C. V. KERR.

CENTRIFUGAL PUMP.

APPLICATION FILED JUNE 21, 1911.

1,089,770.

Patented Mar. 10, 1914.

4 SHEETS—SHEET 1.

Fig. 2.

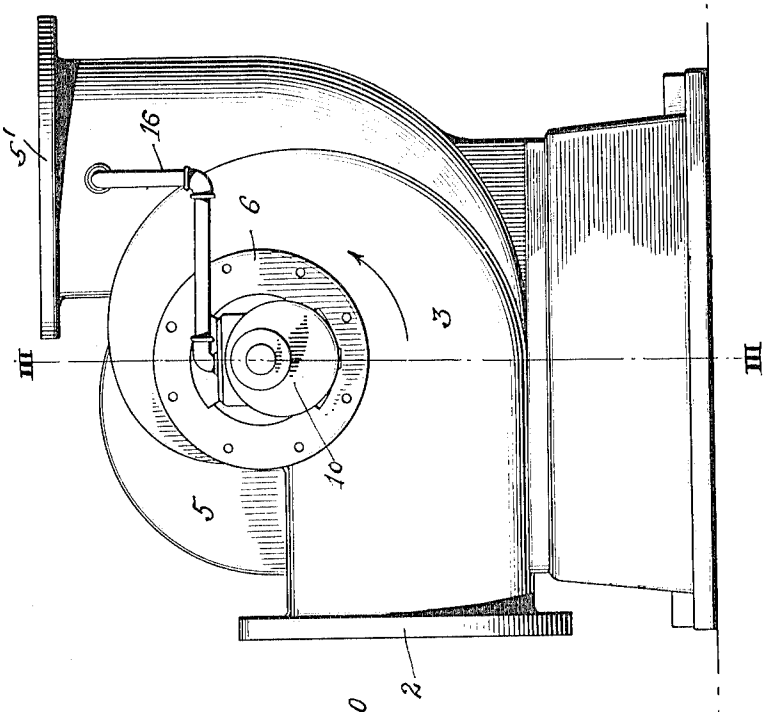
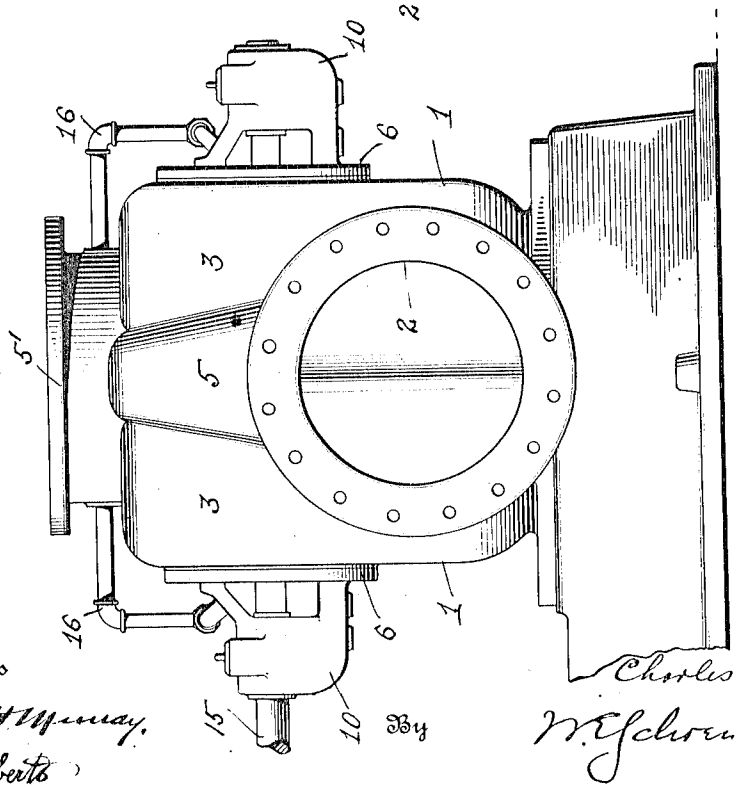


Fig. 1.



Witnesses

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4 SHEETS—SHEET 2.

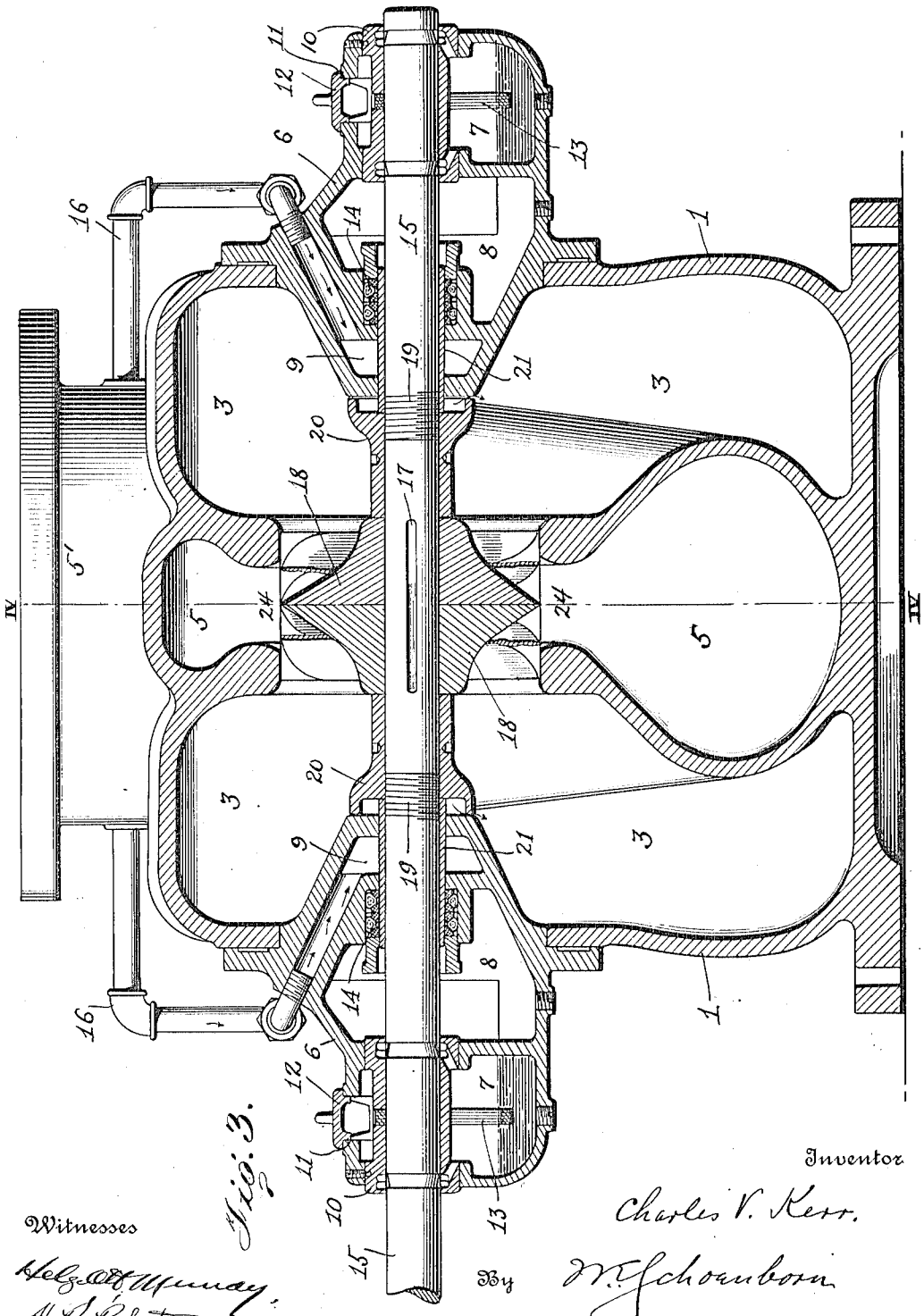


Fig. 3.

Witnesses

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4 SHEETS—SHEET 3.

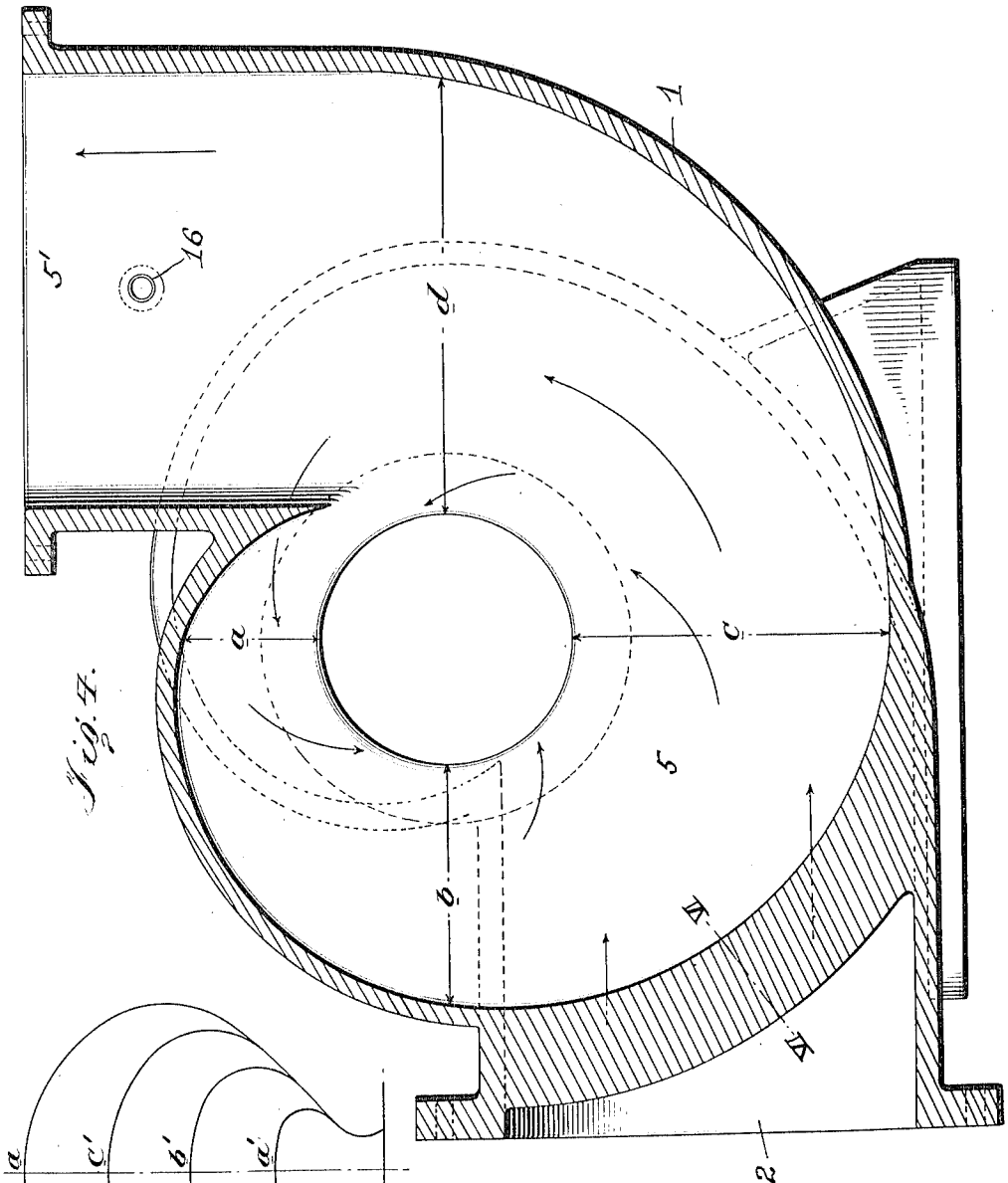


Fig. 4.

Fig. 5.

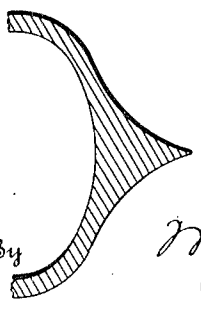


Fig. 6.

Witnesses

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4 SHEETS—SHEET 4.

Fig. 7.

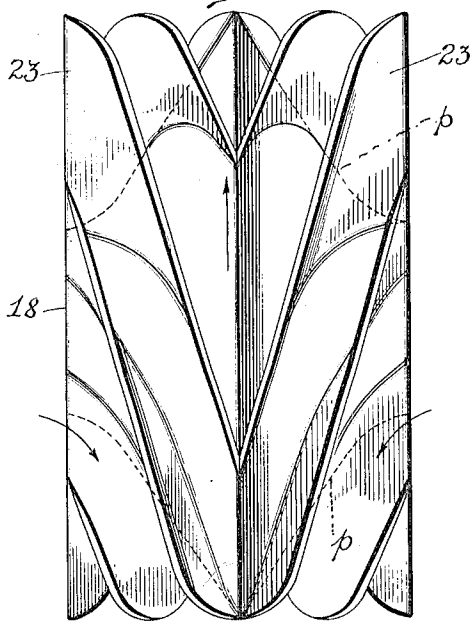


Fig. 8.

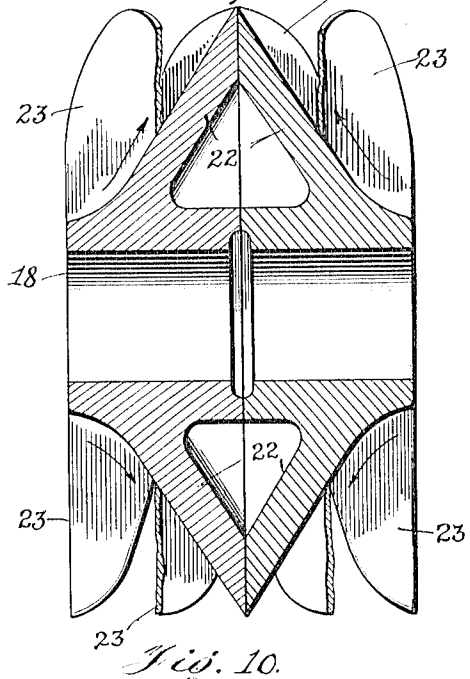


Fig. 9.

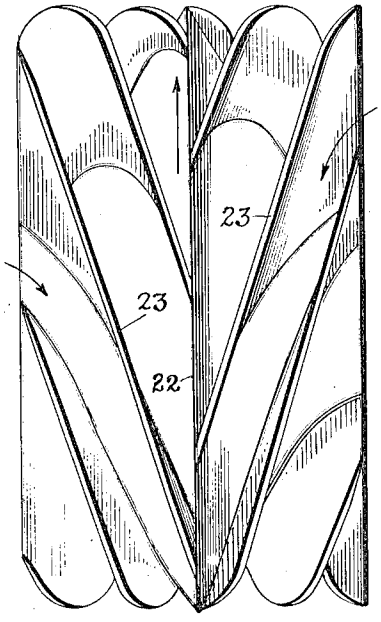
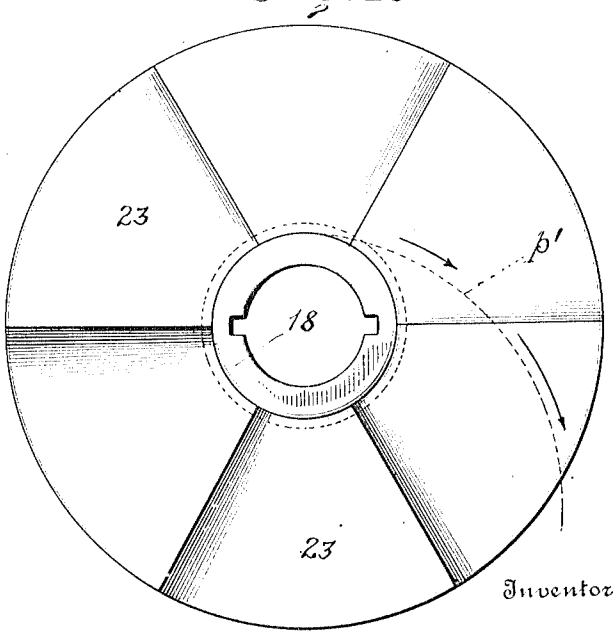


Fig. 10.



Witnesses

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UNITED STATES PATENT OFFICE.

CHARLES V. KERR, OF WELLSVILLE, NEW YORK, ASSIGNOR TO McEWEN BROS., OF WELLSVILLE, NEW YORK, A CORPORATION OF NEW YORK.

CENTRIFUGAL PUMP.

1,089,770. Specification of Letters Patent. Patented Mar. 10, 1914.

Application filed June 21, 1911. Serial No. 634,568.

To all whom it may concern:

Be it known that I, CHARLES V. KERR, a citizen of the United States, residing at Wellsville, in the county of Allegany and State of New York, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a specification.

My invention relates to centrifugal pumps in general, and has for its salient objects to improve the construction of such pumps both as to mode of operation and also as to structural details for the accomplishment of the purposes hereinafter set forth.

My object in developing the present type of centrifugal pump is to secure such a form, that will have good efficiency when running at steam turbine speeds, and delivering a large volume of water at low heads, such as used for condensers in power plants, irrigation systems, and circulating water generally.

It has been found that a satisfactory and efficient high speed pump for large volumes and low heads and for purposes above mentioned has not been available.

The advantage in high speed for turbine driven pumps is clearly evident, when a certain steam turbine using steam at one hundred pounds gage pressure, with atmospheric exhaust, develops at twelve hundred revolutions per minute, seventeen brake horse power; at twenty-four hundred revolutions per minute, the same turbine develops thirty brake horse power; and at thirty-six hundred revolutions per minute, forty-one brake horse power. These different horse powers it has been found are developed by the turbine at the different speeds with precisely the same total amount or consumption of steam. As an increased efficiency is also developed in a pump of my construction at high speeds as compared with ordinary slow speed pumps, a plant comprising such a high speed turbine combined with my form of high speed pump further and greatly increases the economy or efficiency of the pumping unit.

A further object of my invention is to so construct and arrange the blades on the impeller which lifts and propels the fluid, so that the same, in view of its high velocity, will not act too abruptly in changing the direction of the movement of the fluid and cause a churning action, thereby reducing the efficiency, but allow a smooth action thereby enabling the full energy of the impeller to be expended in proper relation and action on the fluid. Said impeller is also provided with coöperating elements, which will automatically act at all times and under all conditions of service, uniformly balance the pressures on both sides or fluid receiving faces of the impeller, and at the same time centralize said impeller with respect to the annular or nozzle outlet for the fluid to the discharge opening.

It is for the purpose of securing to the fullest extent possible, the accomplishment of the various objects and desiderata above set forth, that I have devised the present improvements, a preferred form of which is shown in the accompanying four sheets forming part of this specification, in which similar reference characters indicate the same parts throughout the several figures of drawing.

The invention consists of structural characteristics and relative arrangements of elements, which will be hereinafter more fully and clearly described, and particularly pointed out in the appended claims.

Of said drawings; Figure 1 is a front elevation of the pump on the water inlet side; Fig. 2 is a side view; Fig. 3 is an enlarged vertical longitudinal section on line III—III of Fig. 2; Fig. 4 is a section on line IV—IV of Fig. 3; Fig. 5 represents various cross-sectional areas slightly reduced of the casing shown in Fig. 4, at four different points; Fig. 6 is a section on line VI—VI of Fig. 4; Fig. 7 is an enlarged peripheral view of the impeller; Fig. 8 is a central transverse section of said impeller; Fig. 9 is an enlarged peripheral view of a modified form of impeller; and Fig. 10 is a side view of said modified form.

Referring to said drawings, 1 is a suitable casing provided with water inlet 2, which is preferably branched or divided into two symmetrical spiral suction chambers 3, 3, for reasons to be hereinafter described. The casing is preferably volute in transverse cross section (see Fig. 4) and cast in one piece with a supporting base. The interior or central section of the casing has formed therein the well rounded or annular nozzle 24 (see Fig. 3), which leads into the passageway or discharge conduit 5. Said conduit 5, communicates with the outlet opening 5'

and is of gradually increasing cross-sectional area, the radial cross-section at *a* (Fig. 4) is represented on a slightly reduced scale by line *a'*, in Fig. 5, while lines *b'*, *c'*, and *d'* represent the sections on radii *b*, *c*, and *d* respectively of Fig. 4.

6, 6, are bearing heads suitably secured or bolted over the lateral openings of the casing 1, and each head 6 is cast in one piece and arranged as shown with two large chambers 7 and 8, and a smaller chamber 9. The outer chambers 7, 7, contain the dust proof bearings 10, 10, on the ends, said bearings 10, 10, being provided with the usual oil opening 11, having a covering 12, and the lubricating ring 13. The inner section of the bearing heads 6, 6, containing the chambers 8 and 9, projects into the suction chambers 3, 3, of the pump casing, and the outer side of the wall separating said chambers, is provided with a stuffing box 14, having metallic packing rings backed by soft packing, which permits said rings to center themselves with respect to the impeller shaft 15, passing through the casing 1, and chambers 9, 8 and 7 in the heads 6, 6, and rotatably supported in the bearings 10, 10, as shown. Said shaft 15, may be connected to a high speed steam turbine, by means of a flexible coupling as shown, for example, in my co-pending application Serial No. 586,629.

16 is a pipe connecting the interior of the chamber 9 with the discharge outlet 5', for purposes to be hereinafter described.

Attached by a suitable key 17 or other means to the shaft 15, is an impeller 18, preferably made in two sections, as shown in Fig. 8; but while I have so shown the same as cored, the same may be made solid (see Fig. 3) or in one piece, if so desired, and secured in place by means of oppositely threaded sections 19, 19, on the shaft 15. Water thrust sleeves 20, 20, are firmly secured to the shaft 15, on each side of the impeller 18, and are so arranged that they rigidly hold the two sections of the impeller 18 together in fixed relation, and from slipping longitudinally on the shaft. Also secured to the shaft 15 by means of the threads 19, 19 are sleeves 21, 21, surrounding closely the shaft and rotating therewith, and so arranged that their inner ends abut against the outer or capped ends of the water thrust sleeves 20, 20, while their outer ends pass through the stuffing boxes 14, 14, as indicated. Said impeller 18 is of the open type and may be made of semi-steel, crucible steel, or non-corroding alloy or bronze, and when the two sections are properly placed together or assembled a periphery of V-shaped section 22, is formed as shown in Figs. 3, 7, 8 and 9. The vanes or blades 23, 23 on the periphery of the impeller 18 are so disposed and arranged as to form helicoids on the working surface, as shown, that is, they follow the pitch of a screw, and the form of the body of the impeller as seen projected on a plane through the axis is a conoid. By this form and arrangement of vanes or blades 23, the fluid or water acted upon by the impeller 18 as it flows from the suction chambers 3, 3, is given equal impulses at all points measured from the center outward, and in a path (see lines *p* and *p'*, Figs. 7 and 10), that is helical in the direction of the axis and spiral in the radial direction. In the impeller 18 illustrated for example in Figs. 3 and 7, the helix makes an acute angle with the face of the impeller, and as shown, six blades or vanes 23 are used on each side which number may be varied to suit conditions of speed and capacity, if so desired and will be fully within the scope of my invention. I have found that this form of impeller is not only theoretically correct, but it also permits the vanes and working surfaces to be readily machined or smoothed for action, thereby reducing the frictional resistances. Furthermore, by making the impeller 18 in two sections, the same can be cheaply manufactured, easily handled and adjusted, and made perfectly rigid and balanced, so that it retains its form under the unusual high speeds, which the usual form of built-up impellers will not do.

While my preferred form of impeller is shown in Figs. 3, 7 and 8, in which the vanes or blades on each side of the impeller meet at the center or apex, I have found that this particular arrangement is not necessary for the efficient operation of the pump, and said blades may be staggered by simply partly turning on the shaft 15, one of the sections of the impeller through any angle, but preferably one corresponding to one-half the peripheral distance between the apexes of the blades 23, as shown in Fig. 9. I have also found that the pitch of the vanes 23, may vary, but prefer to use a true screw surface, having a constant angle with a plane at right angles to the shaft of the impeller.

During the operation of the impeller 18, rotating rapidly in the direction of the arrow, shown in Fig. 2, the water flows through the intake or inlet 2, and is divided and carried into the two suction chambers 3, 3, and is there properly taken up as herein explained by the vanes 23, on opposite sides of the impeller 18, and is discharged from the impeller in the path indicated by line *p'* at an angle with the tangent, and enters the volute discharge conduit 5, through a well rounded orifice or annular nozzle 24, (see Fig. 3). It has been found by my arrangement and form of nozzle 24, with respect to the construction of the impeller with its blades 23, the wider lap of the im-

peller 18 with the contiguous inner walls of the conduit 5, no leakage of water or fluid results, or is permitted from the conduit 5 between the impeller 18 and adjacent walls of the conduit 5, and hence the water is only and strongly forced through the throat of the annular nozzle 24, thereby effecting a most efficient operation of the pump.

While I have shown a double suction pump, it will be readily seen that my form of impeller and casing could be adapted for single suction pumps. The double suction has not only the advantage of double capacity at the same speed but is also self-balancing for the reason that if the impeller 18, moves to the right of its position shown in Fig. 3, the area of the discharge from the impeller 18 into the annular nozzle 24 at the right will be made smaller or narrower, while that on the left will be larger or wider, the result is to increase the discharge head or pressure on the right and to increase the suction on the left, the combined effect of which is to promptly adjust the impeller back to its proper and central position. This balancing force is greatest at maximum discharge, and becomes zero at no discharge or shut-off, and in order to cure this shortcoming, I have combined with the water seal packing box comprising the chamber 9 and pipe connection 16, a water thrust which acts automatically as follows: By following the direction of the arrows shown in Fig. 3, it will be seen that the water under pressure near the outlet 5′ is forced down into the pipe connection 16, into the chamber 9 and passes through a small clearance space between the shaft sleeve 21 and bearing head 6, into the cup formed in the water thrust sleeve 20, and thence into the suction chamber 3. From this arrangement it is manifest that should the shaft 15 move to the right, the clearance between the thrust sleeve 20 and the inner end of the bearing head 6 on the left side of the impeller is increased enough to reduce the pressure in the cup of the water thrust sleeve 20 on the left side almost, if not equal to that of the suction chamber 3, and when this takes place, the pressure in the water thrust cup chamber on the right hand side of the impeller 18 becomes equal to that of the discharge outlet 5′, which unbalanced conditions or pressures promptly forces the impeller to the left, and maintains its position centrally with respect to the annular nozzle 24. In the type of pump herein disclosed, the pressure at the discharge increases toward the shut-off, so that the action of the water thrust feature above described is greatest when the pump is not discharging fluid, and it will be seen by the two arrangements and methods of operation devised by me, and embodied in this disclosure, both of which are automatic, the impeller is maintained in its proper and efficient relation with respect to the annular nozzle 24, and without actual contact between either of the thrust sleeves with the bearing heads.

The lateral openings receiving the bearing heads 6, 6, are slightly larger in diameter than the impeller and by removing one of said bearing heads the impeller with its shaft can be easily withdrawn from the casing, which construction and arrangement enables the use of a solid casing, thereby avoiding the use of packed joints required by the usual split case constructions.

From the foregoing disclosure it will be readily seen that the casing, bearings, shaft, and impeller and its parts, are easily accessible, and the construction of the pump is such, that all the parts of the same may be cheaply and accurately manufactured and quickly installed and adjusted, so as to insure steady and continuous running under highest of speeds and with excellent efficiency. It will also be readily seen owing to the spiral shape of the suction chamber or chambers 3, relation of the volute conduit 5, annular nozzle 24, and helicoidal impeller 18, with said suction chambers, the water is directed into the impeller in a perfect spiral path thereby taking up the rapid movement of the impeller without any churning action and producing a smooth and efficient operation of the pump.

What I claim is:

1. A rotary impeller for centrifugal pumps comprising conoidal surfaces having adjoining bases which form a central comb or ridge near the periphery of said impeller, a series of vanes arranged as right and left hand helicoids on said surfaces, said helicoids being generated by a line of constant length which so moves with respect to a fixed straight line with which it constantly forms a right angle that every point of said line shall have a uniform velocity in the direction of said fixed straight line, and said conoidal surfaces being generated by revolving a line about said fixed straight line.

2. A rotary impeller for centrifugal pumps having a conoidal base, all sections of which are normal to the axis being circular with the section of greatest diameter at the center of said base, and a series of vanes arranged as right and left hand helicoids on said conoidal base, said helicoids being generated by a line of constant length which so moves with respect to a fixed straight line with which it constantly forms a right angle that every point of said line shall have a uniform velocity in the direction of and around said straight line, said vanes each having a radial entering edge and a uniform external diameter and terminating in said conoidal base at the section of greatest diameter.

3. A centrifugal pump comprising a cas-

ing having a divided inlet and spiral suction chambers, an inner volute conduit connected with said suction chambers by an annular opening or nozzle, and to the discharge, heads attached to said casing and having a pressure chamber, a shaft rotatably supported in said heads and passing through said pressure chambers, a rotary impeller on said shaft and outside of and adjacent to said annular opening or nozzle and provided on its periphery with a series of oppositely disposed blades so constructed and arranged to take in oppositely moving sheets of fluid in planes at right angles to the axis of the impeller and made to impinge against each other in planes at right angles to the shaft and at the apex of the impeller, to thereby force the fluid from the suction chambers into the conduit through said annular nozzle, a thrust sleeve fixed on said shaft on each side of the impeller and between the heads, and means for effecting a fluid pressure in said pressure chambers.

4. A centrifugal pump comprising a casing having a divided inlet and spiral suction chambers, an inner volute conduit connected with said suction chambers by an annular opening or nozzle, and to the discharge, heads attached to said casing and having a pressure chamber therein, a shaft rotatably supported in said heads and passing through said pressure chambers, a rotary impeller on said shaft and outside of and adjacent to said annular opening or nozzle and provided on its conoidal periphery with a series of oppositely disposed helicoidal blades so constructed and arranged to take in oppositely moving sheets of fluid in planes at right angles to the axis of the impeller and made to impinge against each other in planes at right angles to the shaft and at the apex of the impeller, to thereby force the fluid from the suction chambers into the conduit through said annular nozzle, a thrust sleeve fixed on said shaft on each side of the impeller and between the heads, and means for effecting a fluid pressure in said pressure chambers.

5. A centrifugal pump comprising a casing having a divided inlet, spiral suction chambers, and an inner volute conduit connected with said suction chambers by an annular opening or nozzle, and to the discharge, heads having a pressure chamber attached to said casing, a shaft rotatably supported in said heads and passing through said pressure chambers, a rotary impeller on said shaft and outside of and adjacent to said annular opening or nozzle and provided on its periphery with oppositely disposed blades so constructed and arranged to take in oppositely moving sheets of fluid in planes at right angles to the axis of the impeller and made to impinge against each other in planes at right angles to the shaft and at the apex of the impeller, to thereby force the fluid from the suction chambers into the conduit through said annular nozzle, a thrust sleeve fixed on said shaft end on each side of the impeller and between the heads, and pipes connecting the interior of each of the pressure chambers with the discharge of the pump.

6. A centrifugal pump comprising a casing having a divided inlet, spiral suction chambers, and an inner volute conduit connected with said suction chambers by an annular opening or nozzle, and to the discharge, heads having integral therewith a shaft bearing and pressure chamber attached to said casing, a shaft rotatably supported in the bearings and passing through said pressure chamber, a rotary impeller on said shaft and outside of and adjacent to said annular opening or nozzle and provided on its periphery with a series of oppositely disposed blades constructed and arranged to take in oppositely moving sheets of fluid in planes at right angles to the axis of the impeller and made to impinge against each other in planes at right angles to the shaft and at the apex of the impeller, to thereby force the fluid from the suction chambers into the conduit through said annular nozzle, a thrust sleeve fixed on said shaft and on each side of the impeller and between the heads, and means for effecting a fluid pressure in said pressure chambers.

7. A centrifugal pump comprising a casing having an inlet, spiral suction chambers, and discharge, heads attached to said casing each having a pressure chamber, a shaft rotatably supported in said heads and passing through said pressure chambers, a rotary impeller on said shaft to take in oppositely moving sheets of fluid in planes at right angles to the axis of the impeller and made to impinge against each other in planes at right angles to the shaft and at the apex of the impeller, to thereby force the fluid from the suction chambers into the discharge, a thrust sleeve fixed on said shaft and on each side of the impeller and between the heads, and means for effecting a fluid pressure in said pressure chambers.

8. In a centrifugal pump the combination of a volute casing with an annular nozzle the interior surfaces of which join smoothly to each other, said annular nozzle being generated by revolving about the axis of said casing the longitudinal mid-section of a diverging nozzle having a rounded entrance, said mid-section lying in a plane passing through said axis, and a double helicoidal impeller of uniform external diameter rotatably supported centrally with respect to said annular nozzle, and having axial movement for the purpose of centering said runner in proper relation to the nozzle by the action of the fluid discharge.

9. In a centrifugal pump the combination of a casing having spiral suction and volute discharge conduits, an annular nozzle merging in the discharge conduit, a double suction helicoidal impeller having a central comb or ridge rotatably supported centrally with respect to said annular nozzle and of a diameter to permit axial movement, said parts so constructed and assembled as to produce a self-centering action of the impeller during discharge of fluid.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES V. KERR.

Witnesses:
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C. H. LONGSHORE.