Jan. 29, 1957 K. R. LUNG 2,779,293

METHOD AND APPARATUS FOR PUMPING

Filed Dec. 9, 1953 2 Sheets-Sheet 1

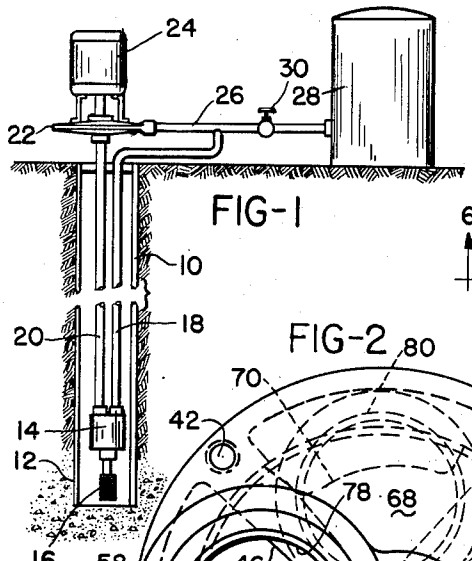


FIG-1

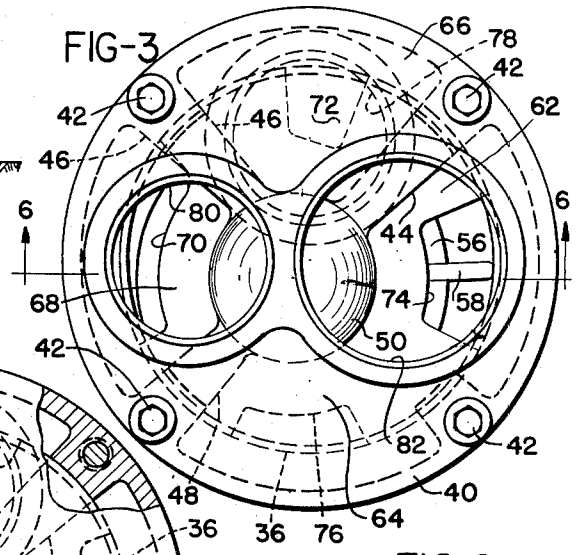


FIG-3

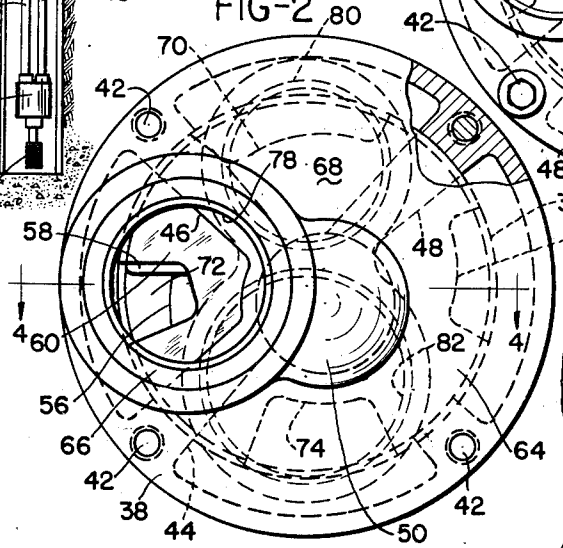


FIG-2

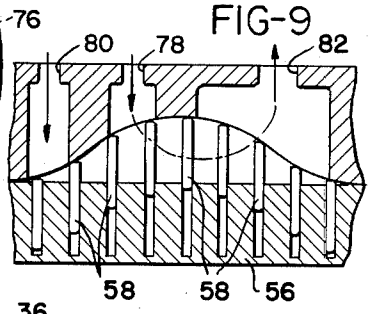


FIG-9

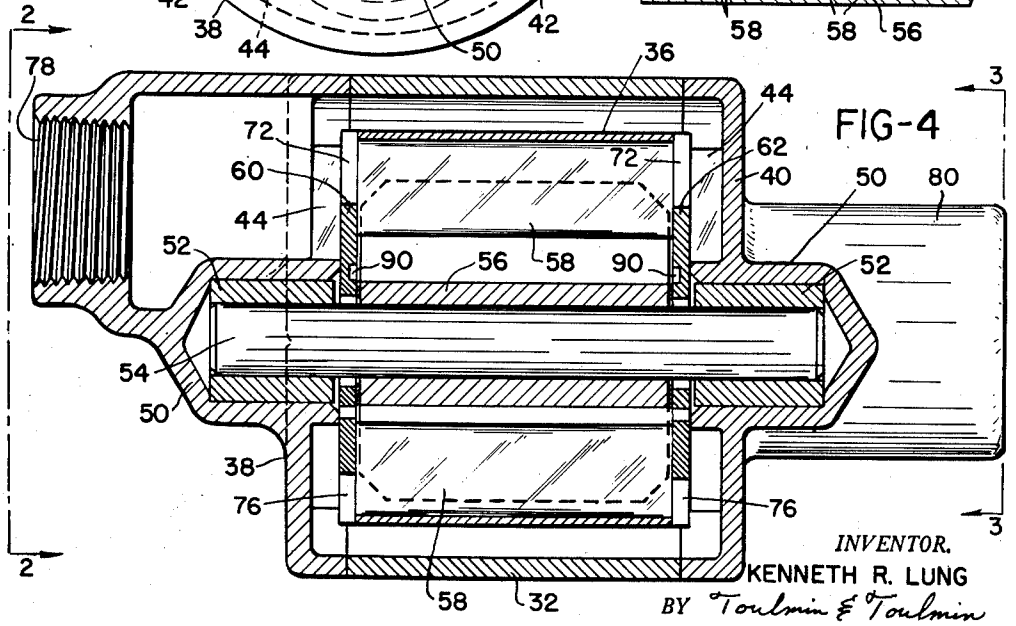


FIG-4

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FIG-5

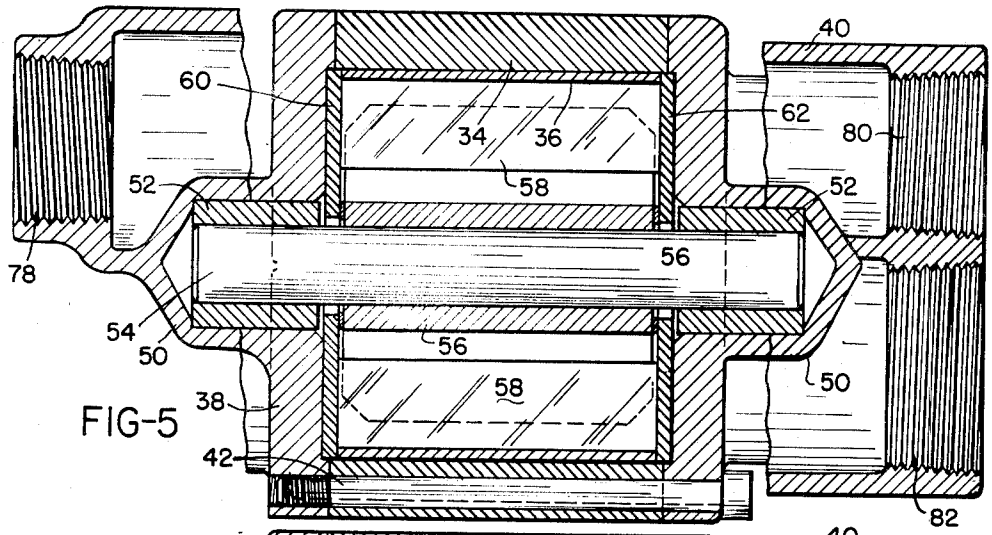


FIG-6

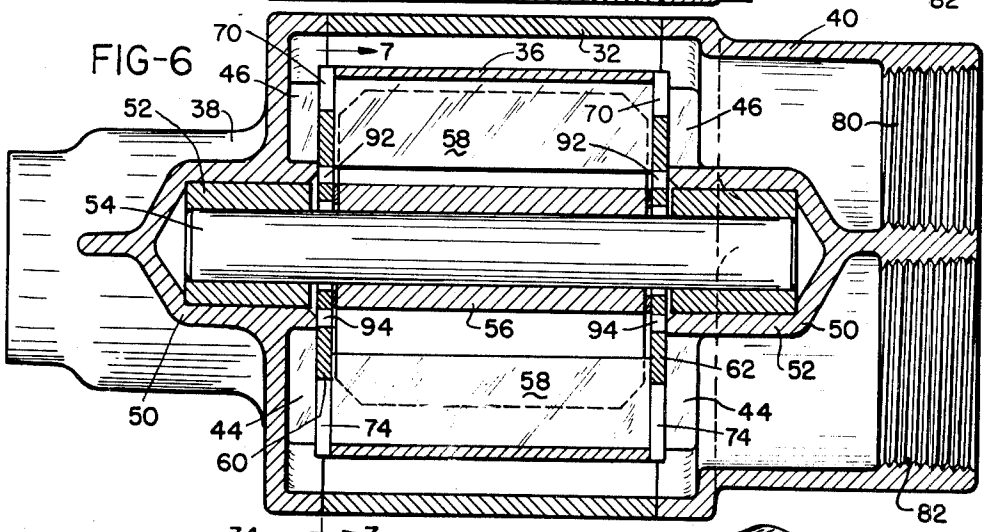


FIG-7

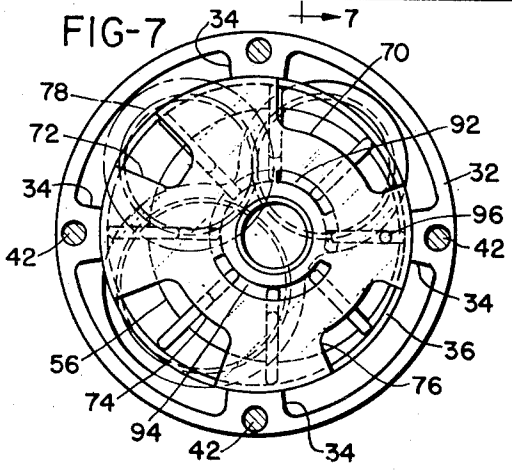
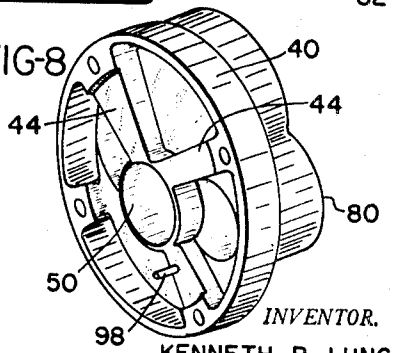


FIG-8



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2,779,293

METHOD AND APPARATUS FOR PUMPING

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Application December 9, 1953, Serial No. 397,220

10 Claims. (Cl. 103—118)

This invention relates to a method and apparatus for pumping, and particularly to a novel combination pump-motor and a method of utilizing the pump-motor for pumping liquids, particularly for pumping wells.

The usual pumping arrangement for pumping a deep well consists of a jet pump located within the well, the jet pump preferably being submerged in the water in the well, with the jet pump discharging into a conduit leading to the suction side of a pump located above the ground, usually a centrifugal pump, and with a portion of the discharge of the centrifugal pump being utilized for supplying the nozzle of the jet pump.

According to the present invention, the necessity for providing a jet pump in combination with a pump above the ground in connection with the pumping of deep wells is eliminated. According to this invention, there is provided, instead, a combination pump-motor, which is energized by pressure fluid from the discharge side of the pump above the ground, and which discharges this same fluid together with additional fluid drawn from the well to the inlet side of the pump above the ground.

The construction of the pump-motor according to this invention, and the operation thereof, are simple, and a distinct advantage exists in that no adjustment thereof is required to accommodate the pumping combination to varying water levels in a well, because the combination pump-motor is self-adjusting and accommodates itself to any water level.

This invention and the advantages thereof will become more apparent upon reference to the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view showing a well pumping installation arranged according to my invention;

Figure 2 is a view showing the combination pump-motor which is located in the well casing of Figure 1 looking up from the bottom thereof as indicated by the line 2—2 of Fig. 4;

Figure 3 is a view like Figure 2 except looking down on top of the pump-motor as indicated by the line 3—3 of Fig. 4;

Figure 4 is a sectional view, indicated by line 4—4 on Figure 2;

Figure 5 is a composite longitudinal section taken through the pump showing all of the ports therein;

Figure 6 is a sectional view, indicated by line 6—6 on Figure 3;

Figure 7 is a sectional view, indicated by line 7—7 on Figure 6, showing a port plate located inside the end cover of the pump-motor combination;

Figure 8 is a perspective view showing the inside of one of the end covers; and

Figure 9 is a diagrammatic sectional view which illustrates the manner in which the device operates.

Referring to the drawings somewhat more in detail, there is shown in Figure 1 a pumping installation comprising a well casing 10 extending downwardly into water-bearing strata at 12. Located in the casing near the bottom thereof is a unit 14 according to this invention, and which is a combination pump-motor having a suction inlet communicating with the water in the well via the screen 16 and a pressure inlet to which fluid under pressure is supplied through a conduit 18, and also having a discharge opening through which the fluid supplied through conduit 18 and the fluid drawn in through the suction inlet is discharged into a conduit 20.

Conduit 20 leads upwardly to outside the well casing and is connected with the inlet side of a pump 22 which may be a centrifugal pump having a drive motor 24. The discharge side of pump 22 is connected by a conduit 26 to a storage tank 28. Conduit 26 advantageously includes a pressure regulating valve mechanism 30 which may be automatic in nature, or which may comprise merely a fixed restrictor, whereby a predetermined minimum pressure is maintained at the discharge side of pump 22 when it is operating, and which pressure is availed of for driving fluid through conduit 18 which is connected with conduit 26 on the upstream side of valve 30.

The unit 14, as will be seen in Figures 3 through 8, comprises a body 32 having spaced inwardly extending ribs 34 which closely embrace a cylindrical sleeve 36 extending substantially the length of the body. The opposite ends of body 32 are closed by the end covers 38 at the bottom of unit 14 and 40 at the top thereof, with through bolts 42 extending through bores in the ribs 34 interconnecting the covers and holding them in position.

Each of the covers 38 and 40 comprises three circumferentially space internal rib portions 44, 46, and 48, that extend inwardly and connect with a hub portion 50. Each hub portion 50 has mounted therein a sleeve bearing 52 that receives the ends of the shaft 54. As will be seen in Figs. 2 and 3, the shaft 54 is supported eccentrically of the cylinder sleeve 36. Shaft 54 internally of the cylinder sleeve supports a slotted rotor 56 having vanes 58 in the slots thereof that bear on the inner surface of cylinder sleeve 36.

Disposed between the opposite ends of rotor 56 and the inner surfaces of ribs 44, 46, and 48 of the covers 38 and 40 are the port plates 60 inside cover 38 and 62 inside cover 40. Each of the port plates also engages the opposite ends of cylinder sleeve 36. At this point, it will be apparent that the described arrangement is that of a vane type pump or motor in which chambers are defined between the rotor and cylinder sleeve by the vanes, and which chambers expand during 180° of rotation of the rotor and contract during the other 180° of movement.

It will also be evident that the inside of each cover outside of the port plate 60 and 62 is divided into three compartments by the ribs 44, 46 and 48. These ribs are so located that the large compartment between the ribs 44 and 48, indicated at 64, and which extends over about 180°, is located over the zone where the chambers between the vanes of the unit are contracting. The compartment formed between the ribs 44 and 46, indicated at 66, is located over the zone where the said chambers between the vanes are commencing to expand, while the chamber located between the ribs 46 and 48, indicated at 68, is located over that zone where the said chambers complete their expanding movement.

As will readily be perceived from Figures 2 through 7, the spaces inside the body 32 between the said ribs 34 thereof provide means for hydraulically connecting the pertaining chambers within the opposite end covers.

Each of the port plates 60 and 62 is provided with ports therein to permit communication of the compartments within the covers with the chambers about the rotor 56

formed between the vanes **58**. These ports are the same for both of the port plates, and those associated with port plate **60** are indicated in Figure 7. These ports take the form of notches in the periphery of the plate and consist of a first port notch **70** which communicates with compartments **68** in the end covers. The next port notch, proceeding counterclockwise about the port plate **60**, is identified at **72** and communicates with the compartments **66** in the end covers. The port plate comprises two further port notches **74** and **76** which communicate with compartments **64** of the end covers.

Referring now to Figures 2 through 6, it will be perceived that lower cover **38** is provided with a threaded port **78** communicating with compartment **66** to which is connected the suction pipe leading to strainer **16**. It will also be observed that top cover **40** has a first threaded port **80** which is connected with pressure conduit **18**, and which communicates with compartment **68**, and a second threaded port **82** to which is connected conduit **20**, and which port communicates with compartment **64**.

In operation, when pressure fluid is supplied through conduit **18** to the interconnected compartments **68** in the opposite end covers of the device, this pressure fluid will pass through the notches **70** into the chambers between the vanes of the rotor and drive the rotor in rotation, specifically, in a counterclockwise direction as it is viewed in Figure 7. As the rotor turns, the chambers referred to will expand, and when each chamber has turned to the point where it communicates with notch **72**, the said expansion of the chambers will create a suction which will be communicated through the notches **72** to the compartments **68** of the end covers, and therefrom through threaded port **78** to strainer **16**, and withdraw fluid from the well.

Further rotation of the rotor will bring the chambers past the center point, where they will commence to contract, and at which time they will communicate with the notches **74** and **76** that open into compartments **64** that are connected with port **82**, which leads to conduit **20**. Thus, all of the fluid supplied to the unit **14** through conduit **18**, and all of the fluid drawn into the unit through strainer **16**, is discharged into conduit **20** leading to the suction side of the pump **22** to be discharged therefrom at increased pressure into conduit **26**.

This cycle of operations of unit **14** will be apparent from the diagrammatic illustration of Figure 9. In order to keep the vanes **58** urged outwardly into sealing engagement with the cylinder sleeve **36**, the port plates **60** and **62** are provided on their inside faces with the annular notches **90** in the region of the bottoms of the vane slots, one extending over the zone where the pumping chambers are expanding, and the other over the zone where the said chambers are contracting. These notches, as will be seen in Figures 6 and 7, have openings therein, as at **92** and **94**. The opening **92** opens into compartment **68** so that pressure fluid in compartment **68** will stand in the notch associated with opening **92** and urge the vanes outwardly.

Similarly, the openings **94** communicate with the chambers **64**, thereby supplying pressure fluid to the bottoms of the vane slots during the time the chambers about the rotor are contracting, thus not only maintaining the vanes pressed outwardly against the cylinder ring **36**, but, likewise, relieving the vane slots of fluid therein as the vanes move inwardly in the slots.

Each port plate is preferably provided with a drilled hole, as indicated at **96**, for receiving a dowel pin **98** in the adjacent rib in the adjacent end cover, whereby once the unit is assembled, the port plates are held fixedly in position.

It will be apparent that while I have shown the chambers of the vaned unit as being connected with a source of pressure during the initial half of their expansion, and with the source of fluid to be pumped during the final half of their expansion, these proportions could be changed and pressure could be supplied during more or less than half the expansion, and the chambers utilized for pumping during the remainder of the expansion period. Also, the pressure could be supplied to the expanding chambers during the final portion of the expansion thereof, and the initial expansion of the chambers utilized for pumping, if desired.

Similarly, while the vaned unit of this invention is disclosed as an arrangement for pumping water wells, it could also be employed for pumping other fluids as well and would lend itself readily to various other usages, such as a proportioning mechanism wherein two fluids were to be mixed, and in which one fluid could form the motive power for driving the hydraulic unit and the other fluid to be admixed therewith would be drawn into the unit by suction and discharge from the unit together with the motive fluid.

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 claims.

I claim:

1. In a combination pump-motor unit, a cylinder, a rotor eccentrically mounted in said cylinder; vanes in said rotor dividing the space between it and said cylinder into a plurality of pumping chambers which expand during 180° of rotation of said rotor and contract during the other 180° of rotation of said rotor; a casing surrounding said cylinder; end covers on said casing and closing the end of said cylinder; partition means in said end covers dividing th space between each end cover into a first compartment communicating with said chambers during the initial expansion thereof, a second compartment communicating with said chambers during the remainder of the expansion thereof, and a third compartment communicating with said chambers during the contraction thereof; passage means in said unit connecting the first, second, and third compartments in one cover with the first, second, and third compartments, respectively, in the other cover; and port means in said covers communicating with said compartments.

2. In a combination pump-motor unit, a cylinder; a rotor eccentrically mounted within said cylinder; vanes in the rotor bearing on the cylinder and dividing the space between the rotor and the cylinder into a plurality of pumping chambers; a casing surrounding said cylinder; end covers secured to said casing; a shaft supporting said rotor and journaled in said end covers; port plates at the end of said cylinder immediately inside said covers; said port plates having first notch means communicating the said chambers during the initial expansion thereof, second notch means communicating with said chambers during the remainder of the expansion thereof, and third notch means communicating with said chambers during the contraction thereof; said end covers being provided with axially aligned paritions engaging said port plates between the said notch means and dividing each end cover into a first compartment communicating with said first notch means, a second compartment communicating with said second notch means, and a third compartment communicating wtih said third notch means; ports in said end covers opening into said compartments; and passage means in said casing interconnecting the first, second, and third compartments of one cover with the first, second, and third compartments, respectively, of the other cover.

3. In a combination pump-motor unit, a cylinder; a rotor eccentrically mounted within said cylinder; vanes in the rotor bearing on the cylinder and dividing the space between the rotor and the cylinder into a plurality of pumping chambers; a casing surrounding said cylinder; end covers secured to said casing; a shaft supporting said rotor and journaled in said end covers; port plates at the end of said cylinder immediately inside said covers; said port plates having first notch means communicating the

said chambers during the initial expansion thereof, second notch means communicating with said chambers during the remainder of the expansion thereof, and third notch means communicating with said chambers during the contraction thereof; said end covers being provided with axially aligned partitions engaging said port plates between the said notch means and dividing each end cover into a first compartment communicating with said first notch means, a second compartment communicating with said second notch means, and a third compartment communicating with said third notch means; ports in said end covers opening into said compartments; passage means in said casing interconnecting the first, second, and third compartments of one cover with the first, second, and third compartments, respectively, of the other cover; at least one of said port plates being provided with groove means on the inside face thereof communicating with the slots in the rotor beneath the vanes therein; one of said groove means being connected with said first compartment; and the other of said groove means connected with said third compartment.

4. In a combination pump-motor unit, a cylinder; a rotor eccentrically mounted within said cylinder; vanes in the rotor bearing on the cylinder and dividing the space between the rotor and the cylinder into a plurality of pumping chambers; a casing surrounding said cylinder; end covers secured to said casing; a shaft supporting said rotor and journaled in said end covers; port plates at the end of said cylinder immediately inside said covers; said port plates having first notch means communicating the said chambers during the initial expansion thereof, second notch means communicating with said chambers during the remainder of the expansion thereof, and third notch means communicating with said chambers during the contraction thereof; said end covers being provided with axially aligned partitions engaging said port plates between the said notch means and dividing each end cover into a first compartment communicating with said first notch means, a second compartment communicating with said second notch means, and a third compartment communicating with said third notch means; ports in said end covers opening into said compartments; passage means in said casing interconnecting the first, second, and third compartments of one cover with the first, second, and third compartments, respectively, of the other cover; one of said port plates being provided with two substantially semicircular groove means on the inside face thereof communicating with the spaces beneath the vanes in said rotor; one of said groove means being connected with said first compartment; and the other of said groove means being connected with said third compartment.

5. A combined pump and motor comprising a housing including a cylinder, a rotor of smaller diameter than said cylinder mounted for rotation therein on an axis eccentric to the axis of said cylinder, a plurality of vanes carried by said rotor for rotation therewith and radial movement therein in maintained contact with said cylinder to define therewith a plurality of sector shaped pumping chambers each adapted to expand during one portion of a complete revolution of said rotor and to contract during the remainder of such revolution, means for supplying pressure liquid to successive said chambers while each said chamber is expanding from minimum volume to an intermediate volume to cause continued rotation of said rotor, means for disconnecting each successive chamber from said liquid supplying means and then connecting successive said chambers to a supply of liquid to be pumped during the remainder of the expansion of said chamber to cause said liquid to be drawn into successive said chambers and mixed with said pressure liquid therein, and means for disconnecting each successive said chamber from said supply of liquid at substantially the maximum volume thereof and then connecting said chamber to a discharge line to cause said mixed liquid to be discharged from said cylinder during contraction of successive said chambers.

6. A combined pump and motor comprising a housing including a cylinder, a rotor of smaller diameter than said cylinder mounted for rotation therein on an axis eccentric to the axis of said cylinder, a plurality of vanes carried by said rotor for rotation therewith and radial movement therein in maintained contact with said cylinder to define therewith a plurality of sector shaped pumping chambers each adapted to expand during one portion of a complete revolution of said rotor and to contract during the remainder of such revolution, pressure port means for causing rotation of said rotor by supplying pressure liquid to successive said chambers while each said chamber is expanding from minimum volume to an intermediate volume, suction port means arranged to disconnect each successive chamber from said pressure port means and then to connect said chamber to a supply of liquid to be pumped during the remainder of the expansion of said chamber to cause said liquid to be drawn into said chamber and mixed with said pressure liquid therein, and discharge port means arranged to disconnect each successive said chamber from said suction port means during contraction of said chamber to cause said mixed liquid to be discharged from said cylinder.

7. A combined pump and motor comprising a housing including a cylinder, a rotor of smaller diameter than said cylinder mounted for rotation therein on an axis eccentric to the axis of said cylinder and having a plurality of radially arranged slots in the outer surface thereof, a plurality of vanes carried by said rotor slots for rotation with said rotor and radial movement in said slots in maintained contact with said cylinder to define therewith a plurality of sector shaped pumping chambers each adapted to expand during one portion of a complete revolution of said rotor and to contract during the remainder of such revolution, pressure port means for causing rotation of said rotor by supplying pressure liquid to successive said chambers while each said chamber is expanding from minimum volume to an intermediate volume, suction port means arranged to disconnect each successive chamber from said pressure port means and then to connect said chamber to a supply of liquid to be pumped during the remainder of the expansion of said chamber to cause said liquid to be drawn into said chamber and mixed with said pressure liquid therein, discharge port means arranged to disconnect each successive said chamber from said suction port means during contraction of said chamber to cause said mixed liquid to be discharged from said cylinder, and means for connecting the interior of successive said slots with said pressure port means during expansion of the associated said chambers and with said discharge port means during contraction of said chambers to maintain said vanes in said contact with said cylinder while relieving said slots of fluid therein during inward movement of the associated said vanes.

8. A combined pump and motor comprising a housing including a cylinder, a rotor of smaller diameter than said cylinder mounted for rotation therein on an axis eccentric to the axis of said cylinder, a plurality of vanes carried by said rotor for rotation therewith and radial movement therein in maintained contact with said cylinder to define therewith a plurality of sector shaped pumping chambers each adapted to expand during one portion of a complete revolution of said rotor and to contract during the remainder of such revolution, a plurality of ports located at angularly spaced positions around said cylinder for communication in succession with each of said chambers during each revolution of said rotor, the first said port means being located to communicate with each successive chamber while said chamber is expanding from minimum volume to an intermediate volume and being adapted to cause rotation of said rotor by supplying pressure liquid to said successive expanding chambers, the

next said port means being spaced to communicate with each successive said chamber following movement of said chamber out of communication with said first port means during further expansion of said chamber and then to connect said chamber to a supply of liquid to be pumped to cause said liquid to be drawn into said chamber and mixed with said pressure liquid therein, and the remainder of said port means being discharge port means spaced to communicate with each successive said chamber during contraction of said chamber to cause said mixed liquid to be discharged from said cylinder.

9. A combined pump and motor comprising a housing, a cylinder in said housing, partitions cooperating with said cylinder to define in said housing a pair of intake compartments and a discharge compartment, a rotor of smaller diameter than said cylinder mounted for rotation therein on an axis eccentric to the axis of said cylinder, a plurality of vanes carried by said rotor for rotation therewith and radial movement therein in maintained contact with said cylinder to define therewith a plurality of sector shaped pumping chambers each adapted to expand during one portion of a complete revolution of said rotor and to contract during the remainder of such revolution, means for connecting the first said intake compartment with a supply of pressure liquid, pressure port means spaced to connect each successive said chamber with said first intake compartment while each said chamber is expanding from minimum volume to an intermediate volume to cause rotation of said rotor by supplying pressure liquid to successive said expanding chambers, means for connecting the second said intake compartment with a supply of other liquid to be pumped, suction port means arranged to disconnect each successive chamber from said pressure port means and then to connect said chamber to said second intake compartment during the remainder of the expansion of said chamber to cause said other liquid to be drawn into said chamber and mixed with said pressure liquid therein, and discharge port means arranged to disconnect each successive said chamber from said suction port means during contraction of said chamber and to connect said chamber with said discharge compartment to cause said mixed liquid to be discharged from said cylinder.

10. A combined pump and motor comprising a housing, a cylinder in said housing, partitions cooperating with said cylinder to define in said housing a pair of intake compartments and a discharge compartment, a rotor of smaller diameter than said cylinder mounted for rotation therein on an axis eccentric to the axis of said cylinder and having a plurality of radially arranged slots in the outer surface thereof, a plurality of vanes carried by said rotor slots for rotation with said rotor and radial movement in said slots in maintained contact with said cylinder to define therewith a plurality of sector shaped pumping chambers each adapted to expand during one portion of a complete revolution of said rotor and to contract during the remainder of such revolution, means for connecting the first said intake compartment with a supply of pressure liquid, pressure port means spaced to connect each successive said chamber with said first intake compartment while each said chamber is expanding from minimum volume to an intermediate volume to cause rotation of said rotor by supplying pressure liquid to successive said expanding chamber, means for connecting the second said intake compartment with a supply of other liquid to be pumped, suction port means arranged to disconnect each successive chamber from said pressure port means and then to connect said chamber to said second intake compartment during the remainder of the expansion of said chamber to cause said other liquid to be drawn into said chamber and mixed with said pressure liquid therein, discharge port means arranged to disconnect each successive said chamber from said suction port means during contraction of said chamber and to connect said chamber with said discharge compartment to cause said mixed liquid to be discharged from said cylinder, and means for connecting the interior of successive said slots with said first said intake compartment during expansion of the associated said chambers with said discharge compartment means during contraction of said chambers to maintain said vanes in said contact with said cylinder while relieving said slots of fluid therein during inward movement of the associated said vanes.

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