Oct. 1, 1957 W. F. KRUEGER 2,808,111

SUBSURFACE PUMP

Filed Oct. 1, 1954 3 Sheets-Sheet 1

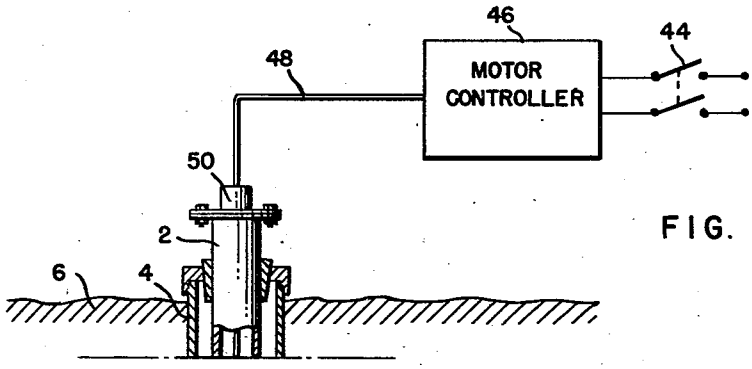


FIG. IA.

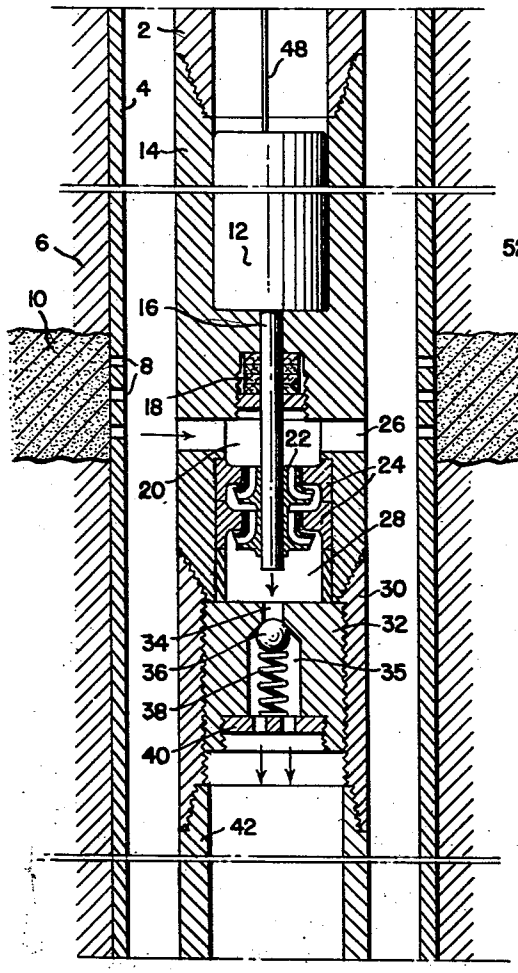


FIG. IB.

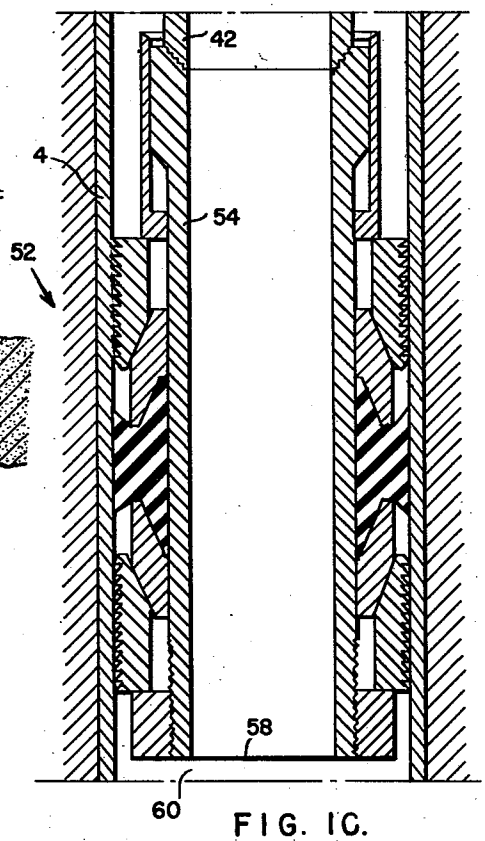


FIG. IC.

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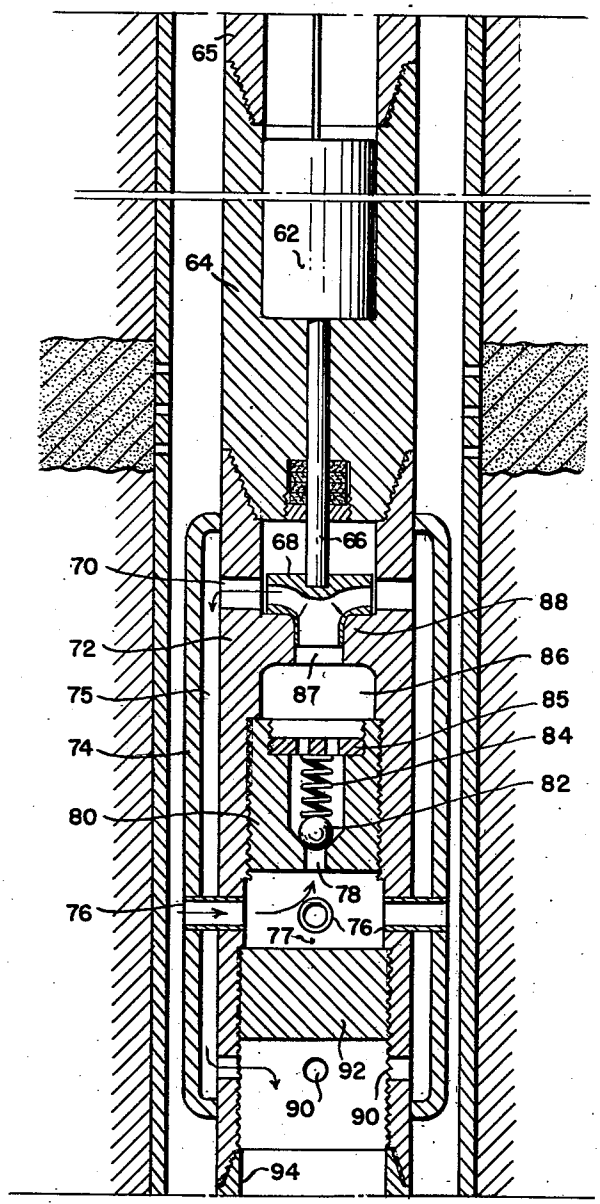


FIG. 2.

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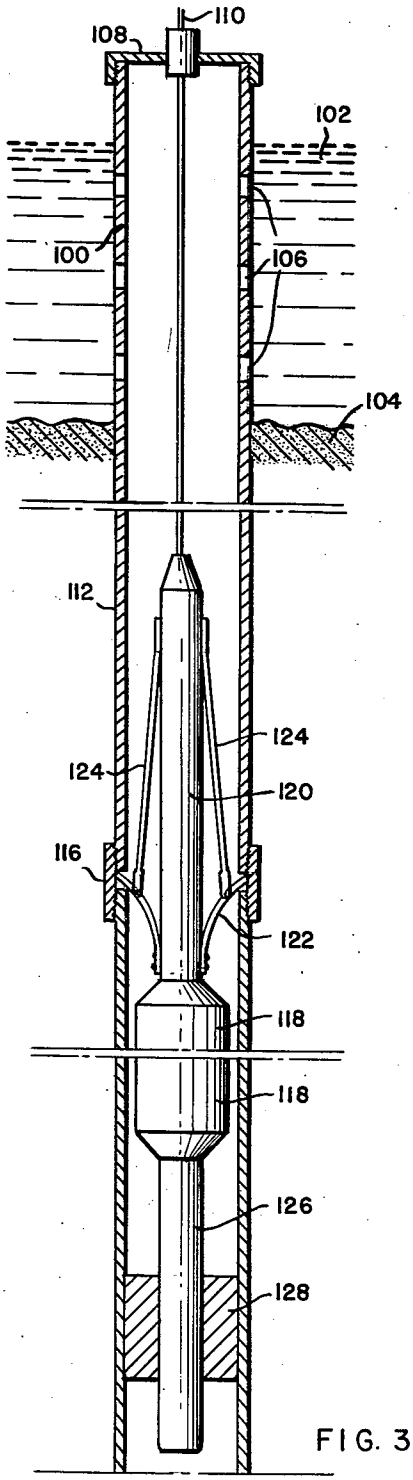


FIG. 3.

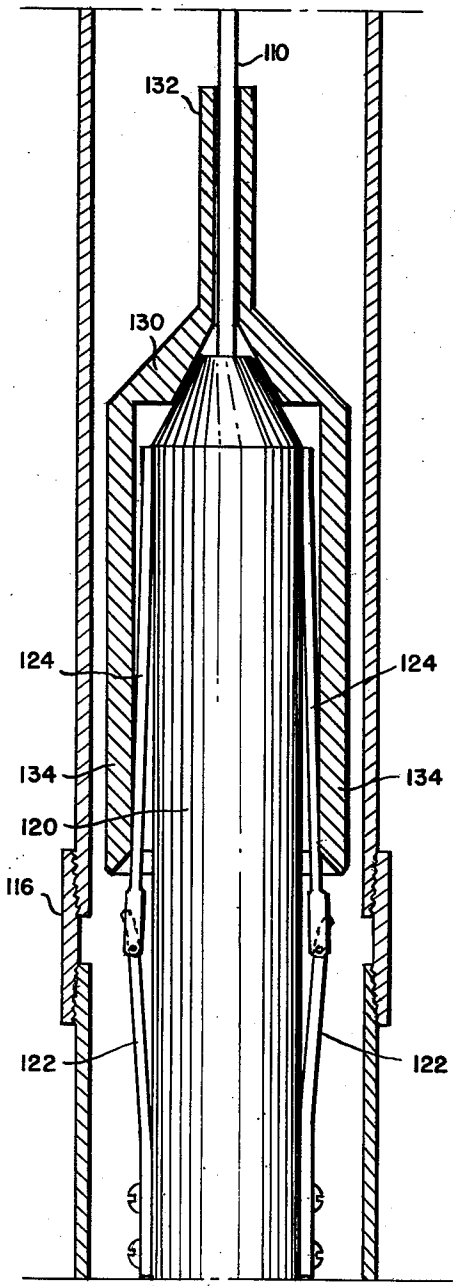


FIG. 4.

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2,808,111

# SUBSURFACE PUMP

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Application October 1, 1954, Serial No. 459,600

3 Claims. (Cl. 166—101)

This invention relates to subsurface pumps and, more particularly, to pumps which may be lowered into a casing in a well by means of a wire line or a drill stem and which are adapted to pump liquid downwardly through the casing.

In obtaining crude petroleum it is a common occurrence to have the pressure within the producing horizon decrease so that it is necessary to introduce water under pressure to the oil bearing strata through former oil wells selected near the producing field in order to increase the pressure within the producing horizon to increase the oil flow to the producing wells.

In some fields water bearing sands which overlie the oil strata are the source from which water is permitted to flow downwardly into the oil reservoir to create the necessary pressure by building up a hydrostatic head proportionate to the depth of the water in the well.

In locations where the pressure in the overlying water bearing sands is relatively low, the water from the formation will not pass downwardly into the underlying oil bearing strata unless water pressure is increased by auxiliary pumping apparatus.

In some fields the wells exist in a bay or lake or deep marsh. In these instances water can be taken from the surface of the earth. In some locations platforms are built and surface pumping apparatus is employed. In other locations, however, the cost of driving pilings and constructing suitable support structure for surface pumping equipment is such that it is preferable to lower pumping apparatus into a well casing on a wire line or on a drill string and to support the pumping apparatus in a position within the well casing in a manner similar to the arrangement employed when subsurface waters are being pumped downwardly.

It is an object of this invention to provide a motor driven rotary pump in which the motor and rotor elements are positioned in a tube string within a casing below the surface of the earth and which will serve to pump water downwardly through the tube string and casing.

It is a further object of this invention to provide a motor driven rotary pump which can be supported within a well casing by latching means locally at the pump, thus avoiding the necessity of having a derrick or a well servicing barge lower the pump into the casing on a drill stem.

These and other objects of the invention will become apparent from the following description when read in conjunction with the acompanying drawings, in which:

Figure 1A is a showing of one form of the apparatus involved at the surface of the earth;

Figure 1B is an enlarged axial section of a tube string and pumping apparatus positioned below the surface of the earth;

Figure 1C is an axial section of the portion of the tube string positioned below that portion shown in Figure 1B;

Figure 2 is an alternative form of apparatus which



may be employed in place of that shown in Figure 1B;

Figure 3 is an axial section through a bore hole showing pumping apparatus such as that shown in either Figure 1B or Figure 2 supported within a well casing by latching means; and

Figure 4 is an enlarged axial section of a portion of the apparatus shown in Figure 3 showing a release mechanism unlatching the latching means.

Referring to Figures 1A, 1B and 1C there is shown a tube string 2 which is supported by a casing 4 extending downwardly in a bore hole in the earth 6. Below the surface of the earth the casing 4 is provided with perforations 8 in the vicinity of a water bearing strata 10 in the earth 6, permitting entry of water from the strata 10 into the space between the tubing 2 and the casing 4.

As previously noted, a surface source of water may be employed. In such a case it will be evident that the well casing will be provided with perforations above the surface of the earth or other inlet means will be provided in the well casing at the upper end thereof to provide for the admission of water into the casing. While the following description is presented with regard to a subsurface source of water, it will be evident that a surface source of water may equally well be employed.

A motor 12 is positioned in a receiving member 14 supported by the tube string 2 and has a downwardly extending shaft 16 passing through packing means 18 into a chamber 20 within the receiving member 14. A plurality of impellers 22 are affixed to the motor shaft 16 and are adapted to rotate in positions adjacent to stationary members 24 mounted within the chamber 20. The receiving member 14 is provided with a plurality of radially extending bores 26 connecting the chamber 20 to the space between the tube string and the casing 4. The impellers 22 and stationary members 24 are so arranged that, upon rotation in response to actuation of the motor 12, fluid is pumped inwardly through the radial bores 26 into the chamber 20 and downwardly into the lower portion 28 of the chamber 20. While two sets of impellers are shown, it will be evident that in a pump of this type any number of successive impeller stages may be employed depending upon the pressure and volume conditions involved.

A sleeve 30 is connected to the tube string below the member 14. A member 32 is threaded into the sleeve 30 and is provided with an axially extending bore 34 through which fluid passes downwardly from the pump impellers 22 into the lower portion 42 of the tube string. A check valve is provided within an enlarged portion 35 of the axial bore 34 in the member 32 in the form of a ball 36, a spring 38 urging the ball upwardly and a retaining plate 40 supporting the spring. It will be evident that the ball valve is provided to prevent upward flow through the tube string when operation of the pump is arrested.

The motor 12 receives power from a suitable source through conventional disconnect switch 44, a motor controller 46, and a multiconductor power line 48. The power line 48 extends through a cap 50 on the tube string 2 and downwardly through the tube string to the motor 12.

The lower end of the sleeve 30 is joined to a tube section 42. The tube section 42 or a successive section below the section 42 is provided with a conventional packer assembly, indicated generally at 52 in Figure 1C, to provide a seal between the well casing 4 and the tube extension portion 54 provided by the packer assembly.

It will be evident that operation of the motor 12 will cause rotation of the impellers 22 and serve to pump liquid entering the casing from the water bearing strata 10 and entering the tube string through the radially extending bores 26 downwardly through the check valve in the member 32, downwardly through the tube string 42

past the packer indicated at 52 and out of the lower end 58 of the packer tube 54 into the lower portion 60 of the well casing. By thus increasing the pressure of the fluid in the lower portion 60 of the well casing, a flow is induced downwardly into the oil bearing strata and the pressure thereof will be at least partially reestablished.

An alternative pumping structure is shown in Figure 2 and may be substituted for that structure shown in Figure 1B. The arrangement shown in Figure 2 includes a motor 62 mounted within a receiving member 64 which is affixed to a tube string section 65. A downwardly extending motor shaft 66 supports at its lower end an impeller 68 which is designed to pump fluid upwardly and outwardly through radially extending bores 70 in a member 72 attached to the lower end of the member 64. A sleeve 74 is affixed at its upper and lower ends to the member 72 and is spaced therefrom to provide an annular passage 75 between the sleeve 74 and the tube string member 72. Radially extending tubular members 76 extend through the sleeve 74, the annular passage 75 and the wall of the member 72, and are provided to convey fluid from within the well casing between the well casing and the tube string into a chamber 77 provided within the member 72.

A member 80 provided with a longitudinally extending bore 78 is threaded into the member 72. A check valve in the form of a ball 82, a spring 84 and a retainer plate 85 is provided to prevent downward flow through the bore 78. A chamber 86 within the member 72 immediately above the member 80 communicates with a reduced diameter bore 87 provided by the portion 88 of the member 72 which serves as the stationary portion of a pump housing associated with the pump impeller 68.

Upon operation of the motor 62 and rotation of the impeller 68, fluid flows from the space between the well casing and the tube string through the tubular members 76, into the chamber 77, upwardly through the bore 78 past the check valve ball 82, through the chambers 86 and 87 and into the impeller 68. Fluid is pumped outwardly by the impeller through the radially extending bores 70 in the member 72 into the annular passage between the member 72 and the sleeve 74, downwardly through the annular passage 75 and back into the lower portion of the member 72 through radially extending bores 90 in the lower portion of the member 72 below a plug 92 which prevents communication through the member 72 from the lower portion thereof to the upper portion thereof. The flow entering the lower portion of the member 72 passes downwardly therethrough and into successive tube string extension 94 past a packer assembly such as shown in Figure 1C and into the well casing at the lower end of the tube string.

It is noted that a multistage pump such as that shown in Figure 1B may be employed in place of the single impeller type pump shown in Figure 2 and that the members 14, 30 and 42 shown in Figure 1B and the members 64, 72, 74 and 94 shown in Figure 2 provide pump housings for their respective pumps.

In the two forms of the invention shown, the pump is positioned in Figure 1B so as to pump fluid downwardly and the pump is positioned in the arrangement shown in Figure 2 to pump liquid upwardly. The entire structural arrangement shown in each form, however, results in the pumping of liquid downwardly from the spacing between the tube string and the well casing into the lower portion of the well below a packer positioned between the well casing and the tube string below the pumping apparatus.

In Figure 3 there is shown a well casing 100 passing through a surface layer of water 102 and downwardly into the earth 104. The casing is perforated at 106 to permit the entry of water into the casing. The casing is capped as indicated at 108 and the cap is provided with a bushing through which a power cable 110 is extended downwardly into the casing and connected to a pump 118 positioned therein.



The pump 118 is positioned within the casing immediately below the jointure between the ends 112 and 114 of adjacent casing sections. These casing sections are joined by means of a casing collar 116. The upper end of the pump housing is provided with a reduced diameter extension 120. Outwardly bowed spring elements 122 have their lower ends affixed to the casing extension 120 and their upper ends in engagement with the wall of the casing in response to their own spring urging. The lower ends of release links 124 are pivotally connected to the outer end portions of the spring members 122. The upper end portions of the release links 124 are adapted to rest against the upper end portion of the pump housing extension 120.

The lower end of the pump housing is provided with a reduced diameter tube portion 126 extending downwardly through the pump and through a packer 128. The packer 128 may be of the type shown in Figure 1C which has been set by a drill stem or, preferably, may be of the type of packer which has been set by a wire line in the well known fashion. The pump is supported in the position shown within the casing by the engagement of the pump tube section 126 with the packer 128.

The pump is so positioned that the outer end portions of the spring member 122 are engaged in the recess between the adjacent ends of the casing sections 112 and 114 within the casing collar 116. It will be evident that, when the pump is in operation pumping fluid downwardly through the tube section 126 into the casing below the packer 128, an upward thrust will be exerted upon the pump housing 118. The spring members 122 will then engage the lower end of the casing 112 and prevent upward motion of the pump housing.

The pump 118 may be similar to either of the pumps shown in Figures 1B and 2.

The arrangement shown in Figure 3 has the great advantage that the pump may be positioned in or removed from the casing by means of a small barge which is equipped with a sand line pulling unit and a suitable type of a frame hoist. This apparatus is relatively inexpensive and is well known to the art.

When it is desired to remove the pump from the well, a release device 130 is run down into the well. The release device is provided with a reduced diameter upper portion 132 which is positioned around the cable 110 and serves to center the device. The release device has an enlarged lower portion 134 which is adapted to pass around the release links 124 pressing them inwardly against the pump housing 118 and thereby moving the spring members 122 inwardly against the pump housing 118 thus releasing the outer ends of the spring members 122 from engagement with the lower end of the casing 112. With the spring members thus unlocked, the pump may be withdrawn from the well casing whenever desired. It is of further importance that this withdrawal may be accomplished by means of a small barge and thus the need of a derrick or well servicing barge such as would be employed if the pump were supported on a drill stem is avoided.

It will be evident that various modifications may be made to the embodiments of the invention disclosed herein without departing from the scope of the invention as set forth in the following claims.

What is claimed is:

1. Apparatus for pumping fluid downwardly through a casing in a bore hole comprising a housing of lesser diameter than said casing suspended within said casing by flexible suspension means, means providing an inlet for flow of liquid from within said casing into said housing, means positioned below said inlet means sealing off the space between said housing and said casing, electric motor driven pump means mounted in said housing for pumping liquid entering said housing through said inlet means downwardly through said housing and out of said housing into the bore hole below said sealing means,

and means acting between said housing and said casing releasably latching said housing in said casing preventing upward displacement of said housing in said casing during pumping.

2. Apparatus for pumping fluid downwardly through a casing in a bore hole comprising, in combination, a housing of lesser diameter than said casing suspended within said casing by flexible suspension means, means providing an inlet for flow of liquid from within said casing into said housing, means positioned below said inlet means sealing off the space between said housing and said casing, electric motor driven pump means mounted in said housing for pumping liquid entering said housing through said inlet means downwardly through said housing and out of said housing into the bore hole below said sealing means, and means acting between said housing and said casing preventing upward displacement of said housing in said casing during pumping, and means for releasing said latching means to permit withdrawal of said housing upwardly through said casing.

3. Apparatus for pumping fluid downwardly through a casing in a bore hole comprising, in combination, a housing of lesser diameter than said casing suspended



within said casing by flexible suspension means, means providing an inlet for flow of liquid from within said casing into said housing, means positioned below said inlet means sealing off the space between said housing and said casing, electric motor driven pump means mounted in said housing for pumping liquid entering said housing through said inlet means downwardly through said housing and out of said housing into the bore hole below said sealing means, and means including members mounted on said housing and urged outwardly into engagement with said casing releasably latching said housing in said casing preventing upward displacement of said housing in said casing during pumping, and means formed to be lowered into said casing and to engage said latching means to release said latching means and permit withdrawal of said housing upwardly through said casing.

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