

Aug. 16, 1932.

J. BRICKEN

1,872,111

SUBMERSIBLE PUMP SET

Filed Feb. 26, 1929

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Fig. 5. Fig. 6.

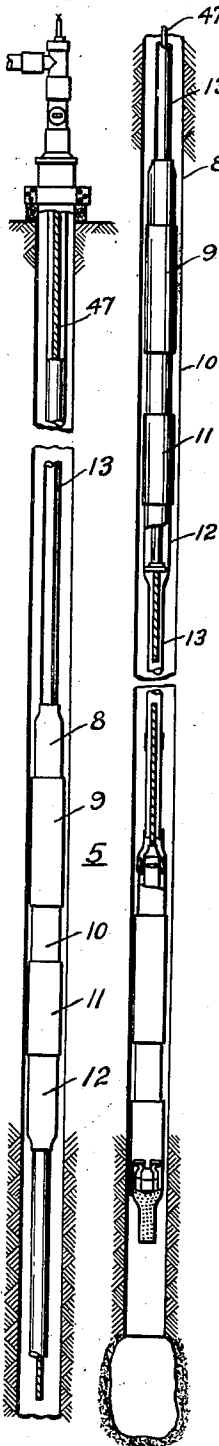


Fig. 1.

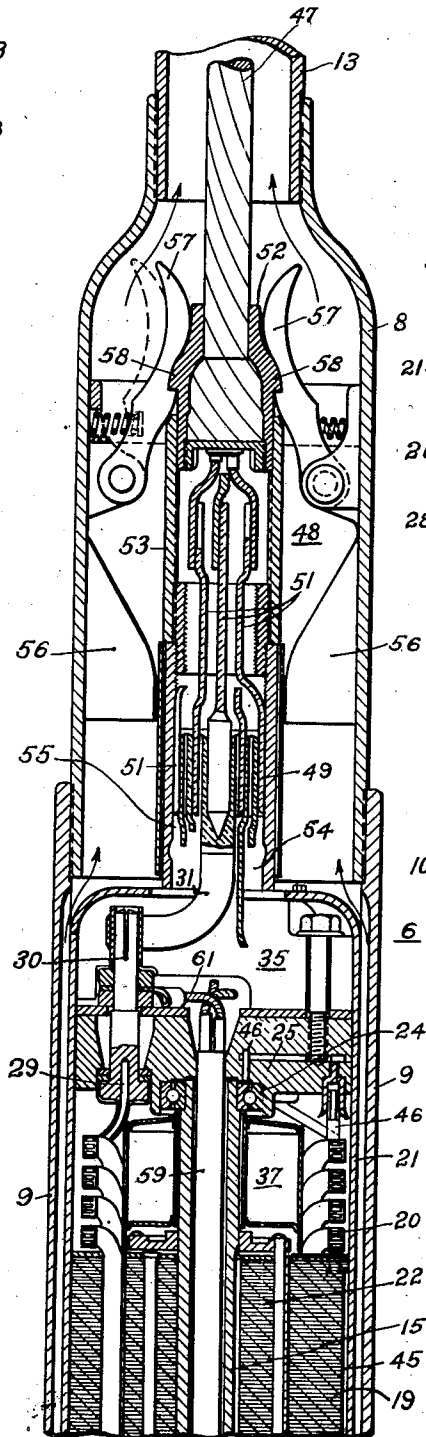
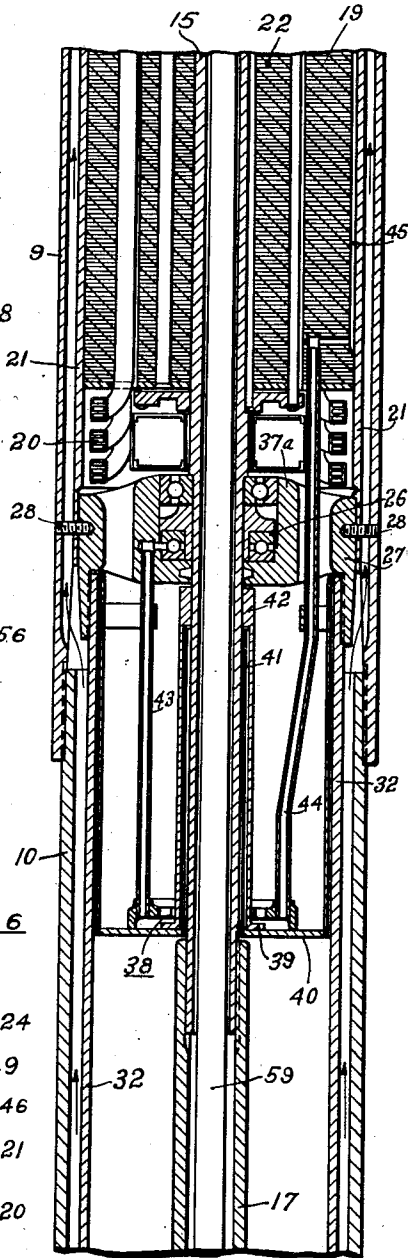


Fig. 2.



INVENTOR

John Bricken.

BY

Wesley C. Shaw
ATTORNEY

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Fig. 3.

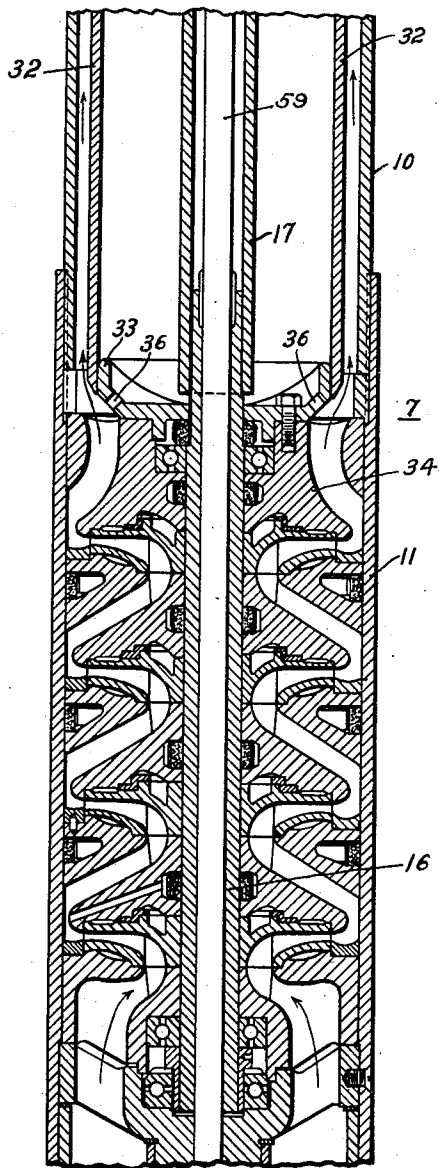
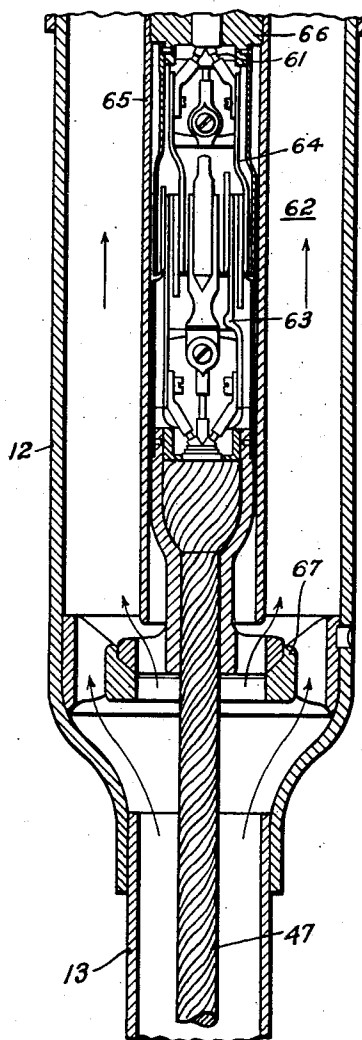


Fig. 4.



INVENTOR

John Bricken.

BY

Herbert A. Barr
ATTORNEY

UNITED STATES PATENT OFFICE

JOHN BRICKEN, OF WEST ORANGE, NEW JERSEY, ASSIGNOR TO E. F. BRITTEN, JR.,
OF MAPLEWOOD, NEW JERSEY

SUBMERSIBLE PUMP SET

Application filed February 26, 1929, Serial No. 342,701, and in Germany February 29, 1928.

My invention relates generally to enclosed electrical machines and, more particularly, to submersible pump-sets for pumping liquid from bore holes.

5 Heretofore, considerable difficulty has been experienced in preventing leakage liquid from entering the motor casing of a submersible pump-set. Usually, the entrance of leakage liquid occurs through the shaft packing or stuffing box, either at the lower or at the upper end of the motor, depending upon whether or not the pump is suspended beneath, or supported above, the motor. In the pump-sets ordinarily used, the motor shaft must necessarily extend through a bearing and a stuffing box, which, after some wear, permits the liquid, under the pressure developed by the pump, to enter the motor housing. The various methods which have been proposed to preserve the sealing qualities of the shaft packing or stuffing box have proved unsatisfactory for the reason that it becomes practically impossible to compensate for the wear which is rapid in pump-sets because of the abrasive action of the fine sand and other deleterious substances which may be carried by the liquid being pumped.

25 The object of my invention, generally stated, is to provide a submersible pump-set which shall be simple and efficient in operation and capable of being economically manufactured and installed.

30 A more specific object of my invention is to provide for preventing the entrance of leakage liquid into the driving motor of a submersible pump-set by utilizing the motor casing as a diving bell to build up, in the motor casing, an air pressure equal to the liquid pressure of the pump.

40 A further object of my invention is to provide for connecting and disconnecting the power-supply conductor of a submersible pump-set while the set is in an operative position in the bore hole.

45 Another object of my invention is to pro-

vide for preventing the entrance of the leakage liquid into the plug-and-socket connection of the supply cable by utilizing their protecting sheaths as diving bells when subjected to the liquid pressure of the pump.

A still further object of my invention is to provide for supplying power to a plurality of tandem-connected submersible pump sets by utilizing a current-carrying cable that extends continuously from the power source through the pump tubing and the hollow pump and motor shafts.

Other objects of my invention will become evident from the following description, taken in conjunction with the drawings, in which

Figs. 1 and 2 are sectional views of the upper and lower ends of an electric motor and pump.

Figs. 3 and 4 are similar views of apparatus which, when combined, constitute a submersible pump-set embodying the principal features of my invention, and

Figs. 5 and 6, are side elevational views (parts being broken away) showing how a plurality of pump-sets may be connected in tandem relation and power supplied to the individual units by means of a power cable extending from the power source through the pump tubing and hollow drive shafts of the several pumps and motors.

Referring now to the drawings, 5 designates, generally, a submersible pump-set which may be used separately, or in tandem relation to other similar sets, for pumping liquids from bore holes. As shown, the pump set comprises, generally, a motor 6 and a pump 7 which are enclosed and combined into a unitary structure by means of an outer casing comprising an upper housing member 8, an outer motor casing 9, an intermediate casing 10, a pump casing 11 and a lower housing member 12. The pump set may be suspended in any suitable manner from the surface. However, in this instance, the upper housing member 8 of the outer cas-

ing is screwed to the lower end of the pump tubing 13, which is also utilized for carrying the pumped liquid to the surface.

In this embodiment of the invention, the motor 6 is supported in the upper part of the outer casing 9 and above the pump 7, which is supported by the intermediate casing 10. As shown, the pump casing 11 constitutes a section of the outer casing of the pump set.

In this embodiment of the invention, the motor shaft 15, the pump shaft 16, and the intermediate connecting shaft 17 are illustrated as being tubular to provide a conduit for conductor cables which may be extended through one pump-set to another.

A motor of any suitable type may be utilized for operating the pump. However, in this instance, a polyphase squirrel-cage motor is utilized. As shown, the stator of the motor, comprising the punchings 19 and stator coils 20, is supported by means of an inner motor casing 21. The squirrel-cage rotor 22 is carried by the tubular drive shaft 15 which is journaled in an upper bearing 24, this bearing being mounted in an upper end bell 25. A lower bearing 26 for the shaft 15 is carried by a supporting member 27. The lower bearing 26 is provided with both guiding and thrust-bearing elements. Therefore, it will be readily understood that the weight of the rotor 22 is carried by the lower bearing 26 and its supporting member 27, which is secured to the inner motor casing 21.

The motor is supported or held in position in the upper portion of the outer casing 9 by means of studs 28 which extend at intervals through the casing wall into the supporting member 27. In this instance, the motor leads 29 are brought out at the top of the motor and connected to terminal members 30 which are adequately insulated from the upper end bell 25. The terminal members are provided with connecting leads 31 which are disposed to connect with the socket members of a cable-connecting device, as will be described in detail hereinafter.

In order to provide for protecting the motor against the entrance of leakage liquid, means are provided for forming the inner motor casing into a diving bell having its upper end closed and its lower open end in communication with the pump chamber. As shown, the inner motor casing 21 is extended by means of a second intermediate casing 32 which is supported from the lower bearing support 27 and extends downwardly, in concentric relation, to the intermediate casing member 10 and is connected to a cap 33 which is supported by the upper bearing support 34 of the pump 7.

As will be readily understood, the upper part of the diving bell is formed by the inner casing member 21 of the motor 6 which may have its upper end sealed against the entrance of liquid in any suitable manner. In this

embodiment of the invention, the upper end of the motor casing 21 is sealed by means of a block 35 through which the connecting leads 31 from the terminal members 30 extend and in which they are sealed in any suitable manner commonly practiced in the art.

It will be readily understood that the diving-bell construction of the inner motor casing provides an air chamber having a volume depending upon the diameter of the pump and the length of the intermediate casing member 10 between the motor and the pump. The size of the chamber is sufficient to trap a considerable quantity of air at atmospheric pressure when the pump-set is submerged, to prevent liquid from the pump chamber from rising within the diving bell to such level as would reach the motor parts.

It is evident that, when the pump set is in operation, the air trapped in the diving bell will be subjected to the full liquid pressure of the pump since the liquid from the pump may flow through the openings 36 in cap member 33, into the lower part of the diving bell; and, since the lower end of the diving bell is always filled with a liquid which may vary in depth in accordance with the pump pressure, a liquid seal is provided around the intermediate drive shaft 17. The height of the liquid level is, therefore, controlled by means of the back pressure set up from the compressed air which is trapped in the upper end of the diving bell.

In order to keep the air space in the motor as small as possible, and thereby increase the volume of compressed air in the lower part of the diving bell, the open spaces above, and below, the rotor 22 are filled with air-tight tanks 37 and 37^a, as shown.

In providing for maintaining a liquid seal around the intermediate drive shaft 17 at some level within the lower end of the diving bell, it is evident that a stuffing box, or other shaft-packing means, is not required to prevent the entrance of leakage liquids into the motor. It will be readily understood that a device of this kind is very desirable from the operating standpoint, since the seal between the pump and the motor is self-maintaining and, therefore, does not require that the pump set be frequently serviced in order to maintain it in operation.

The extension casing member 32, which forms the lower end of the diving bell, also, in conjunction with the intermediate casing member 10 provides an annular passageway, or channel, for conducting liquid from the pump, and around the motor, to the upper housing member 8 and pump tubing 13. From the construction shown, it is evident that the diving bell functions in a double capacity because of its location with respect to the outer casing of the pump set and,

therefore, other liquid-conducting means for connecting the pump to the tubing 13 are not required.

Since it is desirable to reduce the diameter of the set to as small dimensions as possible, it is evident that the utilization of part of the space within the outer casing as a liquid-conducting channel is an important feature. Furthermore, the air chamber in the diving bell must be of considerable volume, which may only be obtained by lengthening the intermediate casing members 10 and 32, and thus tending to weaken the rigidity of the set as a unit. The shell construction provided by the intermediate casing member 10 and the extension member 32 ensures stiffening the casing between the pump and the motor and, therefore, permits the construction of a longer unit.

In order to provide for lubricating the upper and lower bearings of the motor, centrifugal oil pump 38, having an impeller 39 driven from the motor shaft 15, is utilized. The pump is placed in an oil chamber, or reservoir 40, which is suspended inside the intermediate extension casing 32, beneath the motor 6. The oil chamber, or reservoir 40, is provided with an inner sleeve member 41 which extends upwardly along the motor shaft 15, and thereby forms a liquid-tight container around the motor shaft without utilizing a liquid seal of any kind. The impeller 39 of the pump 38 is driven by means of a sleeve member 42, which is attached to the motor shaft 15 at a point above the inner sleeve member 41 of the oil chamber 40, as shown. Therefore, it will be readily understood that the driving sleeve 42 extends downwardly into the oil reservoir, and rotates about the inner sleeve member 41, without interference. Oil is conducted to the lower bearing 26, directly through an oil pipe 43, which discharges directly into the lower thrust element of the bearing, as shown. Oil is supplied to the upper motor bearing 24, through an oil pipe 44, which connects with a channel 45, formed between the inner casing of the motor and the laminated member of the stator, which, likewise connects with a second oil pipe 46, which carries the oil directly to the upper motor bearing.

In this embodiment of the invention, power for operating the pump motor 7 is supplied through a current cable 47, which is carried within the pump tubing 13. In many instances, it is desirable to connect, or disconnect, the conductor cable from the terminals of the motor without raising the pump set to the surface. In order to provide for easily connecting or disconnecting the current cable and the terminal members of the motor, a plug-and-socket device is provided which is shown generally at 48. The stationary part of the connecting device 48 is provided with socket members 49,

which are joined by means of the connecting leads 31, to the terminal members 30, as shown. The separate conductors of the current cable 47 are connected to the plug or finger members 51 which are disposed to engage the socket members 49. The plug-and-socket members are protected by means of a sheath having a head member 52 which is sealed to the cable 47, and a cylindrical member 53, which extends downwardly around the contact fingers 51. The cylindrical member 53 is disposed to engage the neck portion 54 of the block 35, in which the socket members 49 are sealed, thereby forming a liquid-tight joint at 55 between the open space in the housing member 8, and the inner chamber of the connecting device.

In order to facilitate guiding the sheath portion of the connecting device 48, into a sealing position when the current cable 47 is lowered, guide members 56, having inclined faces disposed to engage the sheath, are provided. The guide members 56 are also utilized to hold the sheath securely in position to prevent vibration, which would tend to loosen the joint formed between it and the neck portion 54.

In order to protect the contact members of the connecting device 48 from the pressure or weight of the suspended current cable 47, a plurality of spring-actuated pawls 57 are provided to engage the shoulders 58 formed on the head member 52 of the protecting sheath. The ends of the pawl members 57 are chamfered in order to receive the lower end of the protecting sheath 53 as it is being lowered into an engaging position.

In order to provide for supplying power to a plurality of pump sets which may be connected in tandem relation, provision is made for extending the conductor cable 47 downwardly through the pump and the motor of the upper pump sets by means of an intermediate cable section 59 which extends from the terminals of the motor downwardly, through the hollow motor shaft 15, intermediate drive shaft 17 and pump shaft 16, to the lower housing member 12 where it is connected, by means of another plug-and-socket device, to the next section of the current cable 47, which extends downwardly through a section of the tubing 13 to the next pump set.

In this embodiment of the invention, the intermediate section of current cable 59 comprises a plurality of conductors 61, connected to the terminal members 30, which are carried in an insulated metallic sleeve through the hollow motor and pump shafts. The insulated sleeve, in this instance, is of smaller diameter than the bore of the motor and pump shafts and, therefore, prevents contact between the cable and the rotating shafts.

The plug-and-socket device 62 in the lower

housing member 12 (Fig. 4) is of similar construction to the upper plug-and-socket device 48, having socket members 63 disposed to engage the plug members 64, as hereinbefore described. In this instance, the connecting device is provided with a protecting sheath 65 having a sealed head portion 66, the sleeve of which extends downwardly to a considerable distance below the joint and is disposed to function as a diving bell to prevent liquid from entering the socket. As shown, the weight of the second section of current cable is supported by means of a bracket 67 which is carried by the lower housing member 12. This construction supports the current cable from the top and, assists in relieving the weight which must be supported by the pawl members 57 in the next pump set below.

Referring to Figs. 5 and 6, it will be seen how the pump sets may be connected in tandem relation, at predetermined intervals, with the current cable extending from the surface downwardly through the connecting sections of pump tubing and the pump sets, as hereinbefore described.

It may be stated, in conclusion, that, while the illustrated example constitutes a practical embodiment of my invention, I do not wish to limit myself to the exact details herein illustrated, since modifications of the same may be made without departing from the spirit of the invention, as defined in the appended claims.

I claim as my invention:

1. In a submersible pump-set, in combination, a pump having a hollow shaft, a motor for operating the pump, an outer casing for enclosing the motor and pump, said motor being enclosed in a diving-bell casing disposed within the outer casing, a hollow drive shaft extending through the diving bell for connecting the motor to the hollow pump shaft, a delivery tube for supporting the pump set in an operating position, a power cable extending through the delivery tube for supplying power to the motor, a plug-and-socket device for connecting the power cable to the motor terminals, said power cable being further extended through the hollow drive shaft and the pump shaft, means provided in the lower end of the outer casing for supporting an extension of the power cable, and a second plug-and-socket device for connecting the supported cable section to the cable section extending through the hollow pump and motor shafts.

2. In a submersible pump-set, in combination, an outer casing, fluid-conducting tubing connected to the outer casing for supporting the pump-set, a motor axially supported in the casing, the motor having its upper end sealed and its conductor terminals extending therethrough, a power cable disposed to extend downwardly, through the pump tubing

for supplying current to the motor, a plug-and-socket device disposed within the outer casing for connecting the power cable and motor terminals, and means disposed to engage the lower end of the power cable to relieve the weight of the cable from the plug-and-socket device, said means being operable to release the cable in response to its upward movement.

In testimony whereof, I have hereunto subscribed my name this 23 day of Feb. 1929.

JOHN BRICKEN.