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Carle et al.

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[54] **RECIRCULATING GAS SEPARATION MEANS FOR SUBMERSIBLE OIL WELL PUMPS**

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[52] **U.S. Cl.** **415/53,** 415/168, 415/501

[51] **Int. Cl.** **F04d 29/70,** F04d 29/00

[58] **Field of Search** 415/53, 56, 168, 501; 55/182, 189, 199, 203, 207, 406, 407, 408; 233/13

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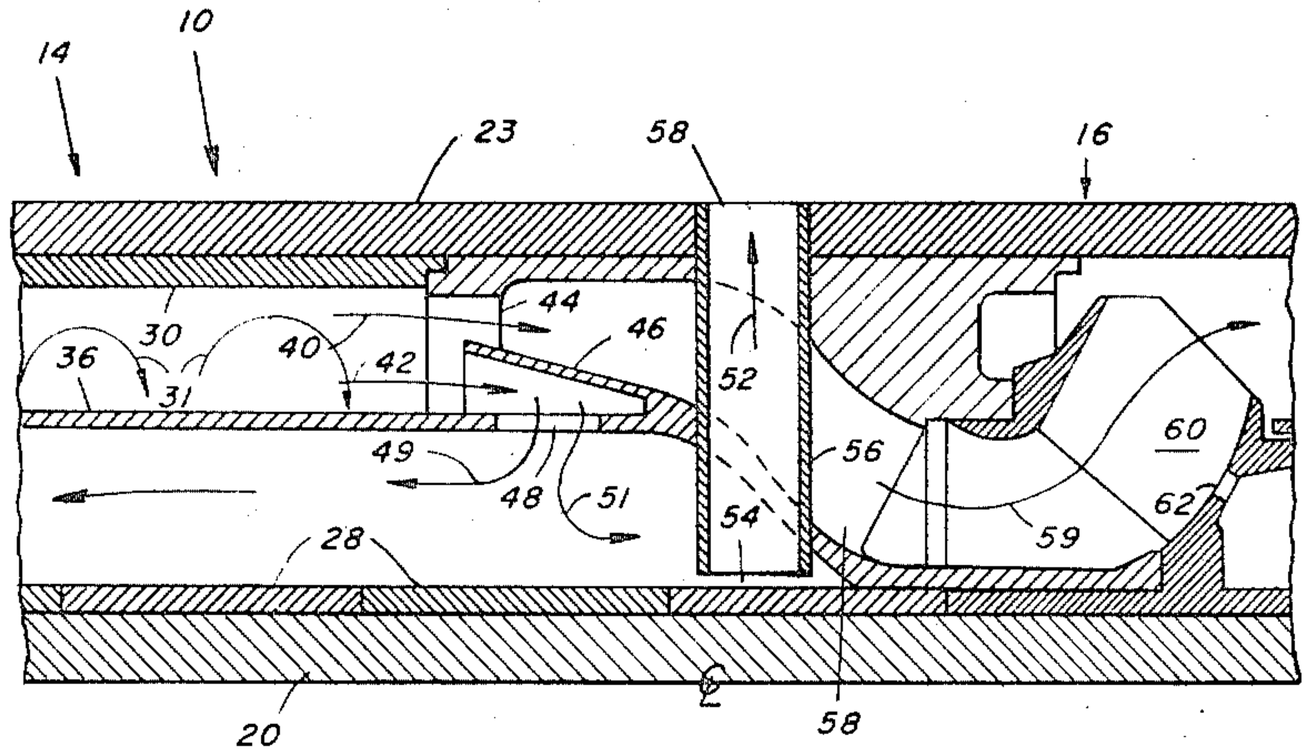
[57] **ABSTRACT**

This abstract describes an improvement in down hole submersible oil pumps for pumping oil and gas mixtures, which includes a section in which the well fluid is given a helical motion within a first outer annular separation chamber, such that there is a physical separation between liquid on the outside and gas on the inside. The liquid passes onto a succeeding stage of impeller, while the gas and some liquid is returned to the first impeller stage through a second inner annular recycle chamber. The gas is vented from the inner chamber to the outside of the pump housing, while the liquid portion is recirculated through the first impeller.

4 Claims, 3 Drawing Figures



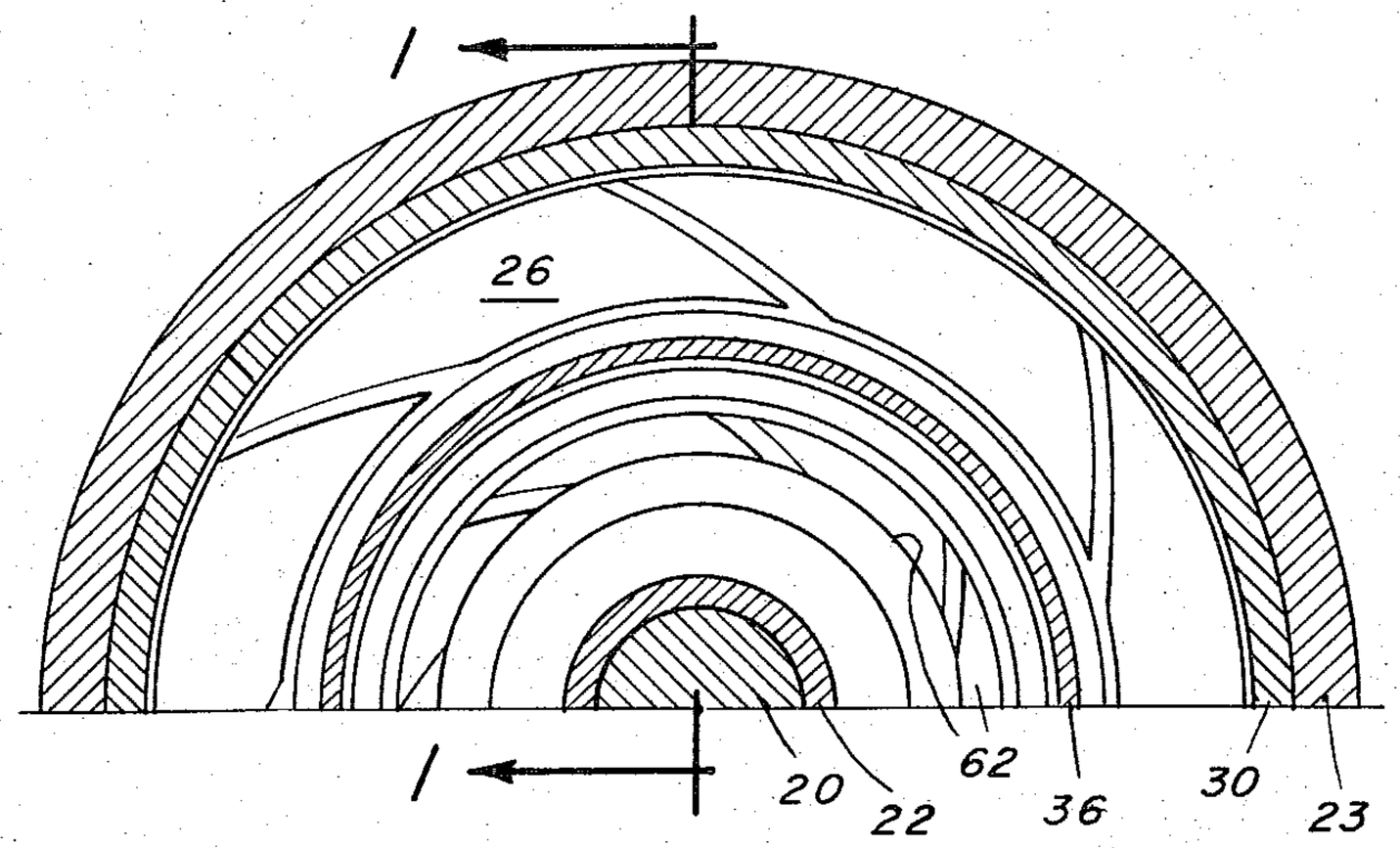


FIG. 2

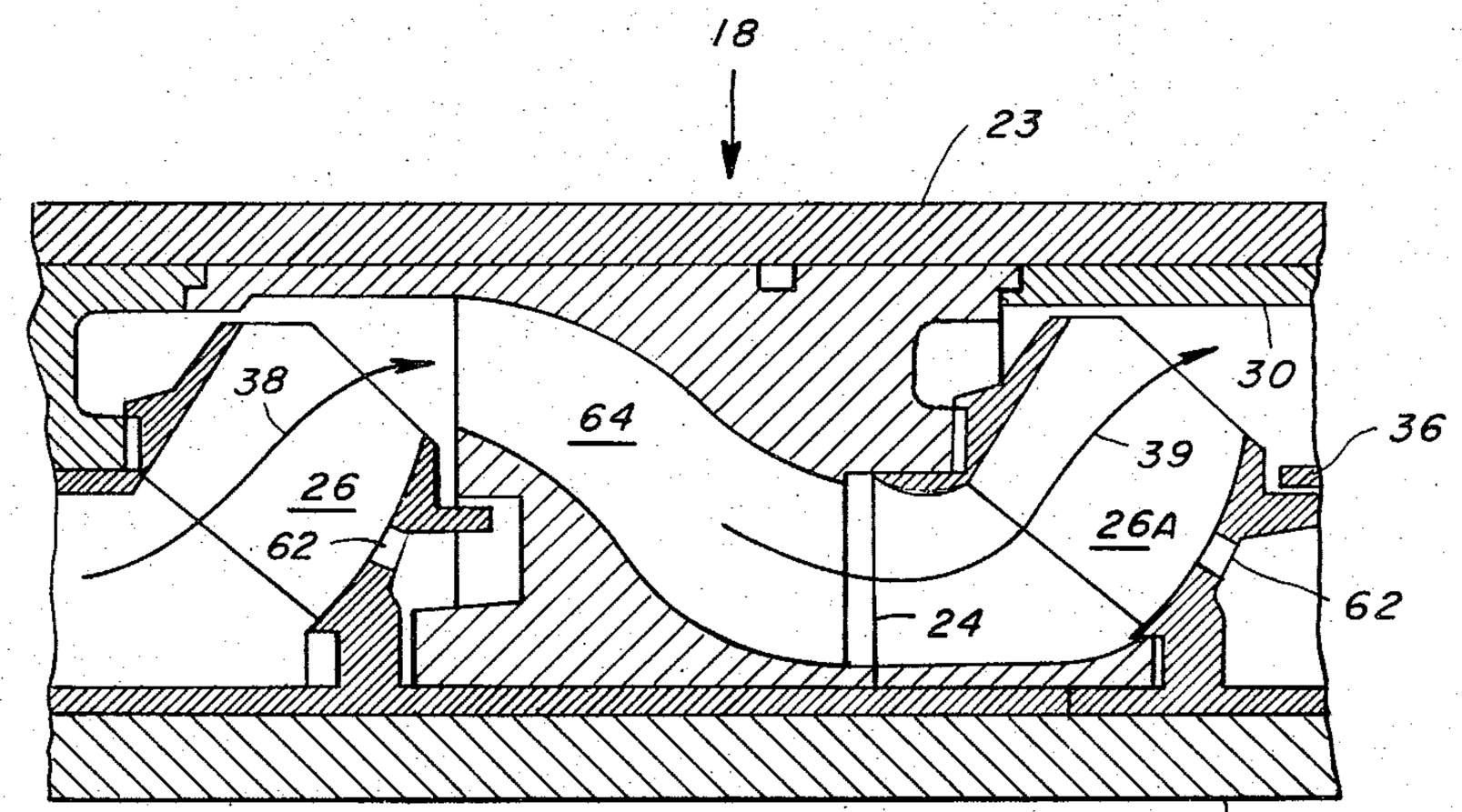


FIG. 3

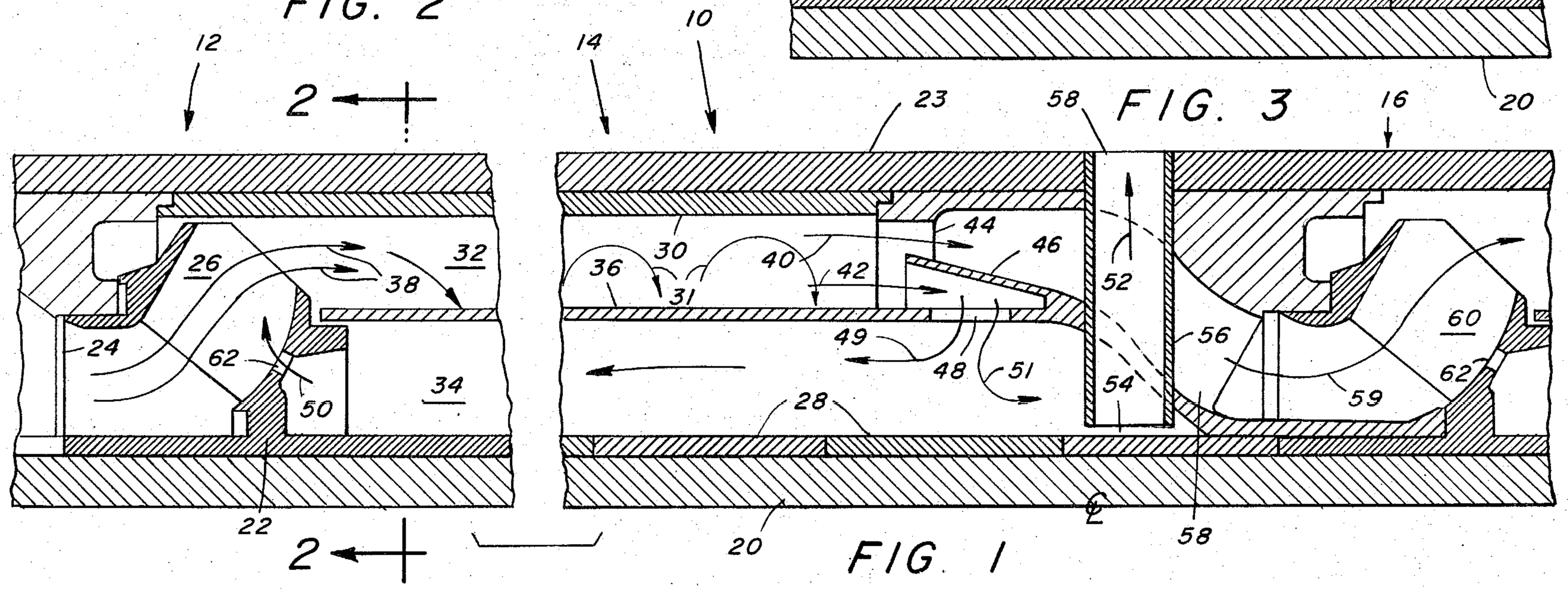


FIG. 1

RECIRCULATING GAS SEPARATION MEANS FOR SUBMERSIBLE OIL WELL PUMPS

BACKGROUND OF THE INVENTION

This invention relates to down hole submersible pumps. More particularly, it is related to apparatus for separating gas from liquids in submersible pumps. Still more particularly, it is related to a recirculating gas separator useful therein.

In oil and gas well operation it is common practice to utilize a submersible pump having coupled to it an electric driving motor. In such wells in which the submersible pump is to be installed, free and/or entrained gas is often produced along with the liquid being pumped. If this gas enters the submersible pump the volumetric and mechanical efficiency of the pump is reduced, and in some instances, produces a gas lock of the pump.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a submersible pump which includes as one portion at the lower end of the pumping system, a recycling portion wherein the liquid and gas are separated, the gas is vented through the wall of the pump into the well annulus and the oil is passed onto succeeding pump stages.

The improved well pump of this invention comprises a first impeller stage having a plurality of openings in the wall of shrouds of the impeller. The outupt of the first impeller stages goes into an outer annular separating chamber adjacent the outer wall of the pump, where the well fluid is given a helica motion either by the rotary motion of the impeller or by fixed means in said chamber. This helical motion causes a physical separation of the liquid and the gas, the liquid being thrown outwardly toward the outer wall of the separating chamber, and the gas being forced toward the inner wall of the chamber. There is a coaxial conical wall which tends to separate the liquid from the gas, the liquid moving outwardly and upwardly into the next impeller stage, while the gas, and some liquid is passed through openings in the inner wall of the chamber to a second inner annular recycle space adjacent the shaft of the pump. Here again, there is further separation of the liquid and gas, with the gas being vented directly, radially outwardly to the well annulus, between the pump and the well casing. The liquid is returned to the openings in the first impeller stage, and is recycled back into the flow of fluid through the first impeller stage into the first separating chamber, and so on. Additional stages of separation of this type can be carried out or the liquid effluent from this first recycling stage can be passed onward to additional pump impellers.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of this invention and a better understanding of the principles and details of the invention will be evident from the following description taken in conjunction with the appended drawings in which:

FIG. 1 is a drawing, in partial section, of the lower end of a submersible well fluid system, which illustrates the recycling gas separator system.

FIG. 2 is a transverse cross section of FIG. 1 taken along the plane 2—2.

FIG. 3 is a view showing multiple stages of impeller which can be provided below the gas separating portion and/or above it.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, numeral 10 indicates generally the recycling gas separator of this invention. It comprises a pump impeller section 12 and a recycling gas separator section 14. Pumping section 16 may either be the actual multiple stage pump to carry the liquid to the surface or may be a second stage recycling gas separator identical to that shown. The drawing of FIG. 1 shows only one-half of the cross section of the pump, the center line being indicated as the axis of the pump.

There is a shaft 20 which supports and carries with it a plurality of impellers. The first impeller section indicated in general by the numeral 12 comprises an impeller 26 mounted by tube 22 onto the shaft 20. The impeller 26 has an outwardly and upwardly inclined series of passageways which lead into an annular space 32 between a tubular shell 30 on the outside, adjacent the outer wall 23 of the pump, and an inner cylindrical wall 36. As a result of rotation of the shaft 20 and the impeller 26, there is liquid flow through the impeller as shown by arrows 38. The fluid passing through the impeller 26 is given a spinning, or helical motion as shown by arrows 31, within the outer separation chamber 32. Thus, as the fluid moves upwardly, (that is toward the right in FIG. 1) there is a separation of gas and liquid flowing in this helical motion. The liquid tends to flow toward the outer wall 30 of this chamber 32, and following arrow 40 will pass into a chamber or diffuser 44 which will then lead into and through a second stage of impeller 60 in accordance with arrow 59. In the chamber 32 there will be a tendency for gas to move inwardly toward the wall 36, and as there is progression toward the right, the fluid mixture which is mostly gas with some liquid as indicated by arrow 42 will be scooped by the conical wall 46 and forced to flow through one or more openings 48 radially inwardly into the inner annular space 34. Here, the liquid will flow in accordance with arrow 49 to the left and in accordance with arrow 50 through the plurality of openings 62 in the side wall of the first impeller stage 26. The gas portion of the fluid flowing in accordance with arrow 42 passes through the opening 48 and in accordance with arrow 51 passes through the gap 54 and into the tube 56 where it will be vented in accordance with arrow 52 through the opening 58 to the exterior of the pump wall 23 and into the well basin. There the gas can flow upwardly through the liquid in the well basin, up to the surface, and be vented at the surface of the well.

Part of the liquid being pumped by the first stage impeller 26 goes directly in accordance with arrow 40 into the following impeller stages and part of it is recycled in accordance with arrow 42 back through the pump following arrows 49 and 50, and into the first impeller stage through the recycle openings 62. This recycling can take place continuously and so long as liquid flows back through the openings 48 the gas portion will be vented, or at least a part of the gas will be vented. In this way the liquid which passes upward into the second stage impeller 60 in accordance with arrow 59 will then go up through successive pump stages and be pumped to the surface of the well.

FIG. 2 is a cross section of the drawing of FIG. 1 taken along the plane 2—2. It shows more clearly the shape of the openings 62 in the impeller. These are bands of considerable circumferential extent but narrow in radial dimension.

FIG. 3 illustrates a variation of the apparatus of FIG. 1 wherein there are two serial stages of impeller which may be the input to the recycling gas separator system. In this case the first stage impeller 26 has the inlet fluid 38 which follows through a series of passageways 64 back into the inlet 24 of a second stage 26A, the flow being shown by arrow 39.

To the extent that there is recycling of fluid back through the pump impeller there will be some loss of pumping efficiency in the first stage. However, there is gained, at the expense of this reduced efficiency in the first stage, essentially gas-free oil flowing through the plural pumping stage. Thus, the pumping efficiency of the pumping stages is greatly increased over what it would be without the gas separator.

It will be clear that the gas separator section of this invention can be used alone, or there can be a plurality of tandem sections or a plurality of sections with each succeeding stage of less gas separation capacity. The primary outlet of the separator section typically supplies the inlet of a multiple stage liquid pump as is well known in the art. Although a centrifugal type of pump is generally taught herein it is to be understood that the pump 12 (FIG. 1) can be an axial flow impeller pump or a mixed (axial and centrifugal) type pump.

While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction and the arrangement of components. It is understood that the invention is not to be limited to the specific embodiments set forth herein by way of exemplifying the invention, but the invention is to be limited only be the scope of the attached claim or claims, including the full range of equivalency to which each element or step thereof is entitled.

What is claimed:

1. In an electric motor-driven rotary submersible well fluid pump, said pump having an impeller, said impeller having one or more shrouded fluid passageways, each passageway having an inlet and outlet, the improvement in means to separate gas from said fluid to be pumped, comprising:

a. essentially co-axial annular separation chamber and recycle chamber formed above and within the diametrical dimensions of said pump, said recycle chambers being inside said separation chamber;

b. said impeller having at least one opening in at least one wall thereof which opening provides communication between said passageway and the lower end of said annular recycle chamber;

c. means to direct fluid from the outlet of said impeller passageways into the lower end of said annular separation chamber;

d. means at the upper end of said separation chamber to by-pass a first part of said fluid from said annular separation chamber into the upper end of said recycle chamber, the remaining second part of said fluid being produced from said pump and said well;

e. gas relief means communicating the upper part of said recycle chamber to the well space of the well in which said pump is installed; and

f. whereby said by-passed fluids in said lower end of said recycle chamber are directed into said impeller opening.

2. The pump as in claim 1 in which said means to by-pass a part of said fluids comprises a conical shell open at its base to allow flow of said bypassed fluids into said chamber.

3. The pump as in claim 1 including means to impart a helical motion to the fluid in said outer annular separation chamber.

4. The pump as in claim 1 including means to direct the said remaining second part of said fluid to a second improved means to separate gas therefrom comprising:

a second centrifugal impeller stage rotary driven by said electric motor, said impeller having at least one opening in at least one wall thereof, which opening communicates with the lower end of a second annular recycle chamber;

the fluid output of said impeller stage directed into the lowerend of a second annular separation chamber;

means at the upper end of said separation chamber to bypass a third part of said fluid from said annular separation chamber into the upper end of said recycle chamber, with the remaining fourth part of said fluid being produced from said well; and

gas relief means communicating the upper part of said second recycle chamber to the well space of the well in which said pump is installed.

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