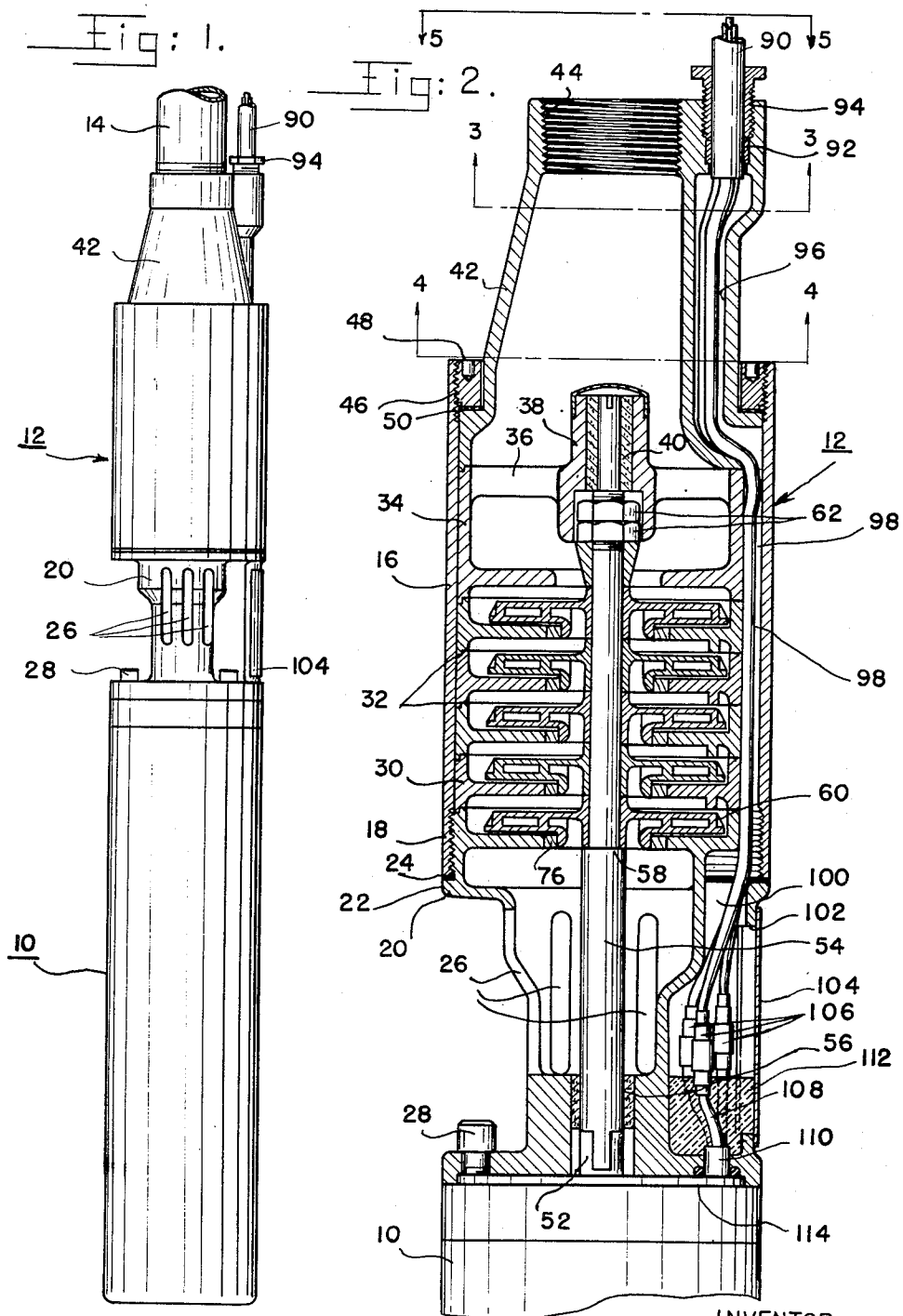


C. J. BERGH
SUBMERSIBLE PUMP

Filed Dec. 13, 1950

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Fig: 5.

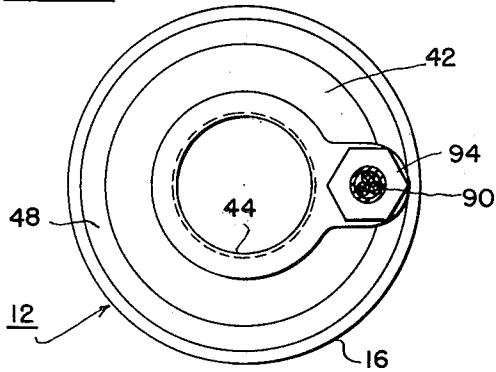


Fig: 4.

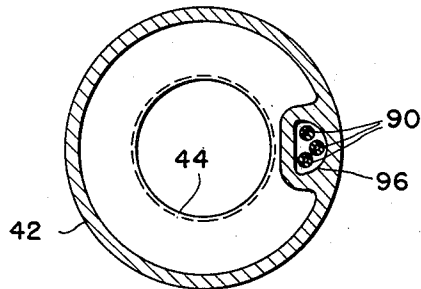


Fig: 3.

Fig: 6.

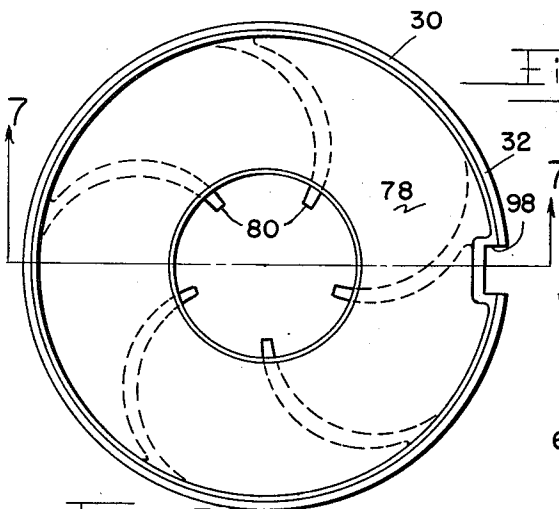


Fig: 8.

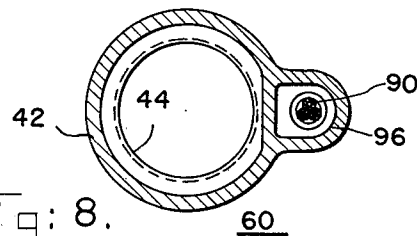


Fig: 7.

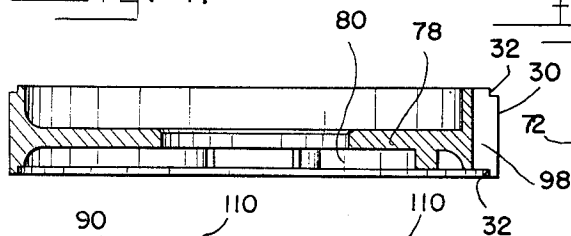


Fig: 9.

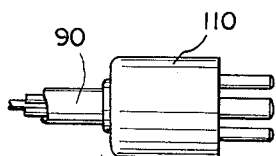
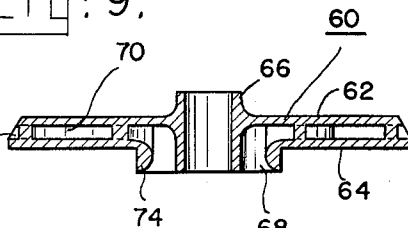


Fig: 10.

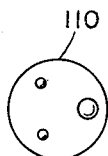


Fig: 11.

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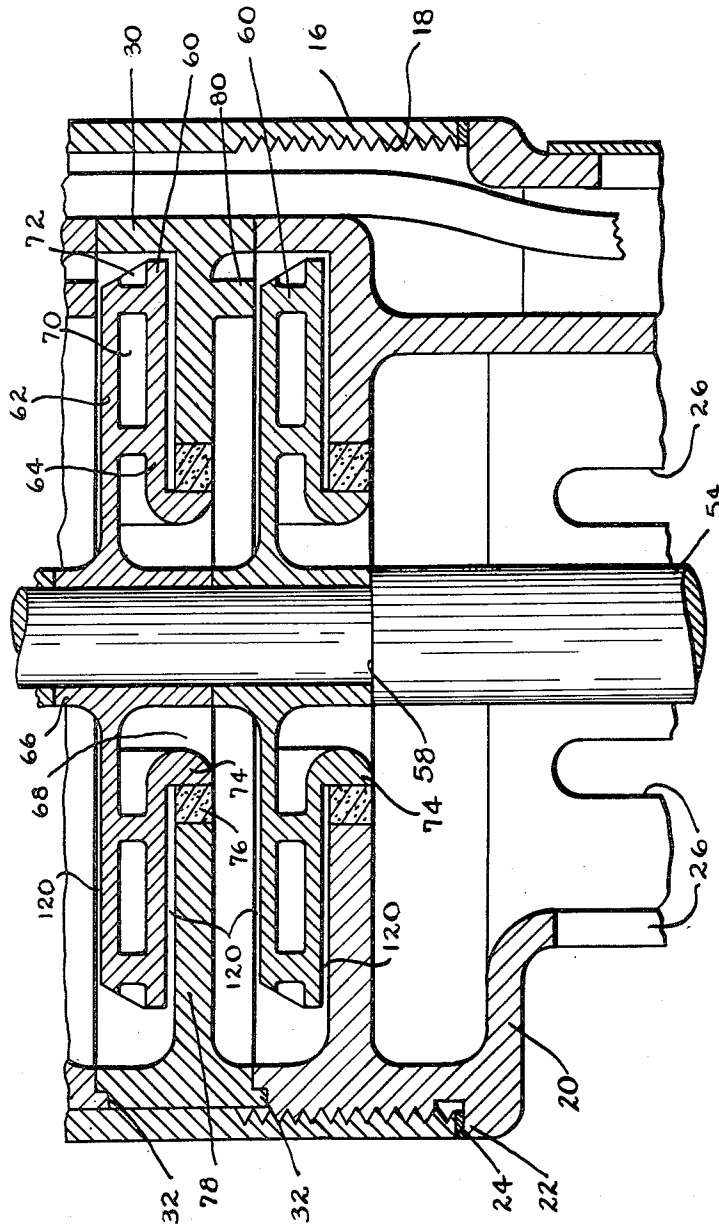
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FIG. 12



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SUBMERSIBLE PUMP

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Application December 13, 1950, Serial No. 200,645

1 Claim. (Cl. 103—102)

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This invention relates to submersible pumps, and particularly to multistage submersible pumps having an electric drive motor integrally mounted therewith.

Pumps of the type generally referred to above are known in the art, and one having the same general construction as the one with which this application is concerned is illustrated in my copending application, Serial No. 176,496, filed July 28, 1950, now Patent No. 2,648,286, of August 11, 1953.

Submersible pumps, as illustrated in the present application and the copending application referred to, are adapted for being inserted in a well casing or the like as a unit to be supported on the down pipe through which the fluid pump from the well is discharged. The pump unit is supported entirely on the down pipe and has no connection with the well casing.

In the pump construction illustrated in application Serial No. 176,496, I illustrated a multistage pump in which the housing of the pump and the various parts associated therewith, such as the end members for the housing, were integrally connected together as by soldering or brazing. This construction I found to be satisfactory when all the pump parts fall within predetermined close limits of size, and when it is unnecessary to service the pump. However, should the manufacturing tolerances on the various parts of the pump exceed predetermined limits, then that type of construction precludes the easy tearing down of the pump in order to replace or modify the defective parts.

Also, should it become necessary to service the pump due to wear or breakage of any of the parts, the integral connection between the pump casing proper and the end closures thereof makes it difficult to accomplish the dismantling of the pump with any ease, and usually it becomes necessary to provide new casing parts.

Inasmuch as the pump unit is supported on the down pipe in the well, the electric drive motor integral with the unit is on the lower end thereof, and difficulty has been encountered in making electrical connections to the motor in such a manner that the electric leads and the motor are at all times sealed against leakage and are so arranged that the cable leading to the motor or the motor itself can readily be independently replaced should it become necessary.

A pump and motor of the type referred to are positioned in a well generally completely below the surface of the liquid level in the well, and there is thus always a certain static pressure

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standing about the pump unit. This leads to certain complications in connection with the lubrication of the bearings supporting the rotating parts of the pump and motor.

With the motor, relatively simple and well-known practices can be followed in order to seal the bearings and maintain them lubricated, as, for example, by the use of ordinary shaft seals and permanently lubricated anti-friction bearings. In the case of the pump proper, however, the problem is somewhat more difficult because fluid flows directly through the pump and at an ever increasing pressure toward the discharge end of the pump, and satisfactory shaft seals and satisfactorily sealed bearings are not available for withstanding these pressures and the erosion of the moving fluid.

It has been attempted to provide pressure lubricating means for the bearings of the pump so that the pressure on the lubricant will counterbalance the water pressure pressing on the bearings from the outside. This scheme, however, is not satisfactory because not only does the pressure on the fluid in the pump vary between the inlet and outlet, but it will also vary from time to time due to changes in water level in the well, and it becomes virtually impossible to balance the lubricant pressure against the fluid pressure. Further, such pumps are often used where it is desired for the delivered water to be pure and no contamination by oil or grease can be tolerated.

Having the foregoing in mind, the principal object of the present invention is to provide a multistage submersible pump having an electric drive motor which overcomes the difficulties referred to above.

A particular object is the provision of a multistage pump which can readily be dismantled at any time for servicing.

Another particular object is the provision of an arrangement for supplying power to the electric drive motor for the pump which does not place any physical load on the lead-in cable and wherein the lead-in cable can readily be replaced at any time.

A further object is a provision of a lead-in arrangement for supplying power to the electric drive motor for the pump and in which there is no leakage of fluid about the cable at any point.

It is also an object to provide an improved journaling arrangement for the rotatable parts of the pump which eliminates the need for any special lubricating arrangements for the bearings.

A still further object is the provision of an

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arrangement whereby the pumped fluid in the pump serves to lubricate the pump impellers and to withstand end thrusts exerted on the impellers.

These and other objects and advantages will become more apparent upon reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a side elevational view of a pumping unit according to my invention;

Figure 2 is a vertical section through the pump proper drawn at a somewhat enlarged scale than is Figure 1;

Figure 3 is a transverse section indicated by line 3—3 on Figure 2;

Figure 4 is a transverse section indicated by line 4—4 on Figure 2;

Figure 5 is a plan view which may be indicated by line 5—5 on Figure 2;

Figure 6 is a view looking down on top of an impeller housing;

Figure 7 is a vertical section taken through the impeller housing and is indicated by line 7—7 on Figure 6;

Figure 8 is a view looking down on top of one of the impellers of the pump;

Figure 9 is a vertical section taken through the impeller and is indicated by line 9—9 on Figure 8;

Figure 10 is a side elevational view of a plug arrangement for making electrical connections with the drive motor of the unit;

Figure 11 is an end view of the plug looking in from the right side of Figure 10; and

Figure 12 is an enlarged sectional view taken through the pump showing the physical relationship of the impellers and impeller housings.

Referring to the drawings somewhat more in detail, Figure 1 shows an elevational view of a pumping unit constructed according to my invention. This pumping unit comprises an elongated electric drive motor 10 at the lower end, the pumping unit proper indicated at 12, and a down pipe 14 which is threaded into the upper end of the pump and supports the entire pumping unit inside the well.

The construction of the pump will become evident on reference to the enlarged sectional view Figure 2. In Figure 2 it will be noted that the pump comprises an outer cylindrical housing member or casing member 16 which is internally threaded at its lower end, as at 18, to receive the threaded part of the suction section 20 of the pump. The suction section 20 has an annular flange 22, and a gasket 24 provides a seal between the end of casing member 16 and flange 22 preventing any leakage into or out of the pump casing.

The suction section 20 is provided with openings 26 through which the fluid to be pumped enters the casing. The lower end of suction section 20 is provided with flange means through which the bolts or cap screws 28 pass to engage the frame of the motor 10 for retaining it in assembled relation with the pump.

Within casing member 16 are stacked a plurality of annular members 30 which are referred to as impeller housings. These annular members have an axially extending peripheral portion for engagement with the corresponding portion of the next housing member, and these portions are shouldered top and bottom, as at 32, to provide for accurate axial alignment of the several parts within the casing of the pump.

Resting on the uppermost of the impeller

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housings 30 is an upper bearing section member 34 which has radial rib parts 36 that support the central hub part 38 adapted for receiving the sleeve bearing 40.

On top of upper bearing section 34 is a discharge section 42. Discharge member 43 has its upper end internally threaded, as at 44, for receiving the down pipe 14 by which the entire pumping unit is suspended in the well and through which pipe the entire discharge of the pump is conducted to its place of use.

The casing member 16 extends beyond the outwardly flanged lower end of discharge section 42 and is internally threaded, as at 45, for receiving the externally threaded annular clamping ring 48. A gasket 50 seals between the ring and the discharge section, and together with gasket 24, provides complete sealing means for the pump casing, so that when it is assembled it is as fluid tight as if the parts were brazed or soldered together. At the same time, the threaded end parts of the casing member provide means whereby the pump can readily be dismantled at any time for servicing.

The output shaft of drive motor 10 is indicated at 52, and it has a tongue and slot arrangement with pump shaft 54 that has its lower end journaled in bearing 56 and suction section 20 and its upper end journaled in bearing 40. Shaft 54 is shouldered at 58 and has mounted thereon above the shoulder a plurality of impellers 60 that are clamped together in rigid relation with the shaft by clamping nuts 62 adjacent the upper end of the shaft.

Each impeller is constructed in a substantially conventional manner, as indicated in Figures 8 and 9, and comprises a back plate 62, a front plate 64, a hub 66, an annular inlet opening 68, and the vanes 70 that direct the fluid from the peripheral openings 72. Each annular inlet opening 68 of the impellers is formed by a cylindrical projection 74, and which projection is journaled relative to the central aperture of the adjacent impeller housing member 36 by a bearing 76.

Turning for the moment to the impeller housing, a typical one of these is illustrated in Figures 6 and 7, wherein the housing will be seen to comprise a flat disk part 78 having the collector vanes 80 dependent therefrom that receive the fluid discharge from the periphery of the impeller beneath the housing and direct it inwardly to the central aperture of the said housing into which extends the annular flange 74 of the impeller immediately above. The collector vanes 80 in this manner serve to minimize turbulence within the pump and also serve to convert a substantial amount of the velocity head of the fluid being pumped into pressure head at the inlet of the next following impeller.

In order to eliminate the need for lubricating the several bearings referred to at 40, 56, and 76, it is preferred to form these bearings of graphite, or of some composition bearing sufficient graphite to provide lubrication for the pump shaft and the impellers. Such a material has long life, and is not subject to corrosion by the fluid being pumped.

The power supply to the electric drive motor 10 is brought through by an electric cable which usually extends into the well beside the down pipe. This cable is so arranged that it assumes no physical load, but merely hangs loosely within the well casing. As illustrated, electric cable 90 is composed of whatever number of wires are

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required, in this case three, which are placed within a waterproof and preferably semi-rigid conduit. This conduit is received in a bearing in discharge section 42 to one side of the threaded bore which receives the end of down pipe 14, and there is a resilient rubber sleeve 92 in the bore that surrounds the end of the conduit.

A gland 94 is threaded into the said bore and serves to compress the rubber-like sleeve so that it is pressed around the conduit and provides a water-tight seal. I have found a number of water resistant synthetic rubbers to be suitable for this purpose, and that a resilience of thirty to forty durometer gives the sleeve the desired characteristics when it is deformed by tightening of the gland.

The said bore opens into a cavity 96 in the discharge section 42 that communicates with the grooves or notches 98 that are formed in the upper bearing member 34, and in the impeller housing members 30. These notches are lined up vertically when the pump is assembled and form a closed channel through which the lead-in wires extend.

This channel is so formed in its lower end to communicate with a cavity 100 in suction section 20, and which cavity has an aperture 102 adapted for being closed by cover plate 104. Within the cavity the wires terminate, and the separable connectors 106 which have parts connected to relatively short leads 108 that lead to a plug 110 that extends through the lower surface of the suction section 20 for connection with the leads of the motor 10.

To provide a good seal to make a permanent installation of leads 108, they preferably have formed therearound a mastic or wax or other suitable waterproof sealing substance, as indicated at 112. Also, the plug 110 is surrounded by the rubber-like O-ring 114 so that there is a seal between the motor and the suction section 20 about the said plug.

A typical plug of this nature is illustrated in Figures 10 and 11, wherein it will be seen to be a substantially conventional male electric fitting which will connect with a corresponding female fitting mounted in the motor 10. The arrangement is such that the cable can be replaced at any time merely by opening the separable connectors 106 having suitable connectors, or the motor can be removed for replacement or repair without interfering with the cable. This serviceability of the electric components of the pumping unit, together with the bearings described which do not require lubrication, and the separable casing parts for the pump proper make the entire unit quite easy to maintain in good working order without the necessity of having to cut the casing of the cable to effect repairs.

It will be observed that as many pumping stages as desired could be built into the pump merely by lengthening the casing 16 and the shaft 54 of the pump and adding the required number of impellers and impeller housings. Since the back or top of each impeller forms the bottom of the passage leading to the next impeller above, any ordinary number of stages in the pump will still produce a relatively compact unit.

A still further feature of my invention is the manner in which the fluid being pumped is utilized for lubricating the impellers and for assisting in withstanding the end thrusts exerted thereon. This feature is brought out in Figure 12 which is an enlarged view showing two of the pump impellers and the impeller housing adjacent thereto.

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In this view it will be noted that there is a space, as at 120, between each face of each impeller and the adjacent face of the impeller housing. The space 120 above each impeller is the space between the back face of the impeller and the lowermost surface of the guide vanes independent of the impeller housing next above the said impeller. The space 120 beneath each impeller is substantially continuous from about the cylindrical projection 74 of the said impeller to its periphery.

It will be noted that the front face of each impeller and the upper surface of the impeller housing directly therebeneath are parallel. The described arrangement is availed of to provide lubrication for both faces of the impeller by adjusting the axial dimension of the space so that a capillary action takes place and causes fluid being pumped by the impeller to form a film on each side of the impeller.

It will be noted that the film standing across the lower face of the impeller is quite effective for lubrication purposes and also serves to assist in cushioning the impeller assembly against end thrusts. These end thrusts will, of course, be exerted generally downwardly and the cushioning film which I provide by this capillary action greatly assists in giving the pumping unit long life and quiet and efficient operation.

The sustaining of the axial thrusts on the impeller assembly by the capillary film referred to, together with the sustaining of radial thrusts on the impeller assembly by the bearing rings 76 serves to maintain the unit in efficient and balanced operation for a long period of time with a minimum amount of service.

The actual dimensions of the space 120 may vary considerably with the referred to action being obtained, but I have found that a dimension of about one thirty-second of an inch is most practical because it can be obtained quite readily by forming the impellers and impeller housing to ordinary manufacturing tolerances and is ample for providing a substantial film between the impellers and impeller housing, without at the same time representing any substantial amount of lost space within the pumping unit.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claim.

I claim:

In a submersible pump of the type described: a cylindrical casing, a discharge section in the upper end of said casing and a suction section in the lower end of said casing, a plurality of pumping units in stacked relation in said casing between said sections, each said unit comprising a centrifugal impeller having an inlet opening in its lower wall and a circular flange projecting downwardly about said opening and an impeller housing comprising a single disk-like wall having a central aperture for receiving said projecting flange, and having a peripheral rib upstanding about the periphery of said impeller, a bearing ring between said flange and the wall of said aperture to journal said flange therein and to sustain radial thrusts on said impeller, each impeller housing having arcuate vanes depending from its underneath surface and forming channel means with the back of the impeller next beneath for directing the fluid being

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pumped into the inlet of the associated impeller, the lower face of said impeller being parallel to and closely spaced from the upper face of the impeller housing next beneath, whereby a film of the pumped liquid is maintained therebetween by capillary action for cushioning and lubricating purposes, the upper face of said impeller being closely spaced from the lowermost surfaces of said vanes whereby a film of the pumped fluid is maintained therebetween by capillary action for purposes of lubrication.

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