

Sept. 8, 1942.

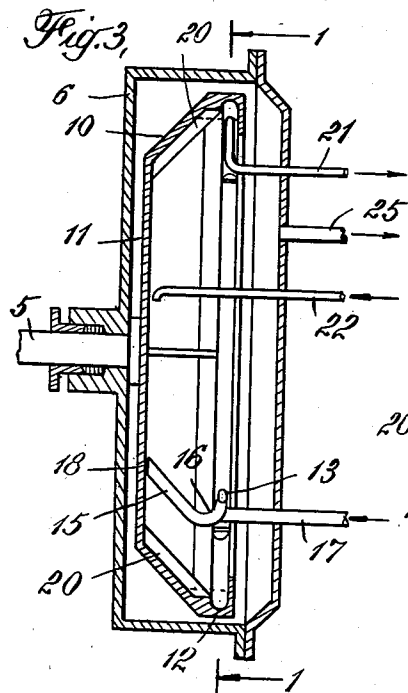
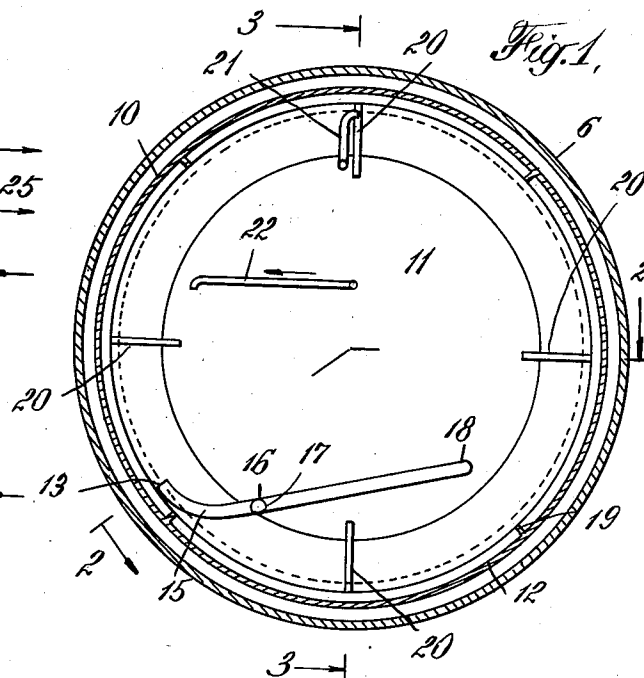
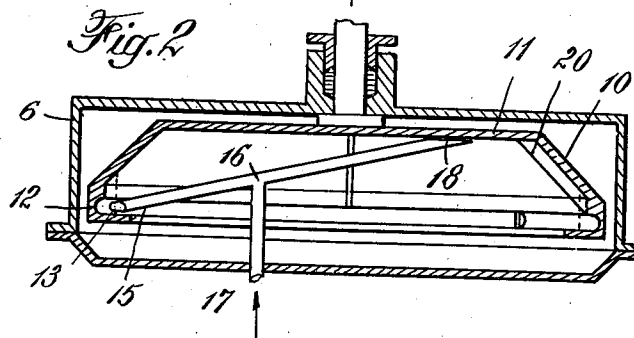
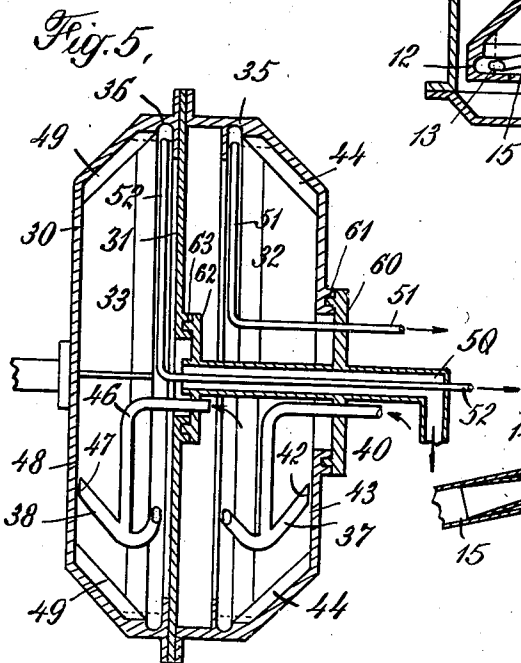
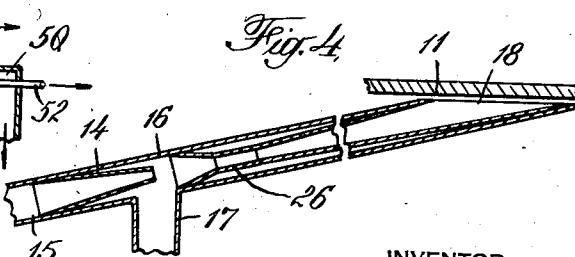
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2,295,024

PUMP

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2 Sheets-Sheet 1



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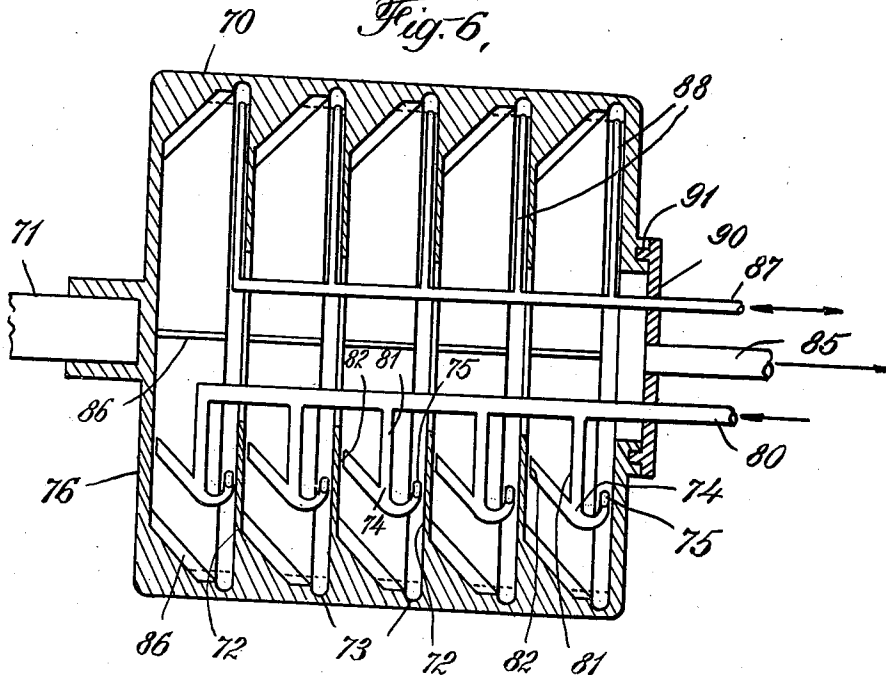
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Fig. 6,



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2,295,024

PUMP

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Application October 25, 1941, Serial No. 416,485

16 Claims. (Cl. 230-75)

This invention relates to pumps and more particularly it relates to pumps in which a rotating annulus of liquid traveling at high velocity is utilized to pump fluids. The invention provides an apparatus for pumping or moving gases or other fluid media which may be operated with high efficiency.

In my copending application, Serial No. 191,367, filed February 19, 1938, which has now resulted in Patent No. 2,260,600, issued October 28, 1941, there is described an apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus traveling at high velocity. The apparatus is provided with means for diverting a stream of liquid from the annulus and with means for utilizing the high velocity of this diverted stream for pumping the fluid which is to be moved, the latter means advantageously taking the form of a jet-type pump element. The mixture of liquid and fluid formed in this element is returned more or less directly to the rotating liquid annulus in the apparatus.

In accordance with this invention the mixture of liquid and entrained fluid is discharged against the side wall of a rotatably mounted shell which is provided with an annular trough in which an annulus of liquid may be formed when the shell is rotated. The liquid discharged against the side wall of the shell has its velocity rapidly accelerated so that when it is returned to the annulus it is moving at substantially the same linear velocity as the liquid in the annulus. To facilitate this acceleration in velocity the side wall of the shell is advantageously provided with fins adjacent to the trough.

The invention will be further illustrated by reference to the accompanying drawings, in which—

Fig. 1 represents a front view, Fig. 2 a section along line 2—2 of Fig. 1, and Fig. 3 a section along line 3—3 of Fig. 1, of a pump embodying the invention;

Fig. 4 is a sectional view of a jet-type pump element;

Fig. 5 illustrates an apparatus in which two stages of a pump such as is shown in Figs. 1 to 3 inclusive are employed; and

Fig. 6 illustrates an apparatus in which a plurality of jet-type pump elements arranged in parallel are employed.

The apparatus of Figs. 1 to 3 inclusive comprises a shell 10 rotatably mounted on a shaft 5 within a suitable housing 6. The shaft may be driven by any suitable means (not shown). The shell 10 has a side wall 11 which communicates with an annular trough 12. When the shell is rapidly rotated, liquid contained in this

trough will be formed into a rapidly rotating annulus. Suitable fins 13, to prevent slippage of the liquid annulus, are positioned within the trough. The inlet 13 of a jet member 15 is immersed in the annulus.

A suitable type of such a jet member is illustrated by Fig. 4. Referring to this figure, liquid passing through the nozzle 14 creates a low pressure region 16 within the jet member. The fluid to be moved or pumped, e. g., air, is drawn into this low pressure region through conduit 17. The flow of liquid from the nozzle 14 into the throat portion 26 causes the entrainment of the fluid with the liquid and the mixture of liquid and fluid is discharged from the outlet 18.

Referring again to Figs. 1 to 3 inclusive, liquid diverted from the rotating liquid annulus in the trough 12 passes through the jet member 15 where a low pressure region is created at 16. The fluid to be pumped or moved, e. g., air, is introduced into this region by means of the conduit 17. The passage of the stream of liquid through the low pressure region entrains the air and the mixture of liquid and entrained air is discharged from the outlet 18 of the jet element at a point adjacent to the side wall 11 of the shell. The liquid impinging on the rotating side wall 11 has its velocity accelerated as it moves away from the center of the shell until at a point adjacent to the trough 12 its velocity will be substantially equal to the linear velocity of the liquid in the rotating liquid annulus. To facilitate the acceleration of the velocity of the liquid discharged from the jet element, the side wall 11 is provided with a plurality of radial fins 20. The continuous introduction of fluid, e. g., air, into the housing 5 results in an increase of the pressure of the air, and the compressed air may leave the housing through the conduit 25. Liquid may be introduced into the housing through the conduit 22. To maintain the liquid in the annulus at a predetermined level a suitable overflow conduit 21 is provided.

In the apparatus illustrated by Fig. 5 a rotatably mounted shell 30 is provided with a partition 31 which divides the shell into two compartments 32 and 33. The compartments are provided with annular troughs 35 and 36, respectively. Jet-type pump elements 37 and 38 are positioned within each of said compartments and are adapted to utilize the high velocity of the liquid in the rotating annulus in order to pump the fluid. In the operation of this device rotation of the shell 30 results in the formation of liquid annuli within the troughs 35 and 36. The fluid to be moved, e. g., air, enters inlet pipe 40 and passes to the reduced pressure region of the jet-type pump element 37 where it is entrained with the liquid passing through the element and is discharged at 42 against the side wall 43 of

compartment 32. Here the velocity of the discharged liquid will be gradually increased and by means of the radial fins 44 be made substantially equal to the velocity of the liquid in the annulus to which the discharged liquid is returned. The air discharged in the chamber 32 is under pressure and passes from this chamber into the low pressure region of the jet-type pump element 38 in compartment 33 by means of conduit 46. The air is admixed and entrained by the stream of liquid passing through the jet-type pump element and the liquid is discharged at 47 against the side wall 48 of the shell. The liquid is returned to the annulus after having its velocity increased due to the rotation of the shell and to the action of the radial fins 49 positioned adjacent to the trough. The air which is under pressure within the chamber 33 leaves this chamber by means of the conduit 50. To maintain the liquid in the annuli at a predetermined level the shell is provided with overflow conduits 51 and 52, respectively. By using a constant level apparatus the same conduits may also be employed to introduce liquid into the troughs.

The conduit 50, which is of course stationary, is integrally connected with a flange or collar 60 having a suitable rotary seal 61 so that the compartment 32 is pressure tight. A similar flange 62 and rotary seal 63 are provided at the end of the conduit 50 and serve to seal off compartment 33 from compartment 32.

The device illustrated by Fig. 6 comprises a rotatable shell 70 mounted at one end on a shaft 71. The other end of the shell is closed off by means of a stationary flange 90 having a suitable rotary seal 91 so that the shell may freely rotate on the flange. The shell is provided with a series of vertically extending walls or partitions 72 which extend part way across the shell so that an open area is formed near the center along the axis of the shaft. Each of the communicating compartments formed by these partitions has an annular trough 73 which is adapted to contain liquids, so that when the shell is rapidly rotated the liquids contained in these troughs will be formed into rotating liquid annuli. A jet-type pump member 74, constructed in the same manner as the jet-type pump element illustrated in Figs. 1, 2, and 3, is positioned within each of these compartments, the inlet 75 of each of the jet members being immersed in the liquid contained in the trough. The gas to be pumped by the device enters through the conduit 80 and is conducted to the low pressure region in each of the jet members by the conduits 81. The mixture of liquid and entrained gas formed in the jet member is discharged from outlet 82 against one of the partitions 72 or the side wall 76 of the rotating shell, depending upon the location of the particular jet member. The gas which will be under pressure leaves the shell by conduit 85. Each compartment in the shell is provided with radial fins 86 adjacent to the troughs. These fins, as previously described, facilitate acceleration of the velocity of the liquid discharged from the jet members to a point where the liquid velocity is substantially the same as the velocity of the liquid in the various annuli. Liquid is introduced into the shell through the conduit 87, and into the individual compartments by means of the branch conduits 88. The same system of conduits may also be used in conjunction with a constant level device (not shown) to remove excess liquid from the various annuli formed in the troughs.

The side wall of the shell may assume various shapes and need not necessarily be in the form of a truncated cone as shown in the drawings. Thus, for example, the shell may be in the form of a section of a sphere or any other suitable form which will provide communication with a trough containing an annulus of liquid. The fins adjacent to the troughs need not be radial but may be curved or set at an angle.

The apparatus of this invention may be used for the pumping of fluids such as air or other gases and may also be used for the evaporation of liquids. In the latter application of the device the liquid to be evaporated may be introduced into the device and formed into a liquid annulus by the rotation of the shell as described in my prior Patent No. 2,260,600.

I claim:

1. An apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus at the peripheral portion of the shell and traveling at high velocity, means for diverting a stream of liquid from said annulus, means utilizing the high velocity of the diverted stream for creating a reduced pressure region, means for conducting the fluid to be moved to the reduced pressure region, means for mixing or entraining the fluid in the reduced pressure region with liquid from the diverted stream, said apparatus having a rotating portion in communication with the peripheral portion of the shell where said rotating annulus of liquid forms and extending radially inward toward the axis of rotation of the shell, and means independent of said rotating portion for discharging the mixture of liquid and fluid against the said rotating portion at a place which is radially inward of said annulus, whereby liquid discharged against said rotating portion will be returned to said annulus.

2. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having a side wall in communication with a trough, said shell being adapted to be rotated at a speed such that liquid when contained in the trough will be formed into a rotating annulus traveling at high velocity, means for diverting a stream of liquid from said annulus, means utilizing the high velocity of the diverted stream for creating a reduced pressure region, means for conducting the fluid to be moved to the reduced pressure region, means for mixing or entraining the fluid in the reduced pressure region with liquid from the diverted stream, and means independent of the side wall of the shell for discharging the mixture of liquid and fluid against the said side wall, whereby liquid discharged against said wall will be returned to said annulus.

3. Apparatus as in claim 2 in which the side wall of the shell is provided with a plurality of fins adjacent to the trough.

4. Apparatus as in claim 2 in which the discharging means is adapted to discharge the mixture of liquid and fluid substantially in the direction of rotation of the side wall of the shell.

5. Apparatus as in claim 2 having means for maintaining the liquid in said annulus at a predetermined level.

6. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having a side wall communicating with an annular trough, said shell being adapted to be rotated at a speed such that liquid when contained in the

said trough will be formed into a rotating annulus traveling at high velocity, a jet-type pump element, means for diverting a stream of liquid from said annulus into the jet-type pump element, means for conducting the fluid to be moved to the reduced pressure region of the jet-type pump element, and means independent of the side wall of the shell for discharging the mixture of liquid and fluid formed in said reduced pressure region against said side wall, whereby liquid discharged against said wall will be returned to said liquid annulus.

7. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having a side wall communicating with an annular trough, said shell being adapted to be rotated at a speed such that liquid when contained in the said trough will be formed into a rotating annulus traveling at high velocity, a jet-type pump element, means for diverting a stream of liquid from said annulus into the jet-type pump element, means for conducting the fluid to be moved to the reduced pressure region of the jet-type pump element, and means for discharging the mixture of liquid and fluid formed in said reduced pressure region against said side wall, whereby liquid discharged against said wall will be returned to said liquid annulus, said discharging means being positioned so that the mixture leaving said means will be traveling at a linear velocity substantially equal to the linear velocity of the portion of the side wall against which it is discharged.

8. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having at least two compartments, each of said compartments having a side wall communicating with an annular trough, said shell being adapted to be rotated at a speed such that liquid when contained in said troughs will be formed into rotating annuli traveling at high velocity, each of said compartments being provided with, (a) means for diverting a stream of liquid from the annulus in said compartment, (b) means utilizing the high velocity of the diverted stream for creating a reduced pressure region, (c) means for conducting the fluid to be moved to the reduced pressure region, (d) means for mixing or entraining the fluid in the reduced pressure region with liquid from the diverted stream, and (e) means for discharging the mixture of liquid and fluid against the side wall of said shell, means for conducting fluid from the interior of the first of said compartments to the reduced pressure region in the second of said compartments whereby fluid under pressure in the first of said compartments will be subjected to further pressure in the second of said compartments.

9. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having at least two compartments, each of said compartments having a side wall communicating with an annular trough, said shell being adapted to be rotated at a speed such that liquid when contained in said troughs will be formed into rotating annuli traveling at high velocity, each of said compartments being provided with, (a) a jet-type pump element, (b) means for diverting a stream of liquid from the annulus in said compartment into the jet-type pump element, (c) means for conducting the fluid to be moved to the reduced pressure region of the jet-

type pump element, and (d) means for discharging the mixture of liquid and fluid formed in said reduced pressure region against the side wall of said shell, means for conducting fluid from the interior of the first of said compartments to the reduced pressure region in the second of said compartments whereby fluid under pressure in the first of said compartments will be subjected to further pressure in the second of said compartments.

10. Apparatus as in claim 9 in which the side walls are provided with a plurality of fins adjacent to the troughs.

11. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having a plurality of annular troughs, said shell being adapted to be rotated at a speed such that the liquid when contained in said troughs will be formed into rotating annuli traveling at high velocity, means for diverting a stream of liquid from each of said annuli, means utilizing the high velocity of the diverted streams for creating a plurality of reduced pressure regions, means for conducting the fluid to be moved to said reduced pressure regions, means for mixing or entraining the fluid in said reduced pressure regions with liquid from the diverted streams, and means for discharging the mixtures of liquid and fluid against rotating portions of said apparatus, each of said rotating portions being in communication with one of said liquid annuli, whereby liquid discharged against rotating portions will be returned to said annuli.

12. An apparatus for moving a fluid medium which comprises a rotatably mounted shell having a plurality of annular troughs, said shell being adapted to be rotated at a speed such that the liquid when contained in said troughs will be formed into rotating annuli traveling at high velocity, a plurality of jet-type pump elements, means for diverting a stream of liquid from each of said annuli to one of said jet-type pump elements, means for conducting the fluid to be moved to the reduced pressure regions of the jet-type pump elements, and means for discharging the mixtures of liquid and fluid formed in said reduced pressure regions against rotating portions of said apparatus, each of said rotating portions being in communication with one of said liquid annuli, whereby liquid discharged against said rotating portions will be returned to said annuli.

13. Apparatus as in claim 11 in which the rotating portions are provided with a plurality of fins adjacent to the liquid annuli.

14. Apparatus as in claim 11 having means for maintaining the liquid in said annulus at a predetermined level.

15. Apparatus as in claim 11 in which the discharging means is adapted to discharge the mixture of liquid and fluid substantially in the direction of rotation of the rotating portions.

16. Apparatus as in claim 11 in which the means for discharging the mixtures of liquid and fluid against the rotating portions are positioned so that the mixtures leaving the discharging means will be traveling at a linear velocity substantially equal to the linear velocity of the rotating portions against which they are discharged.

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