No. 681,581. Patented Aug. 27, 1901.

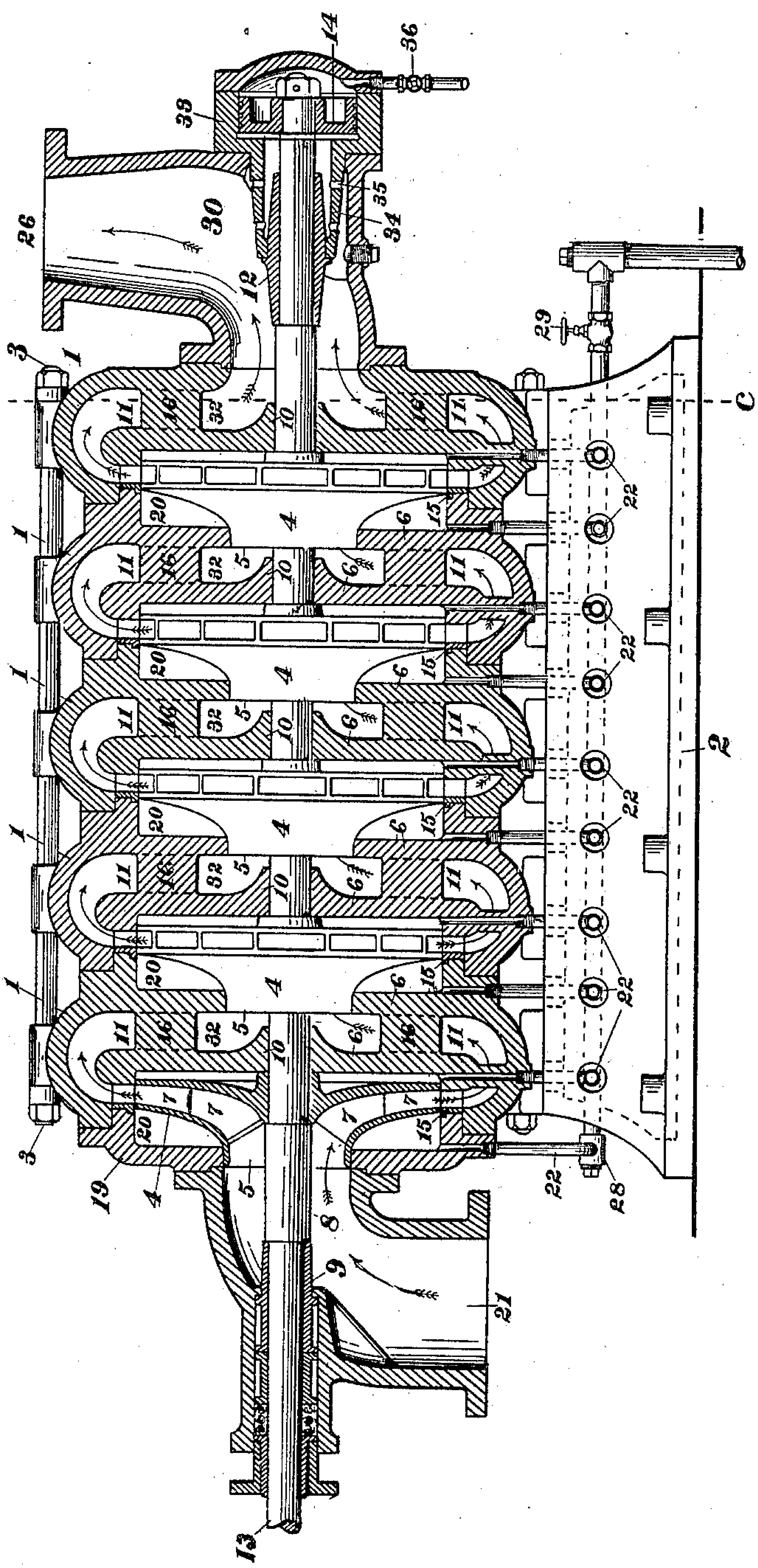
## J. RICHARDS.

## HIGH PRESSURE ROTARY PUMP.

(Application filed Jan. 21, 1901.)

(No Model.) 2 Sheets—Sheet 1.

Fig. I




Witnesses
P. W. J. Lander
Elmer Wickes.

Inventor
John Richards.

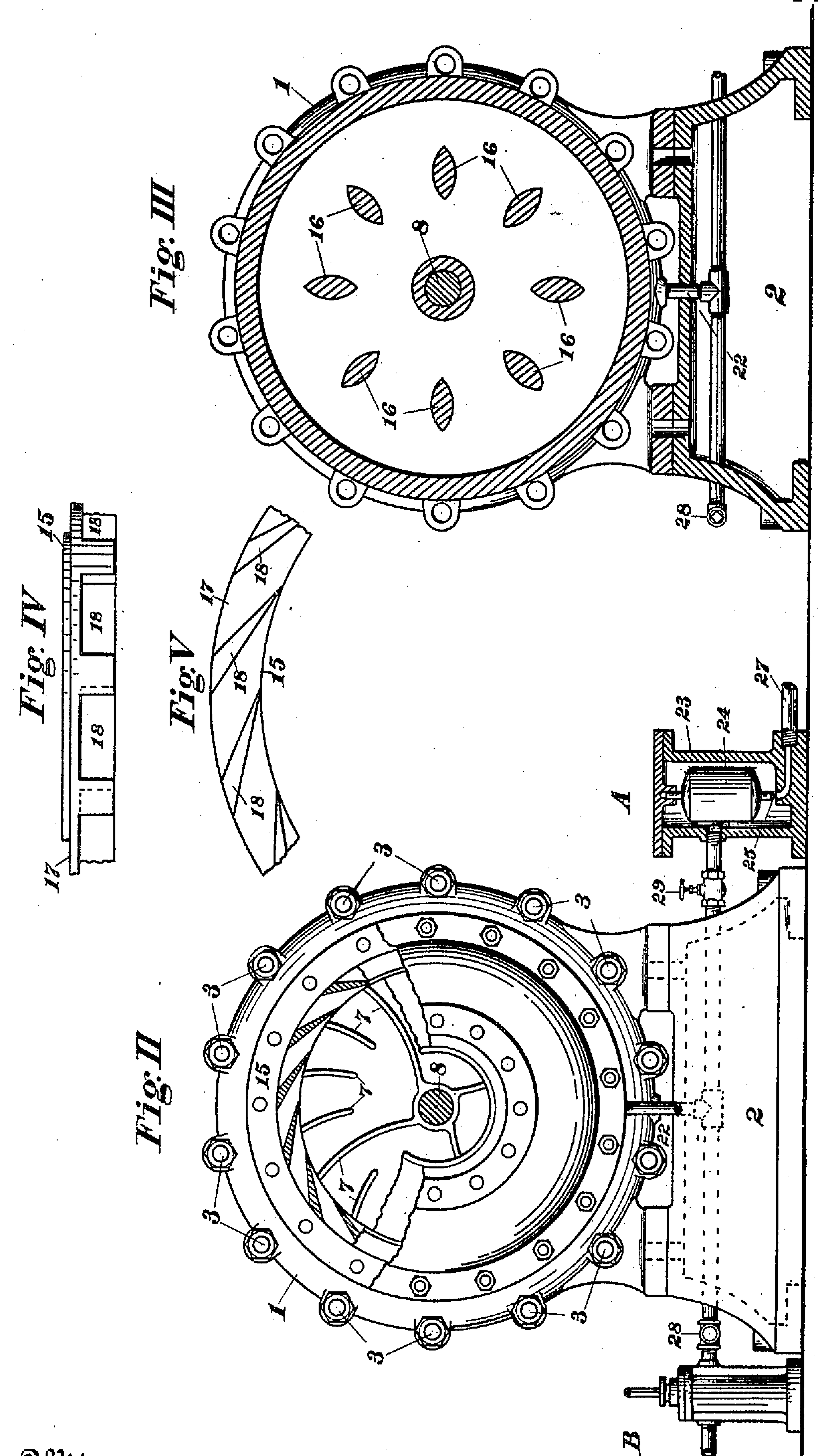
No. 681,581. Patented Aug. 27, 1901.

# J. RICHARDS.

## HIGH PRESSURE ROTARY PUMP.

(Application filed Jan. 21, 1901.)

(No Model.) 2 Sheets—Sheet 2.




Witnesses
P. W. J. Lander
Elmer Wickes

Inventor
John Richards

# UNITED STATES PATENT OFFICE.

JOHN RICHARDS, OF SAN FRANCISCO, CALIFORNIA.

## HIGH-PRESSURE ROTARY PUMP.

SPECIFICATION forming part of Letters Patent No. 681,581, dated August 27, 1901.

Application filed January 21, 1901. Serial No. 44,002. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN RICHARDS, a citizen of the United States of America, residing at San Francisco, county of San Francisco, and State of California, have invented certain new and useful Improvements in High-Pressure Rotary Pumps; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to certain improvements in multiple rotary pumps for raising and impelling water, operating in stages cumulatively by centrifugal, impulsive, and tangential forces.

In multiple pumps of high effective head secured by multiple impellers on a common shaft in a reinforcement series it is essential to good practical results to obtain as direct communication as possible between the elements of the series to obviate the enormous loss of power dissipated into heat by viscous friction and the vortical disturbances entailed by frequent changes of direction of the impelled currents, the liquid being under a high velocity and a constantly-increasing pressure, which becomes very great toward the end of the series.

To this end my improvement consists in the specific reconstruction hereinafter described, and pointed out in the claims.

To these ends I construct rotary pumps substantially as shown in the drawings.

Figure I is a longitudinal section through a multiple pump having five impellers, one of which is in section; Fig. II, an end view of the same pump, some of the parts being broken away to show the interior construction. Fig. III is a section through Fig. I on the line *c c*; Fig. IV, an enlarged broken edge view of a portion of one of the throat-rings and diffusing-vanes; Fig. V, a side view of Fig. IV.

The throat-rings, Figs. IV and V, (not herein specifically claimed,) form a specific feature of my copending application, Serial No. 44,001, series of 1900.

In the operation of pumps of the class to which my invention relates it is known that when the impellers are driven at high speed, fit close around their periphery, and are provided with forwardly-curved vanes the impulsive effect of the tangentially-discharged water directed by fixed diverting-vanes will not permit backward flow and that the impeller-chambers may for this reason be relieved of pressure and also of water, when that is necessary or desirable. It is known that the viscous friction on the sides of the impellers increases as the pressure, following the same law as the friction of solids. It is also known that the cumulative effect of a series of impellers is as the number of such impellers and driving power consumed less the losses of transferring water from one impeller to another. With a view to employing these features in multiple pumps I construct as illustrated in the drawings.

The pump-casing consists of a series of separable units 1, similar in construction and functions. These units are set upon and attached to a base 2 in the usual manner and are preferably joined and held together by a series of through-bolts 3, as shown in Figs. I and II of the drawings.

The impellers 4, the first of which is shown in section, are provided with inlet-nozzles 5 and internal vanes 7, as shown in Figs. I and II. These impellers are made of strong material, finished smooth on the outside and securely fastened on the shaft or spindle 8, all facing in one direction, as shown in Fig. I. The spindle 8, held in bearings 9, 10, and 12, is driven by power applied at 13, and at the other end is provided with a thrust-balancing piston 14, that will be hereinafter described.

In each unit or chamber is inserted concentric with the common rotary impeller-shaft a disk or plate 6, dividing the chamber into two waterways, the first of which contains the running-impeller, while the second forms a direct discharge-way to the center of the second impeller, and so on, the last chamber discharging through outlet 26. The two said waterways are in communication by means of the curved annular passage formed between the curved periphery of the casing and the rounded edge of the dividing plate or disk in each chamber.

The removable throat-rings 15, one of which fits closely around each of the impellers 4, occupying an annular space between the impellers and the curved discharge-passages 11, consist of a plate 17 at one side, as seen in Figs. IV and V, with integral projecting vanes 18 of acute form at their inner ends that guide and diffuse the water as it leaves the impellers 4. These removable throat-rings 15 are clamped and held between the units 1 of the casing and by the removable plate 19, the open sides abutting against the next succeeding unit 1 of the casing, as seen in Fig. I, forming a throatway corresponding to the discharge-ways of the impellers 4. The vanes 18, having plane faces, can be finished by common machine processes, and thus reduce the friction of the fluid on their surfaces. These vanes 18 are in number approximately the same as the vanes 7 in the impellers 4, the latter being curved forward to produce a direct driving force or impact upon the water discharged. The plates 6 between the impellers 4, forming the walls of the water-passages 11, are connected and supported by struts 16. (Shown in section in Fig. III.) These struts are in cross-section of a form to arrest the rotation of the water in the passages 11, but not to disturb its inward flow and cause resistance.

The chambers 20, in which the impellers 4 revolve, are sealed except as to the running joint around the periphery of the latter, and are vented or drained by means of the pipes 22, connecting with the chambers 20 at each side of the impellers 4, as seen in Fig. I. These pipes can all connect to one main branch 28 or extend separately to terminals, as hereinafter explained. In respect to water and pressure in the impeller-chambers 20 the latter can be avoided when the impellers are driven at high speed, have vanes of the correct form, and diffusing throat-rings 15, with smooth and acute vanes, as shown in the drawings; but in common practice when the water is impure or after some wear of the parts the chambers 20 fill at discharge-pressure and require to be vented. This latter can be done by pipes 22 and 28, leading to the open air or to a place of waste when the parts are new and so well fitted that but little water can escape between the impellers 4 and the throat-rings 15; but when these wear and the escape of water into the chambers 20 becomes excessive and causes waste these chambers 20 can be put into equilibrium with the discharge-pressure in the passages 11 by connecting the pipes 28 to inclosed chambers 23, as shown at A in Fig. II. These chambers 23, of which there is one for each stage or impeller, are placed in a position to drain the chambers 20 by gravity, and these later become filled with air instead of water, causing but little frictional resistance to the impellers, and also prevents backflow into these chambers because of the equilibrium of pressure. Water escaping by gravity into the vessel 23 can be discharged at intervals automatically by means of a float 24 and a valve 25, communicating with a waste-pipe 27 in the usual manner of such apparatus. This vessel 23 can be large or small and is preferably placed as much below the level of the chamber 20 as circumstances permit and may be submerged in the sump or supply water. Air can be forced into the chambers 20 from a pump, as at B in Fig. II, or from any source furnishing air-pressure equal to that in the chambers 20, the valve 29 being set to permit the escape of so much water as collects in the chambers 20. In the use of compressed air should its pressure exceed that of the discharge-pressure of the impellers and the quantity be more than will pass out with the water through the valve 29 the surplus air will pass into the water discharged by the impellers and will do no harm unless the quantity is sufficient to effect considerably the gravity of the fluid being pumped. The chambers 20 may also be cleared of water by any other suitable well-known means. These several means that have been described for clearing the chambers 20 of pressure or of water are not alternative, but in practice depend on the degree of economy and perfection of the apparatus required in different cases. When the head to be pumped against does not exceed one hundred feet, it is sufficient in most cases to partially relieve the pressure in the chambers 20 by means of open drain-pipes. For greater heads and economy of power pressure should be wholly removed from the chambers 20, and for the highest efficiency these chambers should be cleared of water, the expense and cost of apparatus being in proportion to the working efficiency. I do not therefore confine myself to a particular means of reducing the pressure in or clearing the water from the chambers 20 except as to conduits or passages therefrom to suitable apparatus for draining, exhausting, or clearing these chambers by means as described or others of like nature and effect.

The operation is as follows: The pump being charged, the impellers 4 are set in revolution, and discharge, as indicated by arrows, into the chambers or passages 11. Water is drawn in through the supply-pipe 21 and after passing through all the impellers 4 is forced out at the discharge-pipe 26 under a pressure equal to the sum of the effect produced by all of the impellers. Should the chambers 20 become filled with water under discharge-pressure in starting or by accident, there will then be a lateral thrust on the impellers 4 equal to the area of the inlet-nozzles 5 multiplied by the pressure produced by each impeller. This is compensated by the rotating piston 14 on the end of the spindle 13, this piston being subject to the pressure in the chamber 30, which is equal to the sum of pressures produced by all of the impellers 4. This piston 14 runs in a short cylinder 33, having a sleeve 34 to support the bearing 12, water passing through the perforations 35 to the piston 14. When the action of the piston 14 is not required, the cock 36 is closed and leakage around the piston puts it into equilibrium by an equal pressure on each side.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a multiple rotary pump, the combination with a series of separate and separable pump-casings having interior chambers bounded peripherally by circular walls, of a driving-shaft passing through all of said chambers in substantially the line of the axes of their peripheral walls, imperforate disk partitions in said chambers surrounding said shaft and dividing each chamber into two waterways in communication by means of an annular peripheral passage formed between the disk edges and the circular wall of the chamber, an impeller on said shaft in one waterway of each chamber, all of said impellers having their suction-inlets central and facing in the same direction, removable annular throat-rings provided with inclined partitions interposed between said impellers at their peripheries and the entrances to the annular peripheral passages, said impellers forming running joints with the entrances to said throat-rings, the other waterway of each chamber forming a direct communication by the shortest path between said peripheral passage and the inlet of the next adjacent impeller, each impeller except the first being supplied from the discharge-waterway of the adjacent preceding chamber.

2. In a multiple rotary pump, the combination with a series of separate and separable pump-casings having interior chambers bounded peripherally by circular walls, of a driving-shaft passing through all of said chambers in substantially the line of the axes of their peripheral walls, imperforate disk partitions with rounded edges in said chambers surrounding said shaft and dividing each chamber into two waterways in communication by means of an annular peripheral passage curved in cross-section formed between the disk edges and the circular wall of the chamber, an impeller on said shaft in one waterway of each chamber, all of said impellers having their suction-inlets central and facing in the same direction, said impellers forming running joints with the entrances to the annular peripheral passages, the other waterway of each chamber forming a direct communication by the shortest path between said peripheral passage and the inlet of the next adjacent impeller, each impeller except the first being supplied from the discharge-waterway of the adjacent preceding chamber, and the last discharging centrally to an outlet.

3. In a multiple rotary pump, the combination with a pump-casing containing interior chambers bounded peripherally by curved walls, of a driving-shaft passing through all of said chambers in substantially the line of the axes of their peripheral walls, imperforate disk partitions in said chambers surrounding said shaft and dividing each chamber into two waterways in communication by means of an annular peripheral passage formed between the disk edges and the circular wall of the chamber, an impeller on said shaft in one waterway of each chamber, all of said impellers having their suction-inlets central and facing in the same direction, removable annular throat-rings provided with inclined partitions interposed between said impellers at their peripheries and the entrances to the annular peripheral passages, said impellers forming running joints with the entrances to said throat-rings, the other waterway of each chamber forming a direct communication by the shortest path between said peripheral passage and the inlet of the next adjacent impeller, each impeller except the first being supplied from the discharge-waterway of the adjacent preceding chamber.

4. In a multiple rotary pump, the combination with a series of separate and separable pump-casings having interior chambers bounded peripherally by curved walls, said casings secured together by interlocking detachable ledges, and recessed to receive annular throat-rings, of removable annular throat-rings provided with inclined wedge-shaped partitions, inserted in said recesses and held in place by said ledges, imperforate disk partitions in said chambers dividing each chamber into two waterways in communication by means of an annular peripheral passage formed between the disk edges and the circular wall of the chamber, an impeller in one waterway of each chamber, a common central driving-shaft for all of said impellers, the latter all having their suction-inlets central and facing in the same direction, said impellers forming running joints at their peripheries with the entrances to said annular throat-rings, said entrances leading by inclined passages into the annular peripheral passages; the other waterway of each chamber forming a direct communication by the shortest path between said peripheral passage and the inlet of the next adjacent impeller, each impeller except the first being supplied from the discharge-waterway of the adjacent preceding impeller.

5. In a multiple rotary pump, a series of impellers, set in like position on one shaft and acting successively on this shaft, a hydraulic piston exposed to the maximum or discharge pressure, and a vent-cock 36 whereby this piston can be placed in or out of action, for the purposes substantially as specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN RICHARDS.

Witnesses:
ALFRED A. ENQUIST,
ELMER WICKES.