July 12, 1927. 1,635,786

R. E. L. HOLMES

PUMP

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Fig. 2.

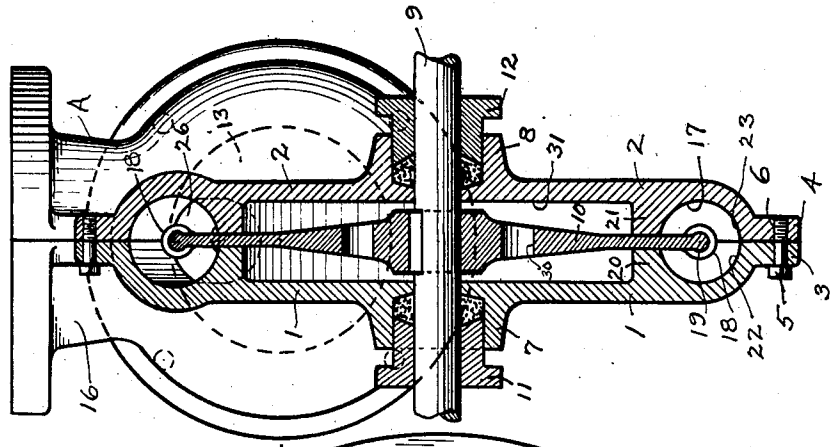
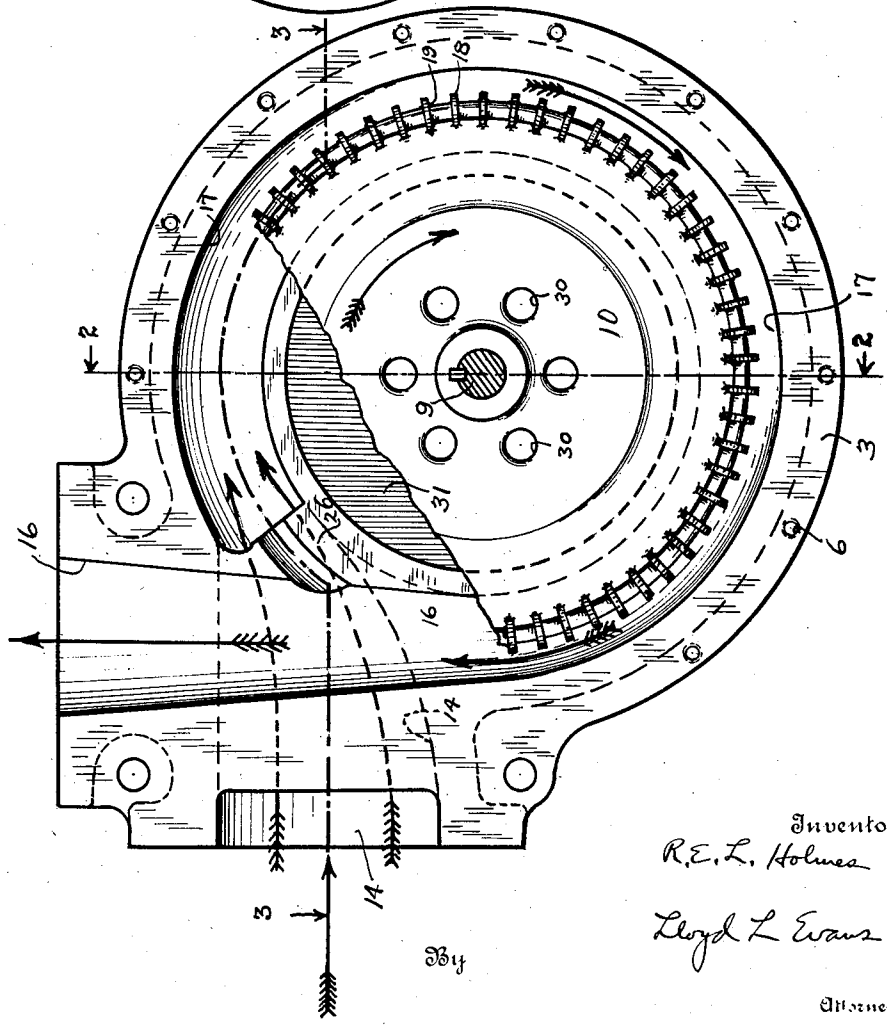


Fig. 1.



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FIG. 4.

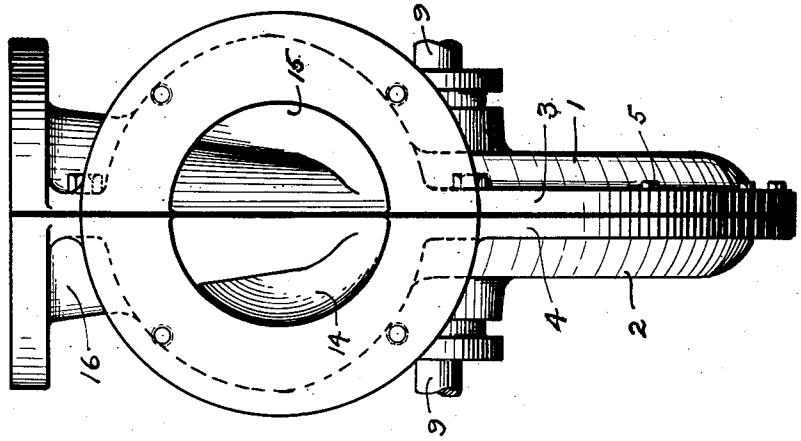
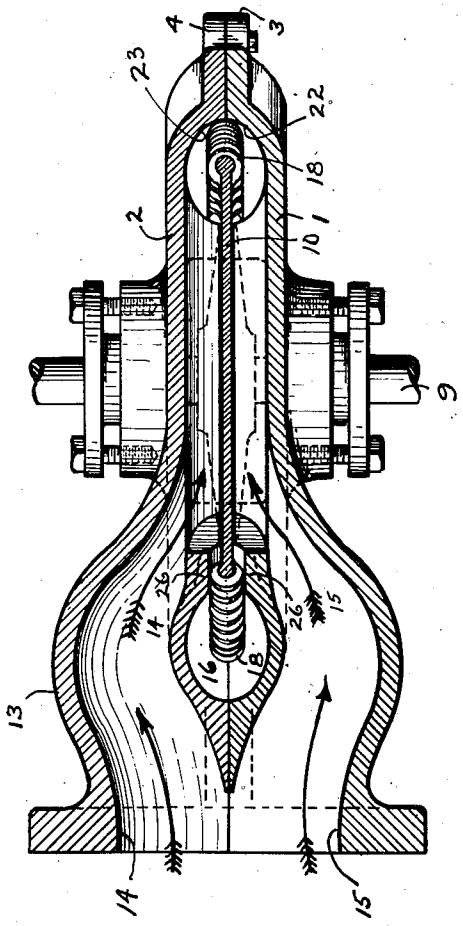


FIG. 3.



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FIG. 6.

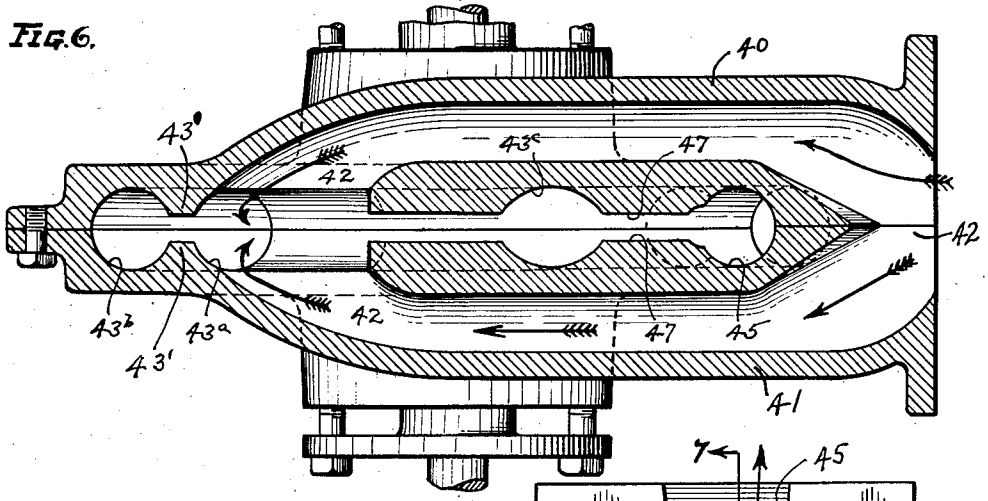
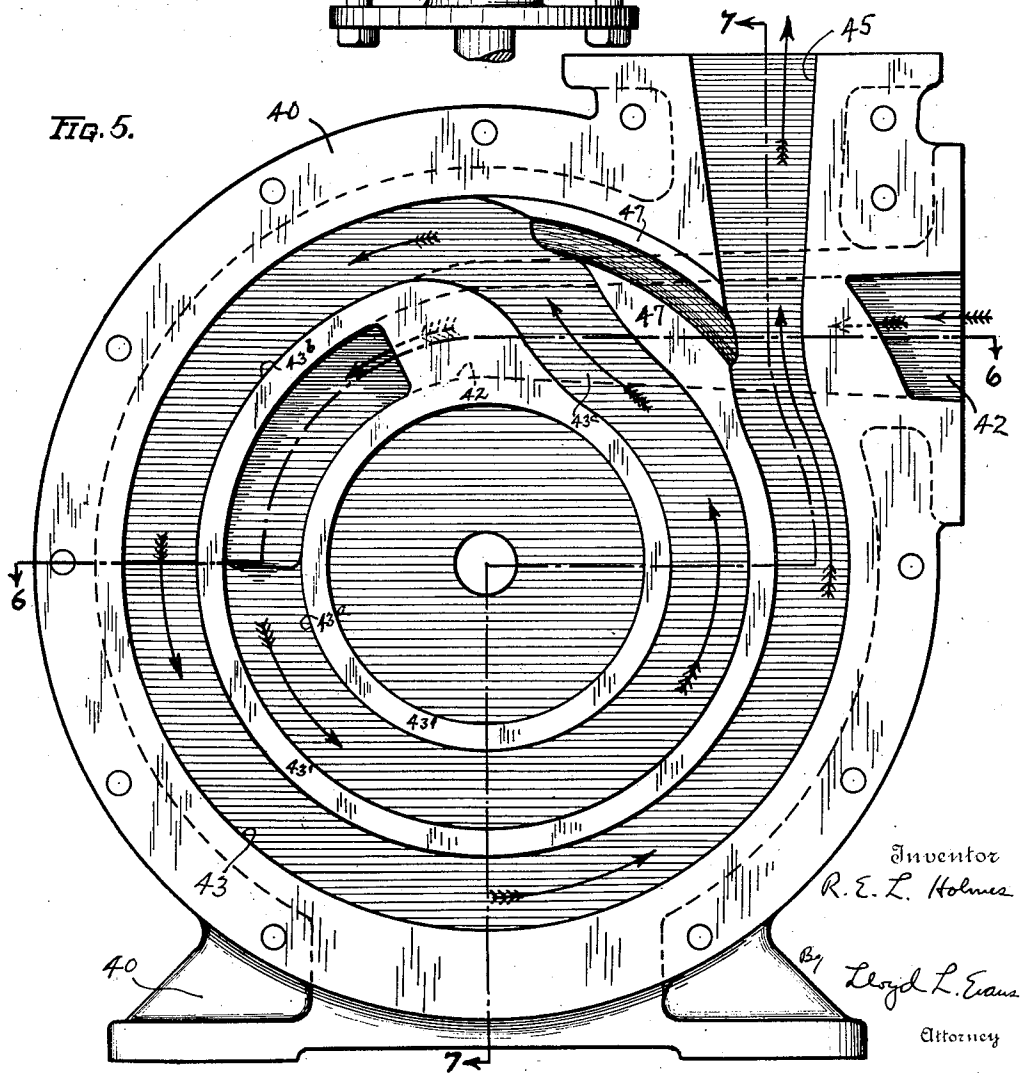


FIG. 5.



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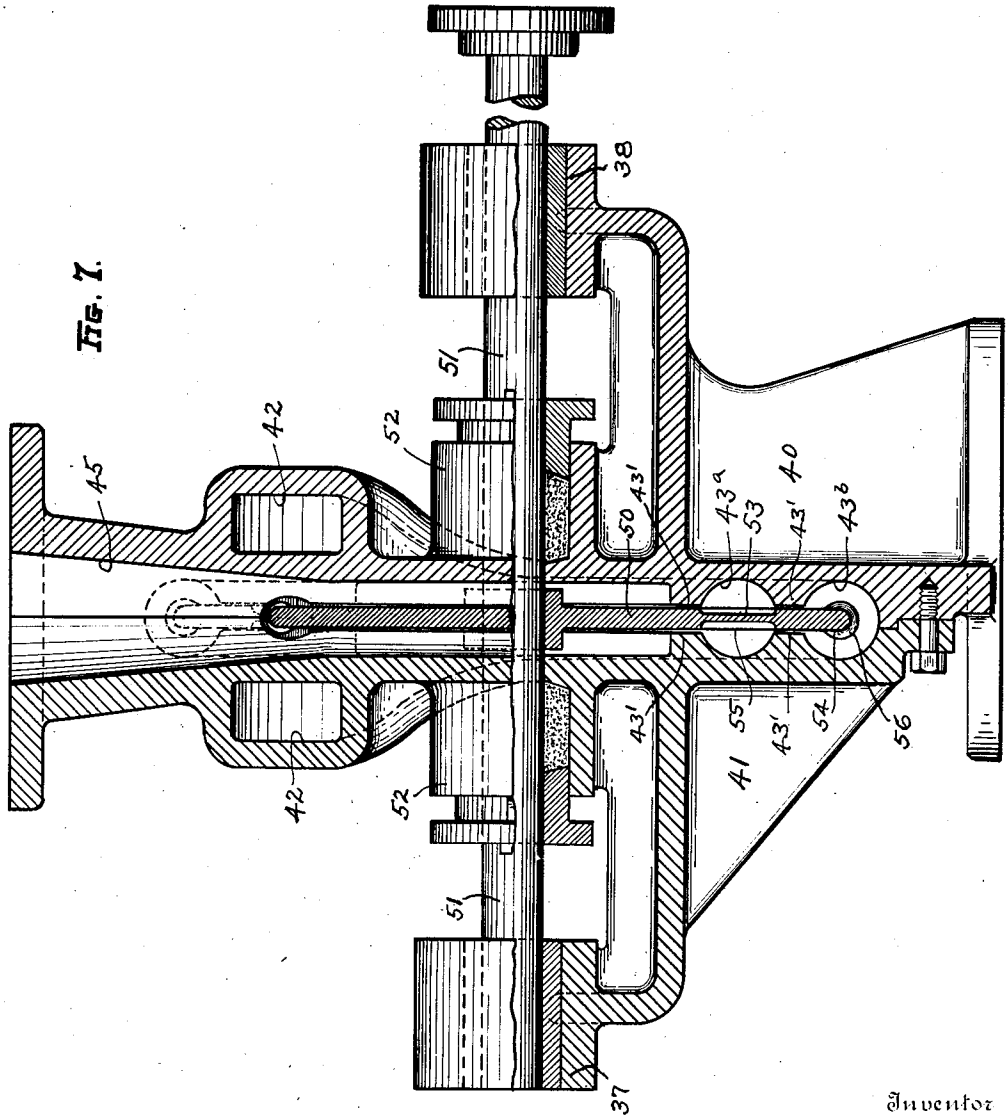
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Fig. 7.



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UNITED STATES PATENT OFFICE.

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PUMP.

Application filed June 16, 1924. Serial No. 720,253.

This invention relates to rotary pumps, and more particularly to the class of pumps having a rotor mounted in a casing.

An object of the invention is to provide a pump with a curved or annular passage or passages and with a rotor which engages fluid in such passages and causes it to be delivered to a suitable discharge with increased efficiency and with a relatively larger pressure or volume, or both, than heretofore attainable in a single rotor pump.

Heretofore pumps have been designed which have incorporated rotating members with impellers or blades to engage the water and force it to the discharge opening. In such designs particular attention has been paid to the shape of the blades, or the shape of the buckets, so that the water contained therein could be thrown outwardly in the channel to thus take advantage of the centrifugal force inherent in such construction.

After considerable study and observation of such pumps I have found that it is only necessary that the rotating members have pockets of such a character that sufficient water will be contained in them to adhere to the water in the passage so that it can be carried along with the rotating member due to its properties of adhesion and viscosity.

I have found that the pockets may be shaped within relatively wide limits, that is, they may be simply cylindrical recesses in the face of the rotor of sufficient depth to hold small quantities of liquid therein, or they may be slots, perforations, depressions, apertures or the like. Preferably there should be a relatively large number of such small independent pockets so that the surface or surfaces of the rotor contacting with the water in the passage or passages after these pockets have been filled with liquid will comprise as nearly as possible a maximum of liquid to which the liquid in the passage or passages may adhere and thus be carried around with the rotor. The number, size and shape of the pockets may be varied according to the duty to be performed and the character and viscosity of the liquid to be handled, the important factor being that the number, size and shape of the pockets be such that the area of metal at the outer surface or surfaces of the rotor when the pockets have been filled with liquid be reduced to a minimum.

These and other objects will be apparent from the following description and annexed drawings, in which

Figure 1 is a face view of one half of the pump casing with the rotor enclosed and part of the rotor broken away.

Fig. 2 is a section on line 2—2, Fig. 1.

Fig. 3 is a section on line 3—3, Fig. 1.

Fig. 4 is an elevation looking in the inlet opening.

Fig. 5 is an elevation of a modified form of pump.

Fig. 6 is a section on line 6—6, Fig. 5.

Fig. 7 is a section on line 7—7, Fig. 5.

In the embodiment of my invention shown in Figs. 1 to 4 of the drawings, the pump comprises a casing, indicated generally at A, and formed of cup-shaped members 1 and 2 having outer flanges 3, 4 which may be held together by any suitable means such as bolts 5 which pass through one of the members and engage threaded apertures 6 in the other member. The members 1 and 2 of the casing are each provided with laterally extending tubular bosses 7 and 8, respectively, to receive the shaft 9 to which the rotor 10 is keyed or otherwise secured for rotation therewith. These bosses may receive suitable packing material, thus forming stuffing boxes closed by the nuts 11, 12, which surround the shaft 9 and are threaded into the bosses.

The shaft 9 may be carried by suitable outboard bearings 37, 38, such as indicated in Fig. 7, and may be driven by any desired power means, such as a motor (not shown).

Projecting inwardly from the members 1 and 2 of the casing are annular ribs or flanges 20, 21 which form the inner walls of the passage 17 and are disposed to have a close running fit with the faces of the rotor 10 to prevent any substantial flow of liquid radially inwardly from the passage 17. The outer walls of the passage 17 are formed by the outer curved portions of the pump casing which meet at 22, 23, and which are extended to form the flanges 3 and 4. It is obvious, of course, that the inner wall of the passage may project from the rotor but this is not a preferred construction because it in-

creases the effective area of the rotor against which the pressure of the liquid in the passage 17 can bear.

I have found that aside from the design of the rotor there are several essentials in the design of the water passage in order for the water to be taken into the pump and delivered in large quantities and at relatively high pressure efficiently. One of these features is to arrange the inlet and outlet substantially tangentially to the passage in the casing engaged by the rotor. In the form shown in Figs. 1 to 4 of the drawings where the annular passage comprises one turn that extends substantially once around the circumference of the casing, it is necessary that either the inlet or outlet be divided to permit the other to pass between the divided portions. I have, therefore, shown the inlet 13 as divided from the inlet opening into two passages 14 and 15, one of which is disposed on one side of the rotor and one on the other, and between these passages 14 and 15 is disposed the outlet 16 of the curved or annular passage 17 in the casing.

By this means of placing the inlet and outlet passages substantially tangentially to the passage 17 wherein the fluid is engaged by the rotor, I provide a minimum of change in the velocity and direction of the flow of the fluid and thus cause the fluid to move in natural lines of least resistance.

This also enables me to provide a curved passage of considerably more than 270° extent wherein the rotor blades act on the liquid in the passage. This greatly increases the effective length of pressure developing channel wherein the rotor buckets engage the liquid. By arranging the outlet and inlet portions of the passage tangentially of the adjacent curved passage, and by crossing them without communication, the extent of the peripheral passage that is effective in developing pressure is limited only by the dimension of the stop for deflecting liquid from the curved passage to the outlet and for preventing free flow of liquid from the outlet to the inlet end of the curved passage.

The rotor 10 may have pockets of various number, size and shape, as I have mentioned above. In the present instance, however, I have shown in Figs. 1 to 4 a rotor having a periphery substantially circular in cross section and conforming to the cross sectional shape of the annular passage 17 in the pump. The peripheral portion, however, is preferably formed integral with the web of the rotor and is also provided with cuts or slots so that ribs 18 remain standing up from the face of the rotor to define pockets 19 in the body of the rotor to contain liquid.

It will thus be seen that there will be a relatively large number of these small pockets to contain liquid which engages and adheres to the liquid in the passage 17 in the pump and causes the latter, upon movement of the rotor, to flow around the passage from the inlet to the outlet.

Between the tangential outlet 16 and the inner end of the inlet 13 is disposed a water stop of sufficient size to extend over a plurality of the pockets in the rotor. The stop has a close running fit with the rotor and comprises projecting members 26 from the casing members 1 and 2. These members 26 are preferably formed integral with the outer and inner walls defining the annular passage 17 and conform to the peripheral shape of the rotor so that leakage of liquid from the passage 17 and the outlet toward the inlet and the beginning of the passage 17 is substantially prevented. If the rotor carries ribs or blades projecting from the surface thereof, the stop obviously must be recessed along the lines of rotation of such ribs or blades, so that they can pass therethrough without interference. Also, the stop is preferably so disposed that it does not project into the outlet 16 and thus interfere with the easy egress of liquid from the pump.

It is desirable, of course, to have the suction line as large as practical to facilitate the flow of water into the pump. The size of the water passage in the pump, however, in order to be efficient must be so proportioned that substantially all the liquid therein is readily affected by adhesion to the liquid in the pockets in the rotor and can thus be carried along with the rotor. By providing a tapered inlet to the passage in the pump engaged by the rotor, I accomplish these results, namely of utilizing a large suction line and a smaller passage in the pump, and thus also effect a nozzle action changing the pressure head of the water into velocity head.

I have also found it to be quite desirable to facilitate the increase in velocity of water in the passage 17 in the pump by progressively tapering the passage from a point adjacent the inlet to a point a substantial distance around the passage 17 after the water is engaged by the rotor. Such tapering of the passage in the pump is dependent upon the design of the pump and the performance desired and it may be that the passage may be tapered one-third or one-half, or even all the way around. This tapering of the passage or this reduction of cross sectional area allows the water in the pockets in the rotor to engage the incoming water and gradually move it along and bring it up to a maximum speed without breaking the adhesion and thus causing eddying and loss of power and efficiency. The distance for which the water passage in the pump casing should be tapered is, therefore, dependent

upon the relative speed of the rotor, the size of the passage, and the viscosity of the liquid being pumped.

The adhesion of the incoming liquid to the liquid carried in the pockets of the rotor is greatly facilitated by dividing the inlet into two portions so that one stream of liquid is directed on each side of the rotor and these portions of the casing are curved and shaped to cause the liquid to move in natural lines of least resistance, as well as being convergently tapered for the purpose set forth above.

In this type of pump the velocity attained by the liquid is usually so high near the discharge portion that considerable power and efficiency are lost unless the velocity head of the liquid is converted into pressure head. I have, therefore, found it very desirable to gradually taper and enlarge the outlet from a point adjacent the stop to form in effect a Venturi tube, and by this means take advantage of the high velocity of the liquid and utilize it to increase the pressure head. It is also very desirable as mentioned above, to have the outlet tangential to the passage in the casing to decrease the resistance of the rapidly flowing liquid from the pump.

Preferably adjacent the central portion of the rotor I provide perforations 30 which serve to balance or equalize the pressure of the liquid on each side of the rotor and thus prevent the pressure of the liquid in the inner portion 31 of the casing from forcing the rotor over against either side of the casing and causing excessive wear or short-circuiting of the liquid from one portion of the outer liquid passage radially across the passage wall of the casing to another portion of the outer passage.

While I have shown in Figs. 1 to 4 a pump having an annular passage of only one turn, that is extending around the pump only once circumferentially, it is of course to be understood that a pump involving my principles and having a plurality of turns may readily be designed and come within the scope of my invention. I have shown one such form of pump in Figs. 5 to 7. In this form the casing members 40, 41 are similar to those shown in connection with the pump above described. The inlet 42 is disposed nearer the central portion of the pump casing as the passage 43 of the pump is shown having substantially two complete turns, one inside the other. The passage 43 is formed by walls 43′ projecting inwardly from the casing and comprises, as shown in Fig. 5, two annular, concentric portions 43^a and 43^b and connecting these portions is a crossover passage 43^c. The inlet 42 is divided and the outlet 45 passes between the divided portions, and both the inlet and outlet are arranged substantially tangentially to the passage 43. A stop 47 is arranged in the casing to direct the flow of liquid into the outlet and to prevent the flow of liquid toward the inlet or the passage 43. The stop of course is of sufficient size to cover a plurality of pockets in the rotor so as to prevent leakage of liquid from one passage into another through the pockets.

Since the passage 43 comprises an inner turn wherein passageways are formed on opposite sides of the rotor and an outer turn wherein the rotor buckets are formed on the periphery of the rotor, these portions of the passage 43 for convenience have been distinguished in certain of the claims by referring to the inner turn passage portions as opposed passageways and to the outer passage portion as the peripheral passageway.

The rotor 50 is secured to the shaft 51 to rotate therewith and the latter may be driven by any suitable power means (not shown). The pump casing is provided with stuffing boxes 52 to engage the rotor shaft and prevent leakage of water from the casing. Also the shaft 51 is preferably mounted in outboard bearings so that the rotor will be held rigidly against inclining or wobbling toward the axis of the shaft 51.

In this embodiment of the invention the rotor is provided with two annular series of pockets 53 and 54. The pockets 53 are formed by cutting recesses in the faces of the rotor and leaving upstanding rib portions 55 and these pockets are arranged to engage the passage 43^a. The pockets 54 are formed in the outer portion of the rotor to engage the liquid in the passage 43^b. These pockets may be of any suitable size and shape but are shown in the drawings as being between ribs 56 similar to those carried by the pump shown in Fig. 1.

The inlet 42 is preferably tapered convergently and the passage 43^a may be tapered progressively smaller a substantial distance around its circumference from the inlet. Also, the outlet 45 may be tapered divergently to convert the higher velocity head attainable in this pump to pressure head and thus increase the efficiency of the pump.

It will also be seen that my invention is capable of use as a motor in which the rotor may be driven by a head of water circulating in the pump passage and power can be taken from the rotor shaft outside the pump.

Furthermore, it is to be understood that the particular forms of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. In a rotary pump, the combination of a

rotor, a casing enclosing the rotor and having a suitable peripheral inlet and peripheral outlet, a curved passage formed in said casing and extending more than 270° around the casing from the inlet to the outlet, said inlet and outlet being substantially tangential to the curved passage, and crossing each other without communication, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

2. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said curved passage comprising a plurality of turns, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly, said curved passage progressively decreasing in cross-sectional area from the inlet for a substantial distance toward the outlet, whereby the inner turn of the passage has a larger capacity than the outer turn of such passage.

3. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable peripheral inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, said inlet being divided to cause the incoming liquid to enter said curved passage in two streams, one on one side of the rotor and the other on the other side of the rotor, said divided inlet passages being arranged to provide a relatively small change in the direction of flow of the liquid into said curved passage whereby the liquid may be gradually introduced to the rotor, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

4. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable peripheral inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, said inlet being divided into two portions to surround said outlet and direct the incoming liquid to both sides of the rotor, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

5. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable peripheral inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, said inlet being divided to direct the incoming liquid to both sides of the rotor, said curved passage being tapered for a substantial distance from the inlet portion toward the outlet, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

6. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said curved passage extending around the circumference of the pump casing more than once, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

7. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said curved passage comprising a plurality of turns, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls forming

said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

8. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable inlet and outlet, a curved passage formed in said casing and extending from the inlet to the outlet, said curved passage comprising a plurality of annular concentric portions each extending nearly around the circumference of the casing and each portion connected with the adjacent outer portion by a connecting passage, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop adjacent the outlet and arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly.

9. In a rotary pump, the combination of a rotor, a casing enclosing the rotor having a suitable inlet and outlet, a curved passage defined by the rotor and casing extending from the inlet to the outlet, said curved passage comprising a plurality of turns, said rotor having a multiplicity of pockets therein arranged to engage liquid in said passage, and a stop adjacent the outlet arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls cooperating therewith to form the passage being disposed sufficiently close to each other to prevent substantial flow of liquid radially inwardly from the passage, said curved passage progressively changing in cross sectional area over a portion of its length whereby the inner turn of the passage has a different capacity than the outer turn of the passage.

10. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable inlet and outlet, said rotor and casing cooperating to form a curved passage of more than one turn connecting the inlet and outlet, said rotor having a multiplicity of pockets therein arranged in a plurality of series and disposed to engage liquid in the passage, one series of said pockets being arranged radially inward from the other series of pockets, and a stop adjacent the outlet arranged to deflect liquid from the passage to the outlet of the casing, the cooperating portions of the rotor and stator that define the passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inward from the passage.

11. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable inlet and a suitable outlet, said rotor and casing cooperating to form a curved passage of more than one turn connecting the inlet and outlet, said rotor having a multiplicity of pockets therein disposed to engage liquid in said passage, and a stop closely fitting the rotor and arranged to deflect liquid from the passage to the outlet, the portions of the rotor and the portions of the casing cooperating to form the passage being disposed sufficiently close to each other to prevent substantial flow of liquid radially inward from the passage.

12. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and defining therewith a curved passage that is connected at its ends respectively to an inlet and an outlet each of which is formed in the outer periphery of the casing, said rotor having a multiplicity of pockets therein adapted to engage liquid in said passage, a stop adjacent the outlet arranged to deflect liquid from the rotor to the outlet, the end portions of the passage connecting respectively with the inlet and outlet being arranged substantially tangentially relative to the adjacent curved portion thereof and said end portions crossing each other without intercommunication, the portions of the rotor and the portions of the casing forming the passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inward from the passage.

13. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and defining therewith a curved passage of more than one turn that is connected at its ends respectively to an inlet and an outlet formed in the casing, said rotor having a multiplicity of pockets therein adapted to engage liquid in said passage, a stop adjacent the outlet arranged to deflect liquid from the rotor to the outlet, the end portions of the passage connecting respectively with the inlet and outlet being arranged substantially tangentially relative to the adjacent curved portion thereof and said end portions crossing each other without intercommunication, the portions of the rotor and the portions of the casing forming the passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inward from the passage.

14. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and defining therewith a curved passage that is connected at its ends respectively to a peripheral inlet and an outlet formed in the casing, the end portions of the passage connecting respectively with the inlet and outlet being arranged substantially tangentially relative to the adjacent curved portion of the passage, said inlet end portion being adapted to introduce liquid into the passage from a lateral side thereof, the radial dimension of

the passage being only a fractional part of the radius of curvature thereof, the cooperating portions of the rotor and the casing forming the passage being sufficiently close to each other to prevent a substantial inward flow of liquid from the passage between the casing and the rotor, said rotor having a multiplicity of pockets therein adapted to engage liquid in the passage, and stops arranged adjacent the outlet adapted to deflect liquid from the rotor to the outlet.

15. In a rotary pump the combination of a rotor, a casing enclosing the rotor and defining therewith a curved passage comprising a plurality of turns, one end portion of the passage being connected to an inlet formed in the casing and the other end portion being connected to an outlet formed in the casing, said rotor having a multiplicity of pockets therein arranged in a plurality of concentric series of different diameters adapted to engage liquid in the passage, a stop adjacent the outlet arranged to substantially prevent the free flow of liquid from the outlet portion of the passage toward the inlet portion, the cooperating portions of the rotor and casing forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inward from the passage, the innermost turn of the passage being of greater cross sectional area throughout its length than the outermost passage.

16. In a rotary pump, the combination of a casing, opposed annular passageways near the inner periphery of the casing but spaced therefrom, and a peripheral passageway of greater diameter than the opposed passageways communicating with the outlet ends of the opposed passageways, a rotor fitting snugly within the casing and having pockets on opposite sides thereof aligned with said opposed passageways, said rotor also having peripherally arranged pockets adapted to act on liquid in the peripheral passageway, and the inlet and outlet ports communicating with said passageways.

17. A pump comprising a casing and a rotor, said rotor and casing cooperating to define a plurality of annular passages spaced from the periphery of the rotor and arranged on opposite sides thereof, blades carried by the rotor adapted to engage liquid in said passages, an annular peripheral passageway also defined by the rotor and casing and communicating with said first named passages and of greater diameter than the first named passages and arranged concentric therewith, blades carried by the rotor adapted to engage liquid in the peripheral passage, the rotor and casing having a substantially liquid-tight fit radially inward of each of said passages, and supply and discharge ducts cooperating with the extremities of said passages.

18. A pump comprising a casing having two parallel opposed fluid raceways and a common inlet for said raceways, a third raceway of greater diameter than said parallel raceways arranged concentrically therewith and communicating with one end of said parallel raceways, an outlet for the third raceway, and a rotor having annular series of buckets adapted to engage liquid in each raceway.

19. In a rotary pump, a casing, opposed annular passageways spaced from the periphery of the casing, a rotor within the casing having pockets on opposite sides thereof aligned with said passageways, an inlet port communicating directly with each of said passageways, a peripheral passageway communicating with the delivery end of each of said annular passageways, and an outlet port communicating directly with said peripheral passageway.

20. A pump comprising a rotor having an annular groove in one surface, a plurality of blades in the groove forming a series of buckets spaced inwardly from the periphery of the rotor, a second series of blades carried on the periphery of the rotor, a casing making substantially water-tight joints with the lateral surface of the rotor on opposite sides of the groove to form a radially closed fluid raceway, said casing also cooperating with the rotor to define a radially water-tight peripheral passageway of greater diameter than the first mentioned passageway, an inlet for the passageway of lesser diameter formed in the casing, an outlet for the passage of greater diameter formed in the casing, and a communicating duct leading from the discharge end of the first passageway into the liquid receiving end of the second passageway.

21. In a rotary pump the combination of a casing, and a rotor enclosed therein and defining therewith a plurality of annular communicating passageways having concentric portions of different radii of curvature, the radial width of said passageways being only a fractional part of their longitudinal extent, said rotor having a multiplicity of buckets concentrically arranged and disposed in different annular series, each annular series of said buckets being adapted to engage liquid in the passageway of corresponding diameter.

22. In a rotary pump the combination of a casing, and a rotor enclosed therein and defining therewith a plurality of annular communicating passageways having concentric portions of different radii of curvature, the radial width of said passageways being only a fractional part of their longitudinal extent, said rotor having a multiplicity of buckets concentrically arranged and disposed in different annular series, each annular series of said buckets being adapted to

engage liquid in the passageway of corresponding diameter, the cross sectional area of the channel in which the buckets operate being of greater dimension for the slower moving series of buckets than for the faster moving series of buckets.

23. In a rotary pump, the combination of a rotor, a casing enclosing the rotor and having a suitable peripheral inlet and peripheral outlet, a curved passage extending more than 270° around the casing from the inlet to the outlet and having a radius of curvature over one portion of its length materially less than the radius of curvature of other portions of its length, said passage being of less cross sectional area throughout than said inlet and being of greatest cross sectional area over the portion of least radius of curvature, said inlet and outlet being disposed tangentially to the curved passage and being tapered convergently and divergently, respectively, in the direction of flow of the liquid and crossing each other without communication therebetween, said rotor having a multiplicity of pockets arranged in series of different diameters and so disposed as to engage liquid in the different portions of said passage, and a stop adjacent the outlet arranged to substantially prevent the flow of liquid from the outlet portion of the passage toward the inlet portion, the faces of the rotor and the faces of the walls forming said passage being disposed sufficiently close to each other to prevent a substantial flow of liquid radially inwardly from the passage.

In testimony whereof, I hereunto affix my signature.

ROBERT E. L. HOLMES.