

July 19, 1932.

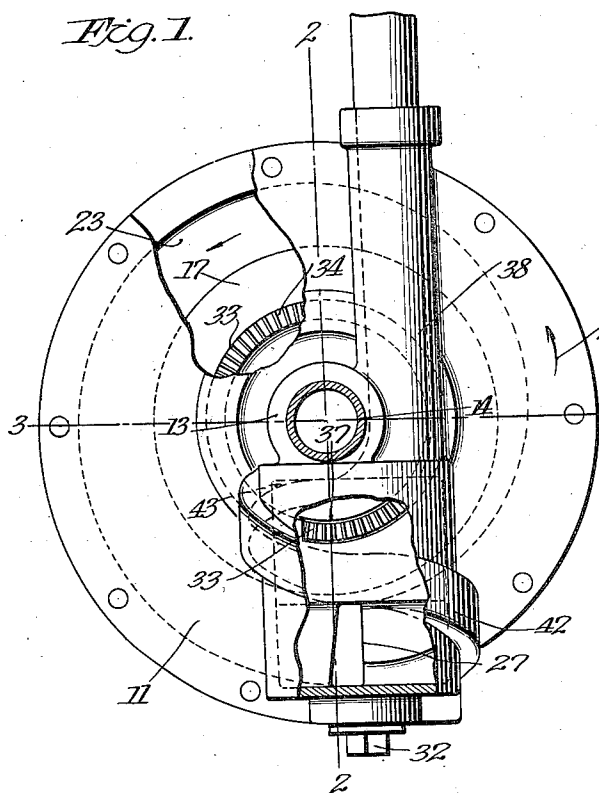
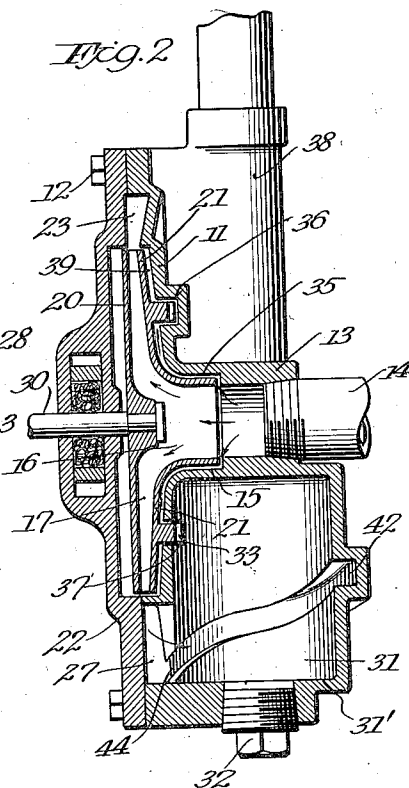
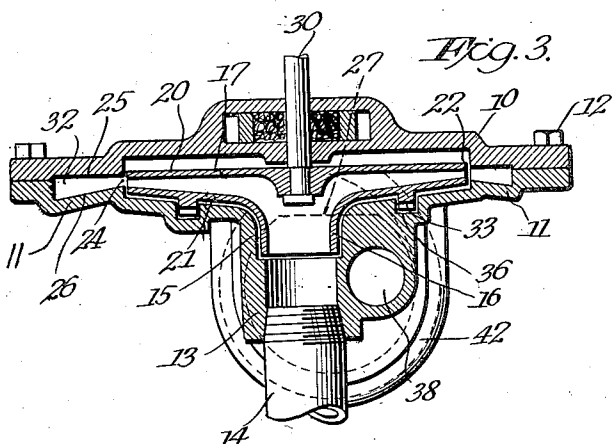
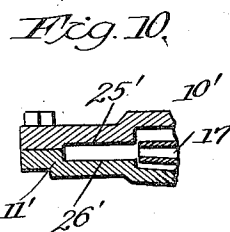
A. W. BURKS

1,867,652

AIR PUMPING CENTRIFUGAL PUMP

Filed Feb. 6, 1930

4 Sheets-Sheet 1



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July 19, 1932.

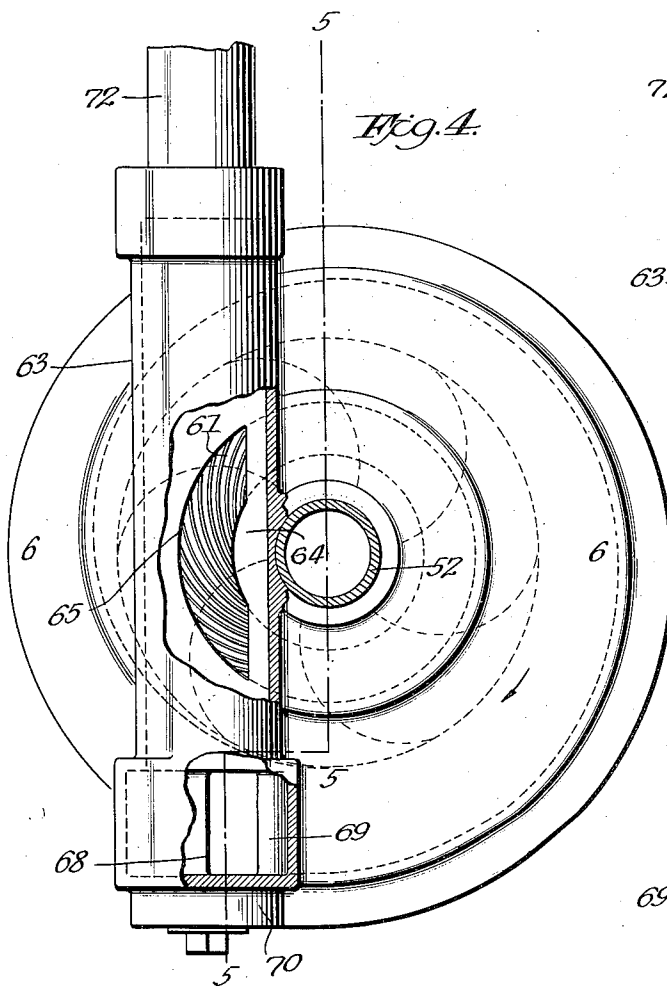
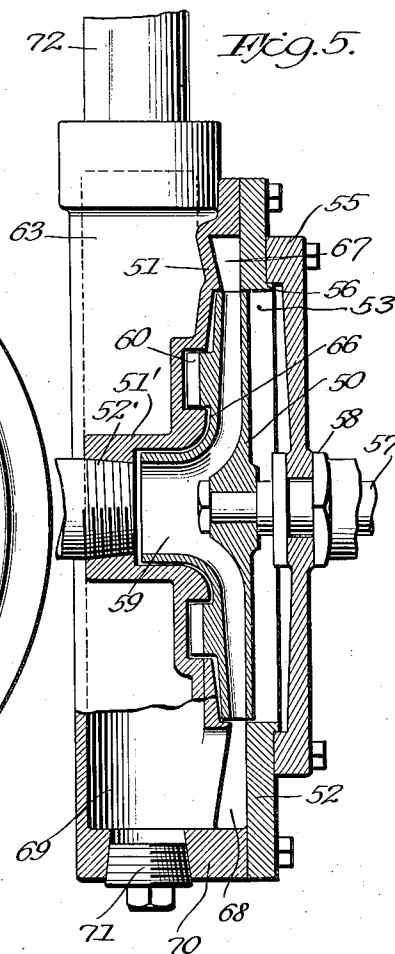
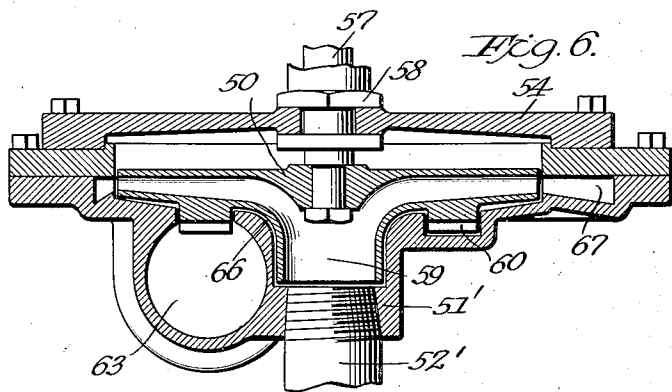
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1,867,652

AIR PUMPING CENTRIFUGAL PUMP

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4 Sheets-Sheet 2



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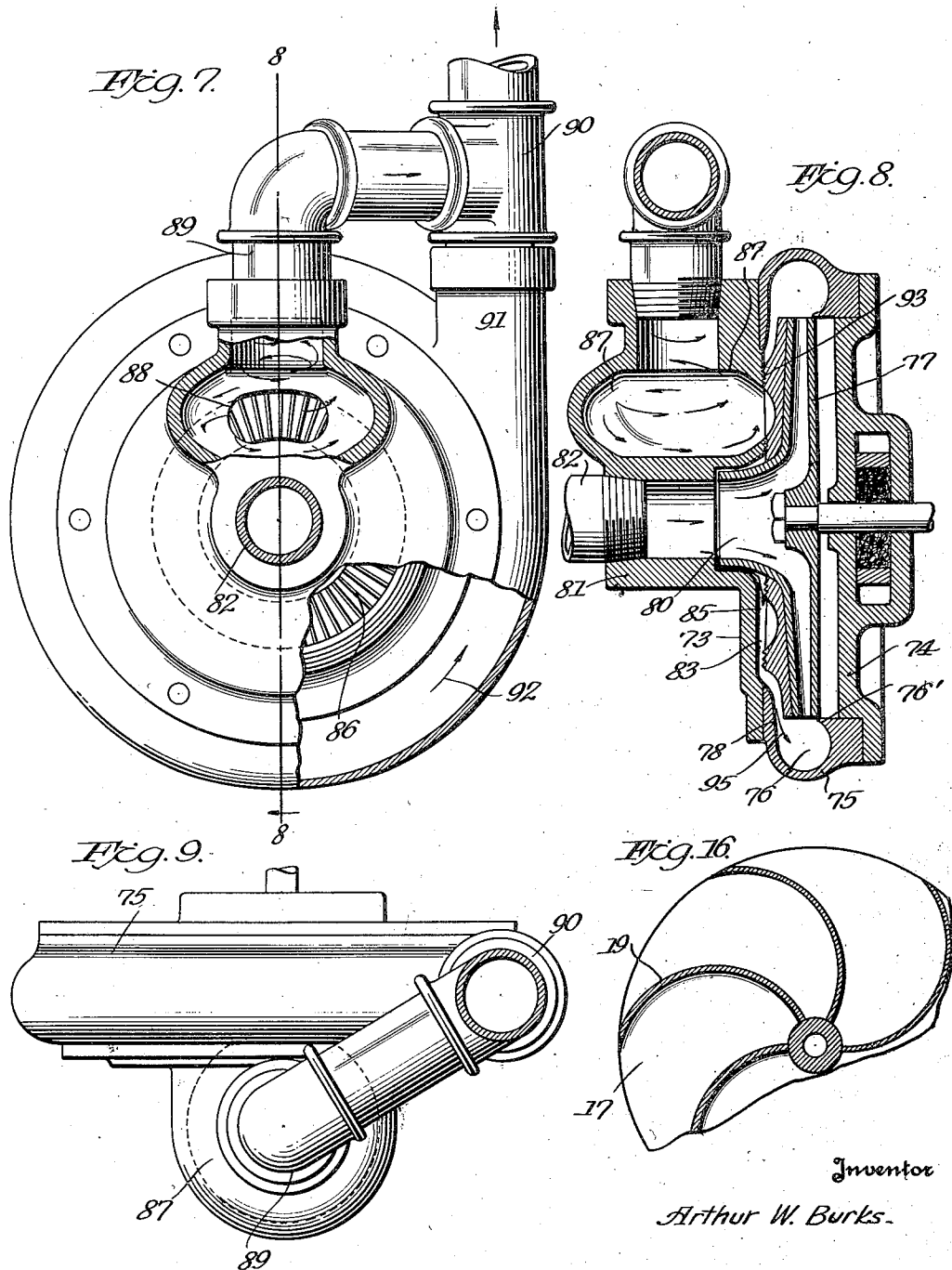
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AIR PUMPING CENTRIFUGAL PUMP

Filed Feb. 6, 1930

4 Sheets-Sheet 3



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July 19, 1932.

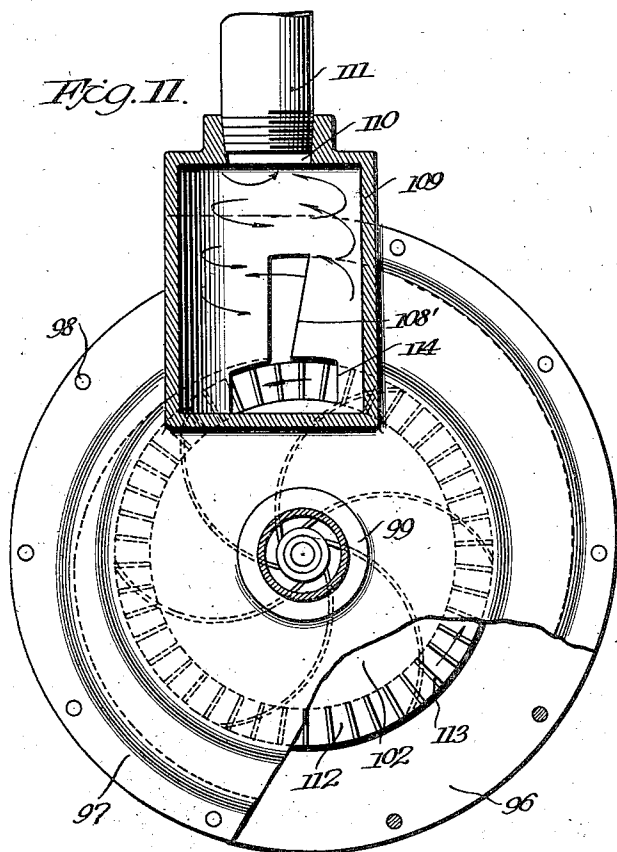
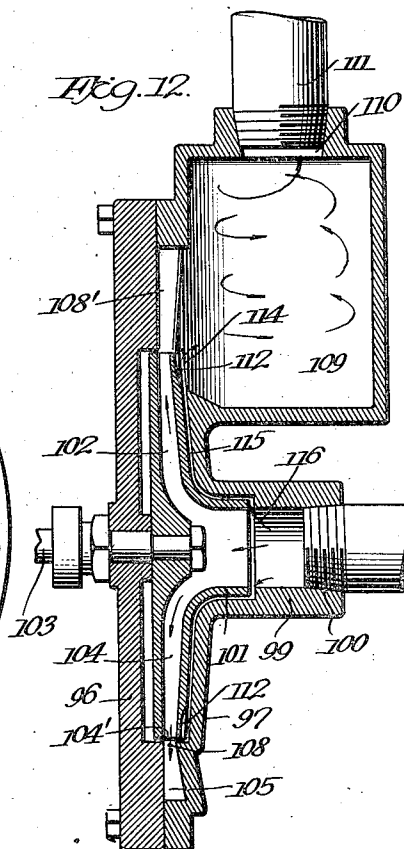
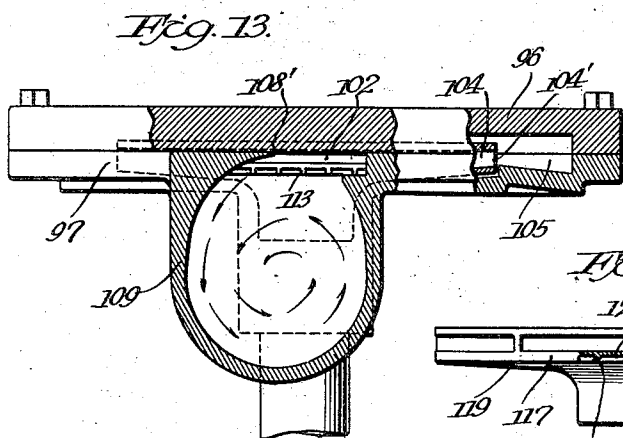
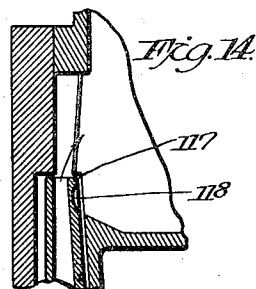
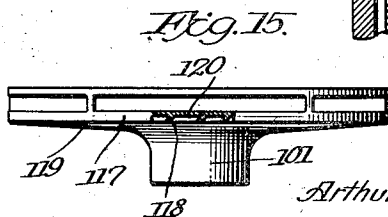
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1,867,652

AIR PUMPING CENTRIFUGAL PUMP

Filed Feb. 6, 1930

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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AIR PUMPING CENTRIFUGAL PUMP

Application filed February 6, 1930. Serial No. 426,358.

The present invention relates to rotary pumps and has as an object the provision of an improved rotary pump of the centrifugal type, although certain features of the invention are applicable to pumps of other types.

A more particular object of the invention is to provide a centrifugal pump which is adapted to pump upon either gas or liquid.

A still further object of the invention is to provide a centrifugal type pump which is self-priming and which is not only novel in construction, but involves a new method of operation.

The invention, therefore, seeks to provide a new and improved pump construction, and a novel method of operating a centrifugal pump, the method having to do primarily with the pumping of air and the automatic priming of the pump.

With respect to the pump construction, the invention relates to the formation of the fluid channel or raceway into and through which the fluid is impelled; to the rotor construction; to the means for adapting the pump for operation upon air; and to means for making the pump self-priming.

The invention has as another object a centrifugal pump which will operate effectively upon air, and which will, therefore, serve as an air compressor, as well as a liquid pump.

The invention also has as an object a centrifugal pump which is self-priming so that it will automatically evacuate the supply line when the pumping operation is initiated and which will automatically remove any air which fills the pumping chamber during the pumping operation and thus automatically insures uninterrupted continuance of liquid pumping.

The present invention involves a method of operation in which fluid is supplied to the rotor whenever the latter tends to become air bound and in which this supply of liquid is utilized for the purpose of withdrawing the air from the pump at the point of supply and for separating and discharging the air withdrawn.

The method also involves means for maintaining at the point of such liquid supply a

whirling body of liquid or a whirlpool which separates the removed air by centrifugal action.

For this purpose, the rotor is provided with a series of buckets which are engaged by the liquid whirlpool to displace air from the buckets into the whirlpool. The buckets are in communication with air in the impeller chamber, and also, preferably, in communication with the pump inlet so that air may be drawn therethrough to the buckets.

In the operation of the pump, the water which enters the buckets to displace the air is returned to the whirlpool, at least as long as air is being pumped. This return is effected through the main fluid channel or raceway of the pump and the channel outlet. In other words, the whirlpool is always maintained sufficiently filled with liquid during the air pumping phase and any liquid carried therefrom by the buckets is returned by means other than the buckets. The buckets are, therefore, free to discharge any water they carry from the whirlpool and to be filled with air before they again reach the whirlpool.

I have also discovered that the operation of a centrifugal pump may be substantially improved by providing a novel form of fluid channel or raceway into which the impeller may centrifugally discharge. The raceway, which follows the periphery of the rotor for a substantial portion of the rotor circumference is relatively narrow, and not substantially wider than the rotor at its periphery, particularly at the entrance throat. I have discovered that if such a raceway is maintained relatively narrow and has flat side walls which may be spaced apart a greater distance radially outwardly from the rotor than at the rotor periphery, there is a substantial reduction in the formation of eddy currents, and furthermore, a marked increase in the pressure developed by the pump.

The foregoing and other features of the invention will become clearer in connection with a detailed description of certain preferred embodiments disclosed in the accompanying drawings.

In these drawings:

Figure 1 is a side elevational view with parts broken away.

Figure 2 is a vertical section on the line 2—2 of Figure 1.

Figure 3 is a horizontal section on the line 3—3 of Figure 1.

Figure 4 is an end elevational view of a modified form, parts being broken away to show the internal construction.

Figure 5 is a vertical section on the line 5—5 of Figure 4, looking in the direction of the arrows.

Figure 6 is a horizontal section on the line 6—6 of Figure 4.

Figure 7 is a side elevational view of another modified form, with parts being broken away.

Figure 8 is a vertical sectional view on the line 8—8 of Figure 7.

Figure 9 is a top plan of the pump shown in Figure 7.

Figure 10 is a fragmentary sectional view showing a modified form of raceway.

Figure 11 is a side elevational view of another form, with parts being broken away.

Figure 12 is a vertical sectional view on the line 12—12 of Figure 11.

Figure 13 is a plan view partly broken away.

Figure 14 is a fragmentary sectional view showing a modified form of rotor construction, which may be used in lieu of that shown in Figures 11 and 12.

Figure 15 is an edge view of the rotor shown in Figure 14, partly broken away.

Figure 16 is a fragmentary sectional view showing the internal construction of the impeller employed in all of the pumps.

Referring to Figures 1, 2 and 3, the pump comprises a casing having two sections 10, 11 secured together as by bolts 12. The casing has a substantially central hollow boss 13 which serves as an inlet and is connected with a supply line 14. The interior of the boss is enlarged as at 15 to receive with substantial clearance, a hollow hub 16 of a centrifugal impeller or rotor 17. The interior of the rotor, as best shown in Fig. 16, is divided by a plurality of curved circumferentially directed webs 19 into a plurality of peripherally directed passages leading from the hollow hub 16, the passages being arranged between the opposite lateral faces 20, 21 of the rotor. At its periphery 22, the rotor discharges into a fluid channel or raceway 23 having at the impeller periphery an entrance throat 24 which is of substantially the width of the rotor at its periphery. The throat faces the rotor to receive fluid centrifugally discharged therefrom into the channel 23, which is relatively narrow, between the flat side walls 25, 26. These walls may be formed so that the channel increases slightly in

width from the throat 24 radially outwardly from the rotor, as by inclining the wall 26 (Fig. 3). In some instances, it may be preferable to provide parallel side walls 25', 26', as in the modified structure of Fig. 10, in which the raceway is formed between the two casing sections 10', 11'.

The channel increases in depth from its discharge or outlet opening 27 around the rotor in a counterclockwise direction (Fig. 1), and as will be evident from a comparison of the radial dimension of the raceway at opposite sides of the rotor in Fig. 3. Fluid drawn into the rotor as the latter is revolved by means of rotor shaft 30, on which it is fixedly mounted, will be centrifugally discharged into the raceway or channel 23, and will pass through this channel to the outlet 27 where it enters tangentially the bottom of a chamber 31 which is substantially circular in horizontal cross section for a purpose to be explained. This chamber has a bottom 31' which may be provided with a drain plug 32 and is in communication with a whirlpool set up by a series of buckets disposed on the rotor, and which will now be described.

The rotor has, preferably on a lateral face, a plurality of buckets 33 formed by a circular series of blades 34 disposed on a lateral face and radially inwardly from the rotor periphery. These buckets are disposed so as to receive air, and in the present instance, this is accomplished by placing the same in communication with the inlet by the space 35 between the rotor hub and the casing portions 13. The buckets travel in a circular channel 36 formed in the casing and are in communication with a body of liquid, which in the present instance, is maintained in the chamber 31. For this purpose, the chamber 31 is provided with an opening 37 in its wall, through which the buckets as they pass the chamber may communicate with the interior of the latter. In the form shown, the buckets project into the chamber (Fig. 3) since they project laterally from the wall of the rotor. As the buckets pass the chamber, they tend to maintain in the latter a liquid air separating whirlpool, the liquid of which engages the buckets and displaces therefrom into the whirlpool air contained in the buckets. This air is separated by the centrifugal action of the whirlpool and passes upwardly from the chamber 31 through the discharge pipe 38 which (Fig. 3) is of considerably lesser diameter than chamber 31.

It will be apparent that in the form being described, the liquid whirlpool in chamber 31 is maintained not only by the action of the buckets as they pass the opening 37, but also by the tangential discharges through the channel or raceway outlet 27.

Obviously, some water will be carried off from the chamber 31 by the buckets, and this

water, as the rotor passes from the opening 37 in counter-clockwise direction, as illustrated by the arrow 28 (Fig. 1) will pass outwardly into the channel 23 through the space 39 between the wall 21 of the rotor and the casing section 10, 11. This water passes around the channel and is discharged again through outlet 27 into the chamber 31, and since the lower end of the latter is in communication with the whirlpool formed by the buckets 37, the water may again engage the buckets.

It will be evident, therefore, that there is a constant circulation of water from the whirlpool within chamber 31 around the raceway and back to the chamber, due to the fact that as air is displaced from buckets 33, the water which has effected the displacing action, must be carried away by the buckets. This water is maintained at a minimum and is returned to the whirlpool by means other than the buckets, namely, through the raceway 23 and channel outlet 27.

Due to the fact that the buckets are in communication with air and promptly discharge into the raceway any water they take from the liquid whirlpool, it is possible for the pump to evacuate effectively its own supply line, provided when the operation of the same is initiated, a sufficient quantity of water is placed in the chamber 31, for example through the discharge 38, to set up the air separating whirlpool in a horizontal plane which will engage the buckets and displace therefrom air which enters the buckets from the inlet. After the line is evacuated, the pump will continue to draw water, and the same will be centrifugally impelled by the rotor into the raceway, although some water may be pumped by the buckets 37, and this is discharged into the chamber 31 as the buckets enter the same.

It will be found that during both the air pumping period and the liquid pumping period a whirlpool is maintained in chamber 31, and this whirlpool will tend to separate from the water any air which may be combined therewith, the air passing from the whirlpool at its center and upwardly through the discharge pipe 38.

When it is desired to pump air alone, it is simply necessary that the chamber 31 contain water in sufficient quantity to form a liquid whirlpool and then the supply line may be opened to the air in any suitable manner so that the pump will draw air therethrough in the manner described.

As will be observed, the chamber 31 is provided with a spiral passage 42, which leads from a point 43 in a horizontal plane adjacent the top of the chamber downwardly to a point 44 adjacent the outlet 27. This passage serves to direct the liquid of the whirlpool adjacent its outer rim from the upper portion of the whirlpool to a lower portion

thereof so as to insure return to the body of the whirlpool from adjacent its upper portion, water which has been freed from air by the centrifugal action. This feature of the pump is more fully described and is claimed in my co-pending application, Serial No. 425,868, filed February 4, 1930.

It has been found that the flat cross sectional shape of the channel 23 (Figs. 2 and 10) materially improves the operation of the pump, and that water is discharged from the impeller into the channel substantially without the formation of eddy currents. Comparative tests indicate that this form of raceway adds considerably to the efficiency of a centrifugal pump. The raceway increases in radial dimensions, as illustrated by the dotted lines in Fig. 1 around the pump and may be either of the substantially wedge-shaped cross sectional form shown in these figures, or of the uniform cross sectional width shown in Fig. 10.

Referring to Figures 4, 5 and 6, the rotor 50 is disposed between casing sections 51, 52, the latter having a central opening 53 closed by a plate 54 maintained in position on section 52 by a marginal rib 55 which fits around a flange 56 surrounding the opening 53. The rotor shaft 57 is mounted in a bearing 58 positioned centrally of the plate 54, and the rotor is of the same construction as the rotor of Figs. 1, 2 and 3. It has the internal discharge or impelling passages (Fig. 16) which communicate with a hollow hub 59 arranged within the inlet boss 51', the latter having a supply connection 52'. The rotor also has the lateral series of buckets 60 formed between blades 61, these blades being longitudinally arcuate as shown in Fig. 1, and in communication through an opening 62 with a chamber 63.

The opening 62 is of substantial length longitudinally of chamber 63 and has arcuate edges 64, 65 which follow for a substantial distance the path of movement of the blades 61. As the blades 61 pass the opening, they communicate with the chamber (Fig. 6) and in the present instance project thereinto, to set up an air separating whirlpool, the liquid of which engages the buckets and serves to displace air therefrom into the whirlpool.

The buckets may draw air through the space 66 between the rotor and the wall of the casing section 51, this space leading from the buckets to the inlet boss and thus being in communication with the inlet connection 52. Water which is carried off from the chamber 61 by the buckets will be discharged outwardly by the buckets after they leave the opening 62 into the channel 67 which corresponds in formation and function to the channel 23 described in connection with the form of Figures 1, 2 and 3. This channel directs the fluid through an outlet 68 and tangentially into a chamber 69 wherein a whirlpool is set up by

the tangential discharges. The chamber 69 is in communication with the chamber 63, and, in the form shown, forms the lower end of the latter. It may have in its bottom wall 70 a drain plug 71, and leads to a discharge connection 72, in the present instance, through the chamber 63.

The operation of this pump is very similar to the pump of Figs. 1, 2 and 3. It will be understood that the liquid which enters inlet 51' is centrifugally discharged by the impeller into the raceway 67, through which it passes to be tangentially discharged into chamber 69. If considerable air is entering the pump through inlet 51', the same will enter the buckets 60, and as the latter pass opening 62, the whirlpool in chamber 63 set up by the action of the buckets, will displace into the whirlpool the air in the buckets, the air being thereafter separated by the centrifugal action of the whirlpool and being discharged through outlet connection 72. It will be understood, of course, that this air displacing action will not continue after there is sufficient air and liquid in the pump to fill the buckets.

To initiate operation of the pump so that it may evacuate its line, it is simply necessary to place in the chamber 63 a sufficient amount of water to form a liquid whirlpool under the action of the buckets 60. Although some water is carried off from the whirlpool by the buckets as they pass opening 60, it is returned to the whirlpool through the raceway 67 and outlet 68. In other words, this water leaves the buckets 60 before the latter return filled with air to the opening 62. Whenever the pump chamber tends to become air filled, the air will be automatically removed in this manner, and the air withdrawn from the buckets is separated from the water in the whirlpool by the centrifugal action of the latter and then discharged. The construction also enables the pump to be utilized as an air pump or compressor, and for this purpose it is simply necessary to place the supply connection 62 in communication with the air and to fill the chamber 63 with liquid.

Although the raceway is shown of substantially wedge-shaped construction, it will be understood that the same may be of the form illustrated in Fig. 10 or of any other preferred form.

Referring to Figs. 7, 8 and 9, the pump shown comprises casing sections 73, 74 having therebetween a peripheral section 75 containing a raceway 76 surrounding the impeller 77, the internal construction of the latter being the same as illustrated in Fig. 16.

The raceway 76 in the present instance is shown as of substantially circular cross section, although it may be of the form shown in Figs. 3 and 10. It has an entrance throat formed between a lip 76' and an opposite wall 78, through which the impeller periph-

erally discharges into the channel which surrounds the impeller.

The rotor impeller has an axially disposed hollow hub 80 spaced from the wall of an inlet boss 81 having a supply connection 82. The interior of the boss 81 is in communication with the raceway 76 through a space 83 between the impeller and the casing wall, so that air entering the pump through the inlet may follow the arrows 85 (Fig. 8) and enter a series of buckets 86 disposed on the lateral face of the rotor. The space 83 is interrupted at a chamber 87 which is formed integrally with the casing section 73, and is adapted to maintain a liquid air separating whirlpool, the liquid of which engages the buckets 86 as the latter pass an opening 88. This whirlpool, as in the forms previously described, serves to displace from the buckets air which enters the same through the pump inlet, the air entering the whirlpool and being separated from the water by centrifugal action. This air may pass upwardly through a passage 89 connected with the discharge connection 90, the latter being connected with an outlet 91, to which the raceway 76 leads, as indicated by the arrows 92 (Fig. 7).

At the chamber 87, the space 83 between the rotor and casing wall is closed by a close fit between the rotor and chamber wall. This fit is preferably made substantially watertight by means of complementary sealing ribs and grooves 93 upon the casing and rotor; these ribs may be used in the other forms described, if desired.

Water which is carried off from the whirlpool by means of the buckets is discharged radially outwardly as indicated by arrows 95 (Fig. 8) into the raceway and from the same is discharged through the outlet 91. Since the outlet 90 is in communication through passage 89 with the chamber 87, sufficient water will return to the chamber to maintain the whirlpool.

Due to the radial discharge of the water from the buckets in this manner, they will return to the opening 88 filled with any air which may be drawn through the pump inlet.

As in the form previously described, the pump is self-priming, and is adapted to evacuate its own supply line. Moreover, it is adapted to pump air alone; to accomplish this, it simply being necessary that the chamber 87 be initially supplied with sufficient water to maintain a whirlpool adapted to displace air from the buckets.

During liquid pumping operations, should the pump tend to become air bound, due to the entrance of air through the inlet, the buckets 86 will begin to pump air as soon as the volume of water in the pump chamber decreases to a point where the buckets are not filled with water, and after the water delivered fills the buckets, the air pumping action will, of course, be discontinued, since the buckets will

pump air only when the supply of water in the supply chamber falls so low that the buckets may pick up air.

Referring now to the form shown in Figs. 11 to 13 inclusive, the pump casing comprises 5 complementary sections 96, 97, marginally secured together as by bolts 98. The section 97 has an inlet boss 99 threaded as at 100, to receive a supply connection, the boss freely receiving a hollow hub 101 of an impeller 102 10 carried by a shaft 103. The impeller has circumferentially directed passages 104 of the same construction as illustrated in Fig. 16; these passages receive fluid from the inlet, 15 discharging the same centrifugally through peripheral openings 104' into a raceway 105, one lateral wall 106 of which is formed on the casing section 97, and the other wall 107 of which is formed on the casing section 96. 20 This raceway, which may be of any form, preferably is of the cross sectional form illustrated in Fig. 2, although it may take the form of the raceway shown in Fig. 10 or in Fig. 8, if desired. The raceway entrance 25 throat 108 is relatively narrow, and of substantially the same width as the rotor openings 104'. Radially outwardly from the rotor, the raceway remains relatively narrow, being at no point of substantially greater 30 width than the rotor periphery, although it may widen slightly, if desired, as illustrated. This channel or raceway leads around the rotor, progressively increasing in radial dimensions or depth, and discharge tangentially through an outlet 108' into a chamber 35 109 formed integral with the casing section 97. This chamber, which is of substantially circular cross section, as in the other forms, has set up therein, in part, at least, by the tan- 40 gential discharge from the raceway, a liquid air separating whirlpool. The air separated by the water by the centrifugal action of the whirlpool passes outwardly through a discharge opening 110 threaded to receive a discharge connection 11. The whirlpool is principally set up by a series of buckets 112 which 45 are disposed at the periphery of the rotor and on one lateral face. These buckets are formed between a circular series of blades 113, the longitudinal direction of which is approximately radial (Fig. 11). The blades are not inclined in a direction outwardly from the face of the rotor, but may be inclined, as shown in Fig. 15.

50 This lateral inclination of the blades (Fig. 15) may be also utilized in the forms of Figs. 1 to 9 inclusive, although it will be understood that the blades may project at right angles from the face of the rotor, if desirable.

60 The blades project at a right angle from one face of the rotor (Fig. 11) and are in communication with the chamber 109 through an opening 114 disposed directly below the raceway outlet 108', as best shown in Fig. 11. 65 The air separating whirlpool in the chamber

is maintained not only by the tangential discharge from the raceway, above described, but also by the action of the buckets as they pass the opening 114. Liquid from the whirlpool will pass the buckets and displace air 70 from the whirlpool into the buckets. This air after entering the pump inlet follows the direction of the arrows 116 through the space 115 between the rotor face and the wall of casing section 97 to the buckets. 75

As the buckets leave the chamber, into which they project as they pass the opening 114, any water carried by the buckets from the chamber is discharged radially outwardly therefrom through the space 116 into the 80 raceway 105, thus permitting the buckets to be filled with air entering the inlet before they return to the chamber. The water passes around the raceway and is returned to the whirlpool through the outlet 108'. 85 Hence, the water is being continuously returned to the whirlpool during an air pumping operation and by means other than the buckets, which are thereby permitted to return to the chamber filled with air. 90

During the liquid pumping stage, provided the pump chamber contains sufficient water to fill the buckets, the latter will not serve to pump air, but should the delivery of the pump fall sufficiently because of air entering 95 the same, the buckets will immediately function, as described, to deliver the air and thus cause the pump to resume a higher capacity liquid delivery.

The pump has been found to be highly 100 efficient in operating upon air alone, not only for evacuating the supply line, but for the purpose of compressing air, as in the forms previously described. The intake connection is preferably of a character which may be 105 placed in communication with the air whenever it is desired to pump air alone. It will be understood, of course, that preliminary to such an operation, the chamber 109 should first be filled with water so that there will 110 be maintained therein the whirlpool necessary to displace the air from the buckets.

Referring to Figs. 14 and 15, there is shown a modified form of impeller construction which may be used in place of that shown in 115 Figs. 11 and 12. In this form, the buckets do not extend to the periphery of the pump, but are closed by means of a peripheral web 117. The buckets are formed by laterally directed blades 118, the edges of which may 120 be substantially flush with the rotor face 119, or may project beyond this surface, if desired. The buckets have bottoms 120, which are arcuate in radial planes, and as will be understood, are engaged by the whirlpool in 125 chamber 109 (Fig. 12) in the same manner as the buckets of the form shown in that figure.

As illustrated in Fig. 15, the blades 118 may be inclined in a lateral direction, and along their longitudinal edges 117 may be 130

exactly radial, or if desired, disposed in planes which are substantially chords of the rotor circumference, as shown in my co-

5 If desired, the rotor of all the forms described may have associated therewith the lateral adjusting means disclosed in my Patent 1,686,549, October 9, 1929, and the blades thereon may be of the form shown in
10 said patent. For purposes of description, I have referred to "air" and "water" as the pumped fluid, but it will be understood that these terms are used in both the description and claims to cover respectively any gas or
15 liquid to be pumped.

Obviously, the invention is not limited to the details of construction above described, and numerous modifications may be made therein without departing from the inven-
20 tion. Although the general method of operation described may be carried out by any of the structures, it will be understood that the method is not limited to the mechanical construction disclosed, and that various
25 forms of pump construction may be utilized for practicing the same.

I claim:

1. A centrifugal pump comprising a rotor having a centrifugal discharge, a casing
30 having an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into which the rotor discharges, said casing having an outlet with which the channel communicates and
35 through which it discharges, a series of rotatable buckets disposed laterally of the rotor and rotatable therewith adapted to receive air entering the pump casing, means for maintaining by the action of said buckets a liquid
40 whirlpool, the liquid from which engages the buckets and displaces their contents into the whirlpool, and means for leading liquid carried by the buckets from the whirlpool back to the latter.

45 2. A centrifugal pump comprising a rotor having a centrifugal discharge, a casing having an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into which the rotor discharges, said casing having an outlet with which the
50 channel communicates and through which it discharges, a series of buckets disposed on a lateral face of said rotor, means for maintaining by the action of said buckets a liquid
55 whirlpool, the liquid from which engages the buckets and displaces the contents of the latter into the whirlpool, said buckets being adapted to discharge liquid carried from the whirlpool before they return to the latter, and
60 means for returning to the whirlpool liquid carried therefrom by the buckets.

3. A centrifugal pump comprising a rotor having a centrifugal discharge, a casing hav-
65 ing an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arc-

ate fluid channel into which the rotor dis-
charges, said casing having an outlet with which the channel communicates and through which it discharges, a series of buckets on the rotor adapted to receive air entering the
70 pump and disposed on a lateral face of said rotor, means for maintaining by the action of said buckets a liquid whirlpool the liquid from which engages the buckets and displaces the contents of the latter into the whirl-
75 pool, and means for receiving from the buckets and returning to the whirlpool liquid carried therefrom by the buckets.

4. A centrifugal pump comprising a rotor having a series of passages leading toward its periphery, a casing having an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into which the rotor discharges, said casing having an
80 outlet with which the channel communicates and through which it discharges, a series of buckets on the rotor adapted to receive air, means for maintaining by the action of said buckets a liquid whirlpool, the liquid from which engages the buckets and displaces the
85 contents of the latter into the whirlpool, and means for leading directly to said channel liquid carried from the whirlpool by the buckets, said whirlpool maintaining means being
90 in communication with said channel.

5. A centrifugal pump comprising a rotor having a centrifugal discharge, a casing hav-
95 ing an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into which the rotor centrifugally discharges, said casing having an outlet with which the channel communicates and through which it discharges, a series of
100 rotatable buckets disposed laterally of the rotor and rotatable therewith adapted to receive air entering the pump, means for maintaining by the action of said buckets a liquid whirlpool, the liquid from which engages the
105 buckets and displaces the contents of the latter into the whirlpool, and means for directing to the channel liquid carried by the buckets from the whirlpool, said whirlpool main-
110 taining means being in communication with said channel through said outlet whereby the liquid is returned to the whirlpool.

6. A centrifugal pump comprising a rotor having a series of passages leading toward its periphery, a casing having an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into
120 which the rotor discharges, said casing having an outlet with which the channel communicates and through which it discharges, a series of buckets adapted to receive air disposed on a lateral face of said rotor, means
125 for maintaining by the action of said buckets a liquid whirlpool, the liquid from which engages the buckets and displaces the contents of the latter into the whirlpool, and means for directing back to the whirlpool liquid carried
130

therefrom by the buckets, said means including said channel.

7. A centrifugal pump comprising a rotor having a series of passages leading toward its periphery, a casing having an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into which the rotor discharges, said casing having an outlet with which the channel communicates and through which it discharges, a series of buckets adapted to receive air independently of said passages and disposed on a lateral face of said rotor, means for maintaining by the action of said buckets a liquid whirlpool, the liquid from which engages the buckets and displaces the contents of the latter into the whirlpool, and means for directing back to the whirlpool liquid carried therefrom by the buckets, said means including said channel.

8. A centrifugal pump comprising a rotor having a series of passages leading toward its periphery, a casing having an inlet adapted to introduce fluid to the rotor inwardly from its periphery, an arcuate fluid channel into which the rotor discharges from its periphery, said casing having an outlet with which the channel communicates and through which it discharges, a series of buckets adapted to receive air through said inlet, means for maintaining by the action of said buckets a liquid whirlpool, the liquid from which engages the buckets and displaces the contents of the latter into the whirlpool, and means independent of the buckets for returning to the whirlpool liquid carried therefrom by the buckets.

9. In a pump, a rotor having a centrifugal discharge, a casing having an inlet adapted to introduce fluid into said rotor inwardly from its periphery and having a fluid channel around the rotor to receive the fluid impelled thereby, said casing also having an outlet opening leading from said channel, a discharge connection in communication with said outlet opening, a series of buckets rotatable simultaneously with the rotor in communication with an air inlet, a chamber for maintaining by the action of the rotor a liquid air separating whirlpool which engages the buckets and causes introduction of air into the whirlpool from the buckets, the chamber being in communication with the buckets through an opening in the chamber wall, and means independent of the buckets for returning to the chamber liquid which is carried from the whirlpool in the buckets.

10. In a pump, a rotor having a centrifugal discharge, a casing having an inlet adapted to introduce fluid into said rotor inwardly from its periphery and having a fluid channel to receive the fluid peripherally impelled thereby, said casing also having an outlet opening leading from said channel, a discharge connection in communication with said outlet

opening, a series of buckets on said rotor opening laterally therefrom and in communication with an air inlet, a chamber for maintaining by the action of the rotor a liquid air separating whirlpool which engages the buckets and causes introduction of air from the buckets into the whirlpool from the buckets, the chamber being in communication with the buckets through an opening in the chamber wall, means for permitting discharge from the buckets into said channel, there being a communication between the channel and said chamber whereby liquid carried off by the buckets from the whirlpool is returned to the latter.

11. The method of operating a centrifugal pump having a centrifugally discharging rotor and air carrying buckets which comprises maintaining in communication with the air carrying buckets a body of liquid, setting up in said body by the rotor action an air separating whirlpool, utilizing the whirling action of said body to displace air into the whirlpool from the buckets, and returning to the whirlpool by means other than the buckets the air displacing liquid which is carried from the whirlpool by the rotor buckets.

12. The method of operating a centrifugal pump having a centrifugally discharging rotor and air carrying buckets which comprises maintaining in communication with the air carrying buckets a body of liquid, setting up in said body by the rotor action an air separating whirlpool, utilizing the whirling action of said body to displace air into the whirlpool from the buckets, and returning the liquid carried from the whirlpool by the rotor buckets to a part of the whirlpool other than that engaged by the buckets.

13. The method of operating a centrifugal pump having a centrifugally discharging rotor and air carrying buckets which comprises maintaining in communication with the air carrying buckets a body of liquid, setting up in said body by the rotor action an air separating whirlpool, utilizing the whirling action of said body to displace air into the whirlpool from the buckets, returning to the whirlpool the air displacing liquid which is carried from the whirlpool by the rotor buckets by discharging the liquid from the buckets before the same return to the whirlpool and re-introducing the liquid into the whirlpool through a passage independent of the buckets communicating therewith.

14. The method of operating a centrifugal pump having a main discharge outlet which comprises maintaining a portion of the pumped liquid adjacent the rotor, setting up by the action of the rotor at a point separate from said outlet, but in communication therewith, a liquid air separating whirlpool, utilizing the whirling action of said liquid to displace air from the rotor into the whirlpool

at a point other than said outlet, discharging the separated air from the whirlpool and returning to the whirlpool through said outlet liquid carried therefrom by the rotor.

5 15. The method of operating a centrifugal pump having a main discharge outlet which comprises maintaining a portion of the pumped liquid adjacent the rotor, setting up
10 by the action of the rotor at a point separate from said outlet a liquid air separating whirlpool, utilizing the whirling action of said liquid to displace air from the rotor into the whirlpool at a point other than said outlet,
15 discharging from the whirlpool-engaging portion water carried thereby from the whirlpool, whereby said portion may return to the whirlpool freed of water, taking up air in said portion, and returning said discharged water to the whirlpool.

20 16. The method of operating a centrifugal pump having a raceway and a main discharge outlet leading therefrom, and a rotor adapted to discharge centrifugally into said raceway,
25 which comprises maintaining a portion of the pumped liquid adjacent the rotor, setting up by the action of the rotor at a point separate from said outlet and radially inwardly from the raceway, a liquid air separating whirlpool, utilizing the whirling action of said
30 liquid to displace air from the rotor into the whirlpool at a point other than said outlet, discharging from the whirlpool-engaging portion into the raceway water carried thereby from the whirlpool, whereby said portion
35 may return to the whirlpool freed of water, taking up air in said portion, and returning said discharged water to the whirlpool.

In testimony whereof I have hereunto set my hand.

40 ARTHUR W. BURKS.

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