 64 is threaded to receive a nut 66 which abuts the outer surface of hub 54 whereby the shaft is rigidly held in non-rotatable position. If desired, extension 64 may be anchored or secured to hub 54 as by a key.

The shaft 62 near the outlet member 14 is also provided with a reduced cylindrical extension 67 similar to extension 64 which extends through opening 68 in the hub 69 of the outlet member 14. The hub 69 is provided with radial arms or webs 72 to provide openings 74 for conducting the pumped fluid from the interior of the pump to the outlet member 14. The stationary shaft 62 is secured to the hub 69 by means of a nut 78 threaded on the outer or free end of the extension 76.

The rotor or rotatable unit generally designated 80 comprises a bearing bracket 82 having a sleeve 83 which surrounds the sleeve 21 on the inlet member 12. Bracket 82 has an upstanding outer end flange 84 adjacent the flange 22 on sleeve 21. A bearing liner or bushing 86 is provided between the bracket sleeve 83 and sleeve 21 on the inlet member 12. The bearing liner

86 extends between the upstanding end flange 84 and the flange 22 on the inlet member 12 and acts as a thrust bearing.

Bracket 82 has an outwardly dished body portion 88 provided with a flanged periphery 92 to which is secured a flat annular extension 93 on an impeller or pumping element 94 by bolts 96. Secured to the extension 93 by bolts 98 is an annular member or sleeve 102 to which are secured the rotor laminations 104 and rotor bars 106. From this it will be seen that impeller 94 is secured to the sleeve 102 around its entire periphery. Rotor lining 108 is provided between the annular member 102 and rotor laminations 104 to hold the laminations as a unit. The annular member 102 extends for the length of the pump and will be referred to hereinafter. The impeller 94 forms part of the rotor and from the above description it will be seen that impeller 94 is secured to and supported from the inside of the rotor which is a squirrel cage type, instead of from a shaft. All impellers are similarly supported.

The impeller 94 is a hollow annular member mounted within the pump for rotation therein. The impeller 94 has an inlet opening 112 at its inner end adjacent the openings 58 in the inlet member 12 and an outlet opening 114 adjacent its periphery through which fluid is propelled by centrifugal force. The opening 112 is larger than the outlet opening 114. The opening 112 is about the same size as the openings 58 in hub 54 and tapers down to the smaller outlet opening 114. Impeller 94 is provided with curved vanes 116 shown in Figure 3.

Impeller 94 has an annular extension 118 which forms one side of opening 112 and which projects over and rotates on the inner end portion of sleeve 21 of the inlet member 12 and acts as a seal, and another spaced annular portion 121 which forms the other side of opening 112 and which projects over and rotates on the inner portion of sleeve 21 and one end portion of the stationary shaft 62. Impeller 94 is shown in vertical position and has its rear wall 122 substantially flat and its front wall 123 inwardly tapered. In Figure 3 front wall 123 has been removed to show the vanes 116.

Impeller 94 is associated with an annular hollow diffuser member 124 which is stationary and has a hub portion 125 mounted on and secured to shaft 62 by means of keys 126. Diffuser member 124 has a curved outer periphery 128 in the shape of a U-bend which cooperates with the outer end or opening 114 of impeller 94 to receive pumped fluid therefrom. The inner portion 130 of the curved periphery of diffuser member 124 has an inlet opening 131 which is arranged close to the outlet 114 of impeller 94 to receive pumped fluid therefrom. The U-bend on diffuser member 124 changes the direction of flow of the pumped fluid. Diffuser member 124 is provided with vanes or diffusers 132 (see Figure 2) which act to reinforce the diffuser member 124 and also to direct the pumped fluid inward toward the outlet 134 in the diffuser member 124. The outlet 134 in the diffuser member 124 is larger than the inlet 131 to the diffuser member and is arranged adjacent the stationary shaft 62. The one wall 135 of the diffuser member is substantially flat whereas the other wall 136 is tapered from top to bottom to provide the large opening 134.

As the impeller 94 is rotated, fluid is drawn into the pump through inlet member 12 and the

fluid is thrown outwardly from the outlet 114 of the impeller 94 by centrifugal force. The fluid is then discharged into the open end 131 of the U-bend portion of diffuser member 124 which reverses the flow of the pumped fluid and converts the velocity energy added to the fluid by impeller 94 into pressure energy. From the drawings it will be seen that the vanes in impeller 94 are curved opposite to the vanes in the diffuser member 124. From the diffuser member outlet 134 near shaft 62 the pumped fluid is discharged to the next impeller presently to be described. By providing a plurality of sets of impellers and diffuser members, the pressure on the fluid may be increased or built up as the fluid is passed through the pump.

The pump is provided with a plurality of spaced impellers and diffuser members. From the diffuser member 124 the fluid is passed to the next impeller 142 which has a flat extension 143 secured to the annular member 102 by means of bolts 144. Impeller 142 has an inlet 146 adjacent the outlet 134 of diffuser member 124. Due to the construction of the pump, inlet opening 112 on the first impeller 94 is different from the inlet 146 on the next impeller 142 in that inlet 112 is provided substantially in the bottom of the impeller 94 for cooperation with suction inlets 58 whereas impeller 142 has a lateral inlet opening 146 to cooperate with the outlet 134 of diffuser member 124. The intermediate impellers are of substantially the same construction.

The inlet 146 on impeller 142 is of substantially the same size as the outlet 134 in the diffuser member 124. A close clearance is maintained between inlet 146 and outlet 134 to reduce recirculation of pumped fluid to a minimum. Recirculation cools inside of rotor laminations. Impeller 142 has an outlet 148 in its periphery adjacent the inlet opening of the next diffuser member 152 which is similar in construction to the diffuser member 124 hereinbefore described. Outlet 148 in the periphery of the impeller 142 is smaller than the inlet 146 in the impeller 142.

Diffuser member 152 has a curved outer periphery or U-bend 154 and an inlet 156 adjacent the outlet 148 in the impeller 142. Diffuser member 152 has a hub portion 157 which is secured to the stationary shaft 62 by keys 158 and is therefore held in a stationary position during the operation of the pump.

Diffuser members and impellers are alternated for the length of the pump and the desired number of sets installed to provide a pump which pumps fluid and places it under pressure as it passes through the pump from impeller to diffuser member. The pumped fluid under pressure passes through the last impeller 162 and last diffuser member 164 and then through outlet member 14. The diffuser members are all of substantially the same construction except the last diffuser member 164 which has a bottom outlet 165 to cooperate with the discharge openings 74 in discharge nozzle 14. Outlet 165 is of substantially the same size as the discharge openings 74. Diffuser member 164 has a curved outlet 165 having an annular portion 165' which is supported on a portion of the discharge nozzle 14. The remaining diffuser members are of substantially the same construction. The last diffuser member 164 has a hub 166 which is keyed to the stationary shaft 62 by keys 167. The last impeller member 162 is secured to the annular member 102 by bolts as described in connection with the previous impellers.

Bracket 168 on rotor 80 at the outlet end of the pump is similar to the bracket 82 hereinbefore described which is arranged near the inlet end of the pump. Bracket 168 has a flanged outer end 172 adjacent flange 44 on the outlet member 14. A bearing liner or member 173 is positioned between sleeve 174 on bracket 168 and sleeve 175 on outlet member 14. A portion of the bearing member extends between the flange 172 on bracket 168 and the flange 44 on the outer end of the outlet member 14 and acts as a thrust bearing.

Annular member 102 which forms part of the rotor or rotating element of unit 80 includes sections which are bolted together to make a large sleeve or annular member 102 and the laminations 104, rotor bars 106 and short circuiting rings 176 of the rotor are attached to the outer periphery of the annular member 102. From the above description it will be seen that the entire pump is formed of sections bolted together or otherwise secured together so that the entire pump may be readily assembled and disassembled and all the impellers and diffuser members removed or replaced. The annular member 102 is secured to the impeller members by means of flat extension members as hereinbefore described. The laminations and rotor bars on the exterior of the annular member 102 and rotor 80 are arranged in close spaced relation to the laminations and windings on the stator 28. The arrangement of stator windings and rotor laminations forms an induction motor of the squirrel cage type for rotating the impellers.

The pump inner casing together with the impellers and motor rotor forms a single rotating unit supported by radial bearings at both ends and with thrust bearings being provided for both ends. The bearings 86 and 173 rotate with the rotor as a unit.

The discharge end bearing 173 acts as a bearing liner and also as a rotating pressure breakdown device. The pressure at the discharge end of the pump near outlet 14 is of course at a higher pressure than the inlet end and some of the fluid under pressure escapes around bearing 173. To equalize the pressures at the ends of the pump a bleed line may be provided. The outlet end cover 18 is provided with an opening 178 for receiving a bleed line (not shown) for connection with the interior of the inlet member 12. The bleed line may be connected with the suction line or the vessel from which the pump takes suction. The bleed line acts to equalize the pressures at the discharge end and inlet end of the pump and axial balance is maintained in this way.

Some of the fluid which escapes around the radial bearing 173 does not return to the suction end 12 through the bleed line but passes through the clearance between flange 172 and flange 44 at the discharge end of the pump and goes up and around to the squirrel cage rotor, passing between and serving to cool the laminations on both the stator and the rotor. It then passes through suction end bearing (thus cooling and lubricating it) and returns to suction of first stage.

The operation of the device will now be described. A volatile liquid such as propane or butane under superatmospheric pressure is led from a source of supply to the inlet member 12. Electricity is supplied to the induction motor to cause rotation of the rotor 80 comprising the impellers 94, 142, 162, etc. Brackets 82 and 168 and sleeves 83 and 174 rotate with the impeller

members as a unit. As the impellers rotate, they draw in liquid propane through their inlets and throw it outwardly by centrifugal force through their outlets. In this way velocity energy is added to the liquid propane and it is thrown outwardly from the outer periphery of the impeller into the diffuser member. In the diffuser member the velocity energy is converted to pressure energy and the propane is placed under greater pressure. From the diffuser member 124 the liquid propane is passed to the next impeller 142 where the liquid propane is again thrown out by centrifugal force and velocity energy is added to the liquid propane. From here the liquid propane is passed to the next diffuser member 152 where the liquid propane is placed under a greater pressure.

The liquid propane is passed through the pump in this manner passing from each impeller to the next diffuser member until it reaches the last diffuser member 164 at which time the liquid propane is under the desired pressure. From here the liquid propane under pressure passes through outlet member 14 to a suitable tank or other distributing point.

From the above disclosure it will be seen that I have provided a centrifugal pump which has no stuffing boxes and in which leakage losses are avoided. The pump is relatively simple and of compact construction due to the inclusion of the pumping element inside of the motor rotor. The rotating impellers are supported from the outside periphery of the pump rather than on the central shaft. The size of the shaft can be greatly reduced in diameter because the only load on the shaft is the static load of the diffuser members rather than the dynamic load of impellers and associated parts as used in ordinary centrifugal pumps. The pump is in hydraulic balance and as a result thrust loads will be very small.

While I have shown a preferred form of my pump, it is to be understood that this showing is by way of illustration only and various changes and modifications may be made without departing from the spirit of my invention.

I claim:

1. A centrifugal pump without stuffing boxes including a stator shell and a rotor each provided with laminations to form an electric motor, relatively short stationary inlet and outlet members, said inlet and outlet members each having a hub at their inner ends, dished front and back cover members for fixedly connecting said inlet and outlet members to said stator, a stationary shaft extending longitudinally of the pump along its axis, means for securing one end of said shaft to said hub in said inlet member and the other end of said shaft to said hub in said outlet member, said rotor including a relatively large cylinder concentric with said shaft and having dished bearing brackets provided with sleeves rotatably mounted on said inlet and outlet members, bearing means between said sleeves and said inlet and outlet members, said rotor also including open ended hollow and annular impeller members having circumferential extensions connected to said cylinder and being concentric with said shaft, each impeller member having an inlet adjacent said shaft and an outlet adjacent said cylinder, a plurality of open ended, stationary hollow annular diffuser members fixedly held on and concentric with said stationary shaft, each diffuser member having an inlet near the outlet of one impeller member and an outlet

adjacent said shaft and near the inlet of the next impeller member, whereby rotation of said rotor causes fluid to pass through said inlet member, then an impeller member, then a diffuser member and successive impeller and diffuser members until the fluid is discharged through said outlet member at a higher pressure than it was at the inlet member.

2. A pump according to claim 1 wherein each of said inlet and outlet members has an outer flange and each of said dished bearing brackets has an end flange adjacent each of said flanges on said inlet and outlet members and bearing liners between each outer flange and end flange to act as thrust bearings.

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