C. V. KERR.

CENTRIFUGAL PUMP.

APPLICATION FILED OCT. 29, 1917.

1,334,461. Patented Mar. 23, 1920.

3 SHEETS—SHEET 1.

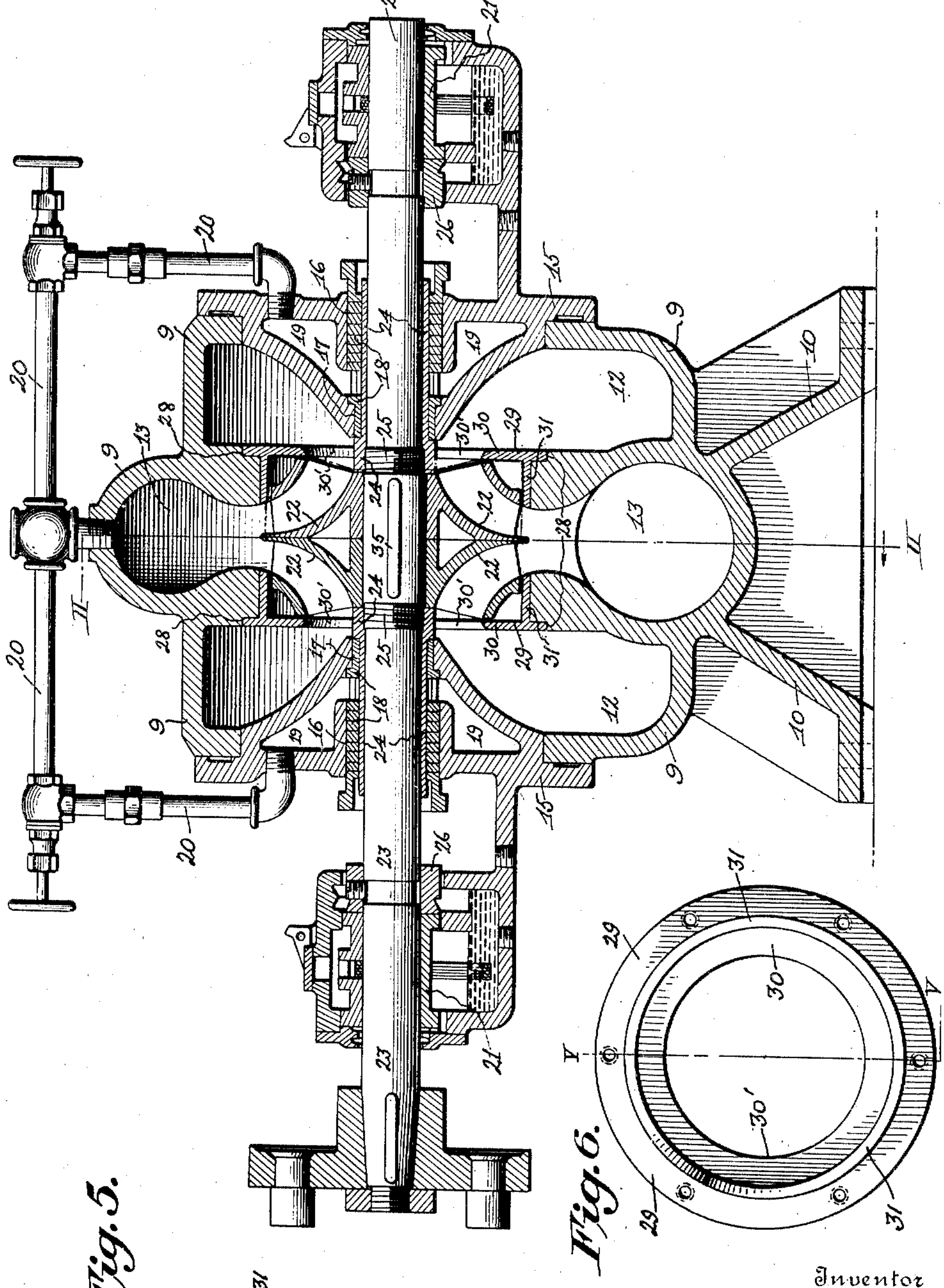

Fig. 1.

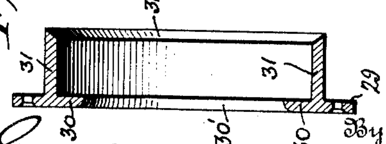

Fig. 5.

Fig. 6.

Witness

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3 SHEETS—SHEET 2.

Fig. 2.

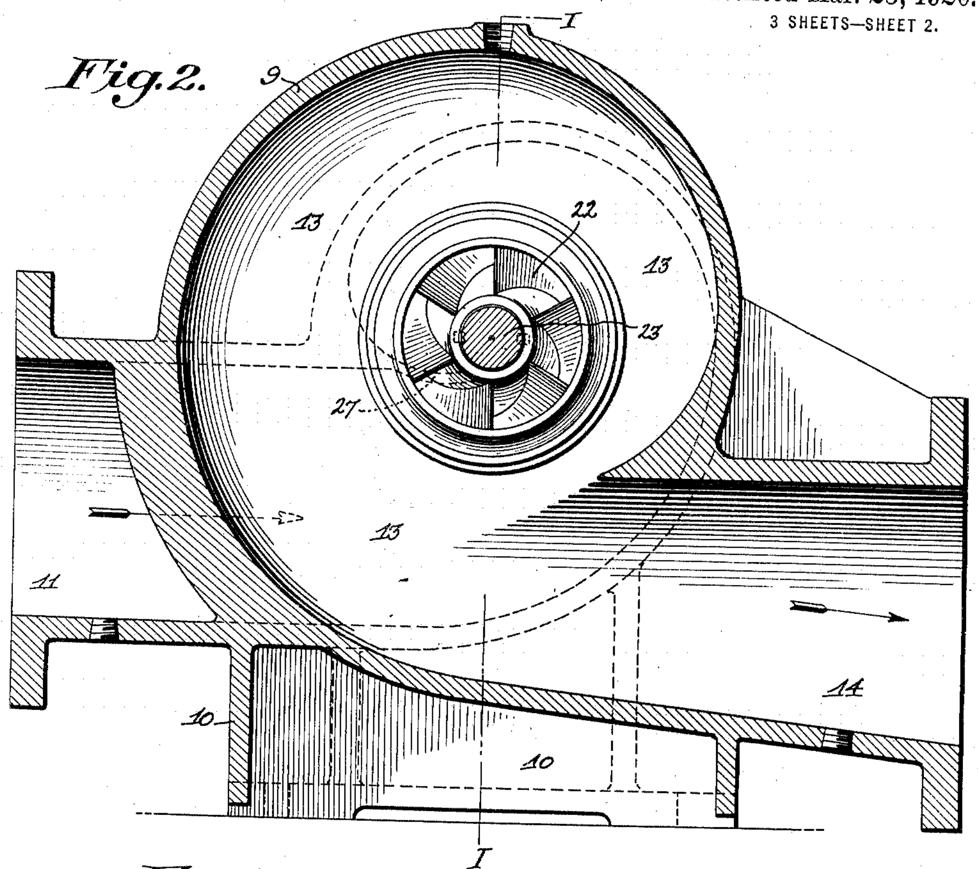


Fig. 3.

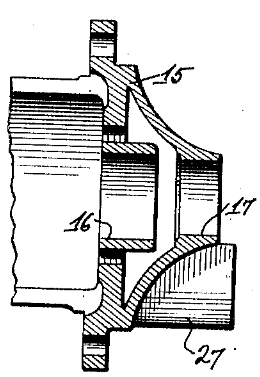
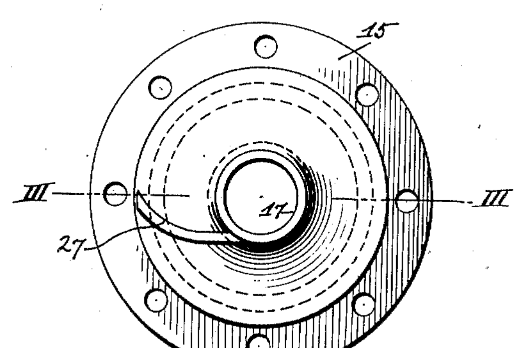


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 7.

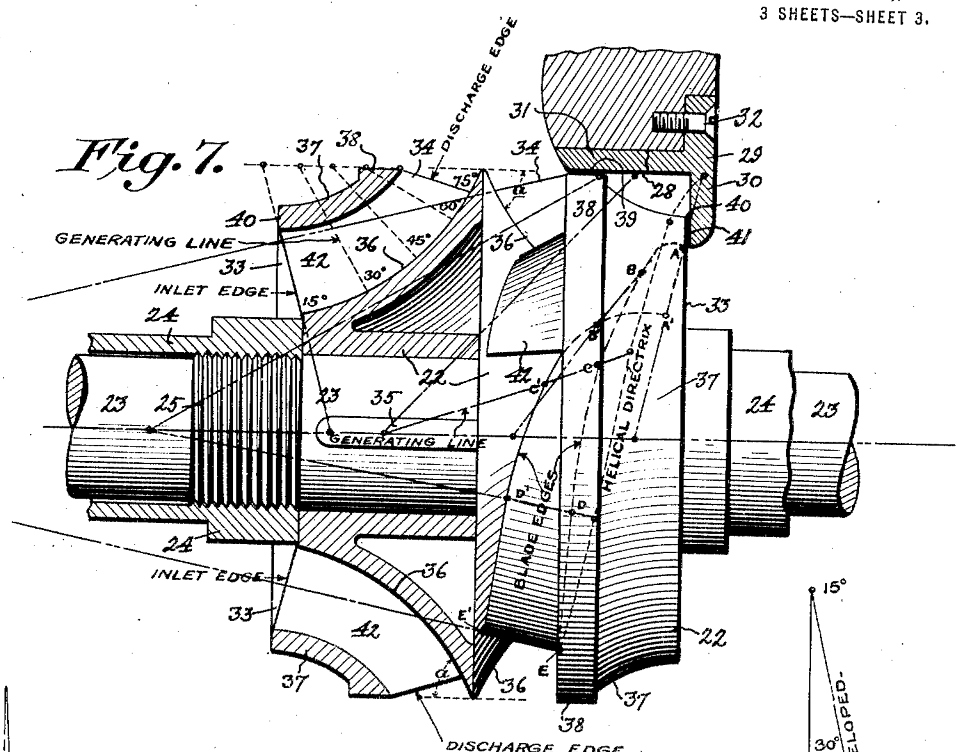


Fig. 8.

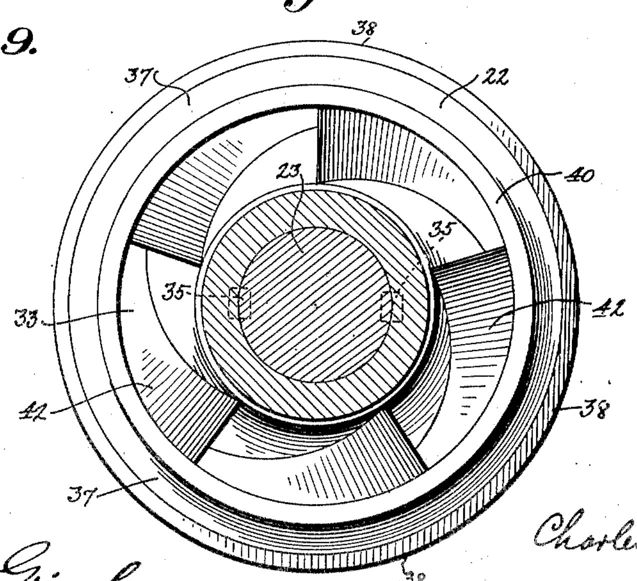


Fig. 9.

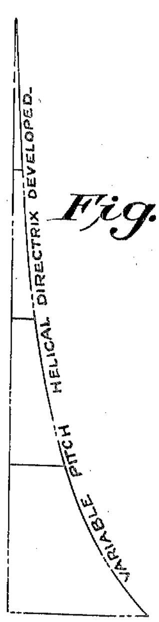
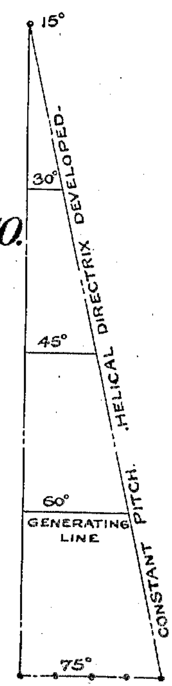


Fig. 10.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL PUMP.

1,334,461. Specification of Letters Patent. Patented Mar. 23, 1920.

Application filed October 29, 1917. Serial No. 198,981.

To all whom it may concern:

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

This invention relates to centrifugal pumps in general and more particularly to those having impellers of the propeller or screw type, and has for its principal objects to improve the operation of such pumps and to simplify their structural details, especially those of the casing and the impeller for the accomplishment of the purposes hereinafter set forth.

Pumps having impellers of the propeller or screw type are commonly designed to raise large volumes of water to a small height at a slow speed of rotation and it has been found that their efficiency is usually low.

The object of this invention is to modify the present type of such pumps so as to obtain a greater range of pumping head, increased rotative speed for direct drive by steam turbines or other high speed motors, a higher efficiency and improved and simplified construction.

A further object of my invention is to 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 act gradually in changing the direction of the movement of the fluid thereby avoiding churning of the same which by absorbing power reduces the efficiency of the pump. The working surface of the blade in the ordinary screw impeller of centrifugal pumps is generated by a line which remains perpendicular to the shaft or axis while moving axially along a curved directrix. Such an impeller can give an impulse to the fluid pumped only at pick-up by the inlet edge of the blade, and results in waste of energy by striking the fluid at a large angle, and if the pump is run at high velocity to obtain greater pressures, causes great loss of efficiency and noisy action. In the impeller of my construction the entrance angle of the blades is very small and enables the fluid to be picked up close to the shaft, gradually increasing its velocity as it is carried toward the periphery of the impeller and to the outlet. Said impeller is also arranged and constructed with respect to the annular outlet so that it will automatically act under all conditions of service, to uniformly balance the pressure on both sides or fluid receiving surfaces 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.

To secure to the fullest extent the various objects above set forth I have devised the present improvements, a preferred form of which is shown in the accompanying three sheets forming part of this specification, in which similar reference characters indicate the same parts throughout the several figures of the drawings.

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.

In the drawings:—

Figure 1 is a transverse section of the pump on the line I—I of Fig. 2;

Fig. 2 is a section on line II—II of Fig. 1;

Fig. 3 is a transverse section of the left hand head of the casing on the line III—III of Fig. 4;

Fig. 4 is an end view of the left hand head of the casing shown in section in Fig. 3;

Fig. 5 is a transverse section of the left hand wearing or balance ring on the line V—V of Fig. 6;

Fig. 6 is an end view of the wearing or balance ring shown in section in Fig. 5;

Fig. 7 is a detail and enlarged peripheral view of the runner or impeller, one half being in elevation and the other half in section, showing also a part of the balance ring in section in its relative position to the impeller;

Fig. 8 is an end view of one half of the impeller, forming the inner central part of the impeller.

Fig. 9, represents the development of the helical directrix of variable pitch, and

Fig. 10, represents the development of the helical directrix of constant pitch.

Referring to the drawings, 9 is a suitable casing having a base or stand 10, a water inlet 11 preferably branched or divided into two symmetrical volute suction chambers

12, 12, an interior or central discharge chamber 13 preferably of volute form and ending in the discharge nozzle 14.

15, 15, are bearing heads suitably bolted or fastened to the casing, closing the suction chambers 12, 12, and projecting into them. These bearing heads have central openings 16, 16, 17, 17 for the insertion of suitable forms of water packings 18, 18 around the shaft of the impeller, and the heads are cored and have inner spaces 19, 19 which are charged with fluid under pressure from the discharge chamber 13, by pipe connections 20, 20 to form an inner seal to the packing, thereby preventing the admission of air into the discharge chambers through leakage past the packing. The bearing heads have brackets to carry suitable bearings 21, 21 for the shaft of the impeller. These bearings may be of any suitable character, but preferably of the dust-proof type with lubricating rings as shown.

The casing may be made in more than one part, but as shown in the drawing can easily and preferably be manufactured in one piece as all joints and packings that may cause leakage are thereby avoided.

The propeller or screw impeller 22, is preferably made in two sections, but may be made solid or in one piece if desired.

It is secured in its place on the shaft 23 by a key and by means of two sleeves 24, 24 which are firmly fastened to the shaft by the right and left hand screw threads 25, 25 on the shaft 23 or by other suitable means. These sleeves are so arranged that they rigidly hold together the two sections of the impeller in a fixed relation and keep them from slipping longitudinally on the shaft. The impeller with the sleeves and the shaft are held in proper central position in the casing by means of the two set collars 26, 26 which abut against the inner faces of the bearings 21, 21.

To each of the bearing heads 15, 15, there is attached a wing 27, shown in detail in Figs. 2, 3 and 4 extending permanently across the bearing head close to the shaft, in order to stop the whirling of the fluid around the shaft and made of such form as not to impede the spiral forward flow into the impeller.

The casing 9 has two recesses 28, 28 in the walls separating the suction chambers 12, 12 from the discharge chamber 13. Into these recesses 28, 28 are fitted closely, preferably ground in tightly, two wearing or balancing rings 29, 29 each of which consists of a plate 30, with a central circular opening 30′ admitting the fluid from the suction chamber to the central parts of the impeller and an inner ring 31, fitting tightly into the casing, and of such inner dimensions of the ring and the plate that the impeller may freely rotate therein. These wearing or balancing rings 29, 29 form an automatic and perfect method of balancing the impeller 22, and permitting it and the shaft 23, to move freely in a central position without touching the wearing surfaces 29, 29, thus securing a hydraulic bearing with a very slight leakage of fluid and with a minimum of friction. When the pump is in operation the fluid is drawn from the suction chambers 12, 12 through the impeller into the discharge chamber 13. The pressure in chamber 13 forces a small amount of liquid through the narrow spaces between the stationary plate 30 and the inner ring 31 of the wearing ring 29, and the rotating adjoining surfaces or shroud ring of the impeller 22, causing a slight leakage.

The collars 26, 26 on the shaft 23 are set to permit the surfaces of the impeller to come in contact with the opposing surfaces of the wearing rings 29, 29 and then any unbalanced axial pressure on the impeller will move the latter and the shaft 23. Assuming this movement to be toward the right in Fig. 1, then the surface of the impeller 22 on the right will contact with the opposing surface on the wearing ring 29, and close the passage along the interior of the latter. At the same time the passage between the impeller 22 and the wearing ring 29, on the left side is enlarged and a larger flow of fluid permitted, this resulting in a reduction of the pressure on the left side and an increase of the pressure on the right side, thereby equalizing the end pressure on the impeller. If the excess of pressure is toward the left the operations will be reversed.

The wearing rings 29 are held in their position by being closely fitted into place and by two or more screws 32, see Fig. 7.

Referring to Figs. 7 and 8, it will be seen that the impeller 22 consists of two parts, each of which is an integral structure and when assembled they form an impeller having two separate suctions or intakes 33, 33 and two separate outlet openings 34, 34, the latter conveying and discharging the fluid into the central chamber 13. The two parts of the impeller 22 are held together in proper relation and secured on the shaft 23, by the sleeves 24, 24 engaging threaded sections 25, 25 on the shaft, and prevented from rotating by the keys 35, 35. I have shown the impeller 22 preferably made in two parts because of the greater ease of manufacture in that form, but it may be made in one part with very slight changes.

The impeller when assembled forms a periphery of V-shaped or conoidal sections 36, 36 having an angle "a" with the axis of the impeller. The vanes or blades are so placed on the conoidal sections 36, 36 that they form proper working surfaces and they and the conoidal sections are incased by the shrouding 37 which is so fitted at its periphery 38 to the inner ring of the balance or wearing ring 29 at 39, that the impeller 22 will run freely, but as close as practicable within the the wearing ring 29, however, leaving a very small space or opening that the fluid may reach the space between the end surfaces 40 of the impeller and the plate of the wearing or balance ring 29 at 41, for the purpose of automatically balancing the impeller 22 by hydraulic pressure on its opposite ends and keeping it in a central position within the casing as previously described.

The blades 42 of the impeller may be of any suitable number and are of helical or screw form, and their surfaces are generated by a line following a helical directrix of constant pitch, having a very small angle of entrance at the inlet edge of the blade with the plane of rotation, gradually and preferably uniformly increasing as the blade surface approaches the periphery of the impeller at the discharge edge. Thus referring to Fig. 7 it will be seen that at A, A′, or the inlet edge, the line generating the blade surfaces of the impeller 22, makes an angle of 15° with the plane of rotation; at B, B′, an angle of 30°; at C, C′, an angle of 45°; at D, D′, 60°; and at E, E′, or discharge edge it is 75°. The purpose of this construction is to pick up the fluid at the inlet edge with a small angle of impulse and then increase the acceleration by the greater angles of the generating line, until the action approximates that of the purely centrifugal blade at its discharge. The generating line may begin at the inlet edge with a zero angle and increase to 90° at the discharge edge, or the rate of inclination of the generating line may be varied, as it moves along the helical directrix and the shaft, or the pitch of the helical directrix may be variable as shown in Fig. 9 instead of uniform, as shown in Figs. 7 and 10, or any other of the well known variations of the screw propeller may be used as suits the conditions under which the pump is to run, as regards speed of rotation, pressure and quantity of discharge.

Assuming the parts of the pump are assembled and adjusted as shown in Fig. 1, and the pump primed or completely filled with liquid before starting, as the impeller 22 is rapidly rotated, it picks up the liquid to be pumped at its inlet edges or intakes 33, 33, after passing from the inlet 11 into the volute suction chambers 12, 12, at a small angle of impulse, and gradually accelerates said liquid during its passage over the surfaces of the blades 42, and throws it at the velocity required from the discharge edges or outlets 34, 34 through the annular nozzle into the volute discharge chamber 13 in a manner approximating that of a centrifugal blade at its discharge, from whence it is finally discharged through the nozzle 14.

The wings 27 being arranged at the proper angle in the volute suction chambers 12, 12 with respect to the path of the liquid in the inlet 11 and inlets of the impeller 22, entirely stop the liquid within the suction chambers 12, 12 from whirling around the shaft 23, and without sacrificing the advantage due to spiral forward flow of the liquid in the suction chambers 12, 12 into the intakes 33, 33 of the impeller 22, thereby enabling the impeller to readily take up and conserve the velocity which the liquid has gained in passing through the inlet 11 and suction chambers 12, 12.

It will also be seen that from the construction and arrangement of the various elements of the pump the inlet edges of the impeller blades may be sharp compared with the usual centrifugal blades and machined in the plane of rotation, thereby enabling said edge to be easily made true and sharp and capable of picking up the liquid close to the shaft at a high rate of speed.

Furthermore, in the design of the pump shown, the contact surfaces between the casing 9, bearing heads 15, and wearing or balancing rings 29, can be machined smooth and accurately which will permit the easy and fluid tight assembling of these parts without loss of time in fitting and use of gaskets, and as the impeller is relatively small in diameter, it may be withdrawn with one balance ring 29 through the opening in the casing 9 for the bearing head 15.

From the foregoing descriptions, it will be seen that this centrifugal pump is of simple construction and minimum cost of manufacture, easily accessible in all its parts, provided with all means for taking up wear, can be made of any suitable material as cast-iron, steel, bronze, aluminum, etc., is readily adjusted and will run noiselessly and with great efficiency under varying conditions of speed, pressure, and volume discharged. It will also be seen that this type of impeller and pump can readily be designed and constructed for operation in horizontal, angular or vertical positions.

What I claim is:

1. A centrifugal pump comprising a rotary shaft, an impeller on said shaft, said impeller having a plurality of working surfaces each of which surfaces is generated by a line making a variable angle with the axis of the shaft while moving along said axis and guided by a helical directrix having a varible pitch, the movement of said generating line being so limited and in such a manner as to form inlet and discharge edges on said working surfaces making acute angles with the axis of said shaft.

2. A centrifugal pump comprising a casing having a suction inlet and a discharge outlet, a rotary shaft, an impeller on said shaft, said impeller having two oppositely

disposed sets of working surfaces to pick up the liquid in the suction inlet without shock and gradually accelerate and impel the same through the discharge outlet, each of said working surfaces being generated by a line making a variable angle with the axis of the shaft while moving along said axis and guided by a helical directrix having a variable pitch, the movement of said generating line being so limited and in such a manner as to form inlet and discharge edges on said working surfaces making acute angles with the axis of said shaft.

3. A centrifugal pump comprising a casing having a spiral suction inlet communicating with a discharge chamber, a rotary shaft, an impeller on said shaft interposed between the spiral suction inlet and discharge chamber, and a spiral wing interposed between the suction inlet and impeller near the shaft and forming a continuation of the spiral suction inlet for the purpose of properly guiding the liquid passing through the suction inlet into the inlet of the impeller and prevent said liquid in the suction inlet from whirling about the shaft.

4. A centrifugal pump comprising a casing having volute suction inlet chambers communicating with and arranged on each side of a discharge chamber, a rotary shaft, an impeller on said shaft interposed between the volute suction inlet and discharge chambers, and a spiral wing arranged within each of the suction inlet chambers and on each side of the impeller near the shaft and forming a continuation of the volute suction inlet for the purpose of properly guiding the liquid passing through the suction inlet into the inlet of the impeller and of preventing said liquid in the suction inlet from whirling about the shaft.

5. A centrifugal pump comprising a casing having a spiral suction inlet communicating with a discharge chamber, a bearing head secured to the casing, a rotary shaft supported in said bearing head, an impeller on said shaft arranged between the spiral suction inlet and discharge chamber, and a spiral wing secured to the inner side of the bearing head and interposed between the suction inlet and impeller near the shaft and forming a continuation of the spiral suction inlet for the purpose of properly guiding the liquid passing through the suction inlet into the inlet of the impeller and of preventing said liquid in the suction inlet from whirling about the shaft.

6. A centrifugal pump comprising a casing provided with suction and discharge members and having an impeller chamber communicating with and arranged between said suction and discharge chambers, a rotary shaft, an impeller on said shaft in said impeller chamber, a combined wearing and balancing ring consisting of a plate with central opening and an inner ring surrounding said impeller, interposed between the impeller and suction chambers and constructed, arranged and coöperating with said impeller to preserve the impeller in positive hydraulic balance by creating a variable pressure chamber between said impeller and combined wearing and balancing ring.

7. A centrifugal pump comprising a casing provided with suction and discharge chambers and having an impeller chamber communicating with and arranged between said suction and discharge chambers, a rotary shaft, a double suction impeller on said shaft in said impeller chamber having intakes communicating with the suction chambers and outlets with the discharge chamber, a combined wearing and balancing ring consisting of a plate with central opening and an inner ring surrounding said impeller, interposed between the impeller and the suction chamber on each side of the impeller constructed, arranged and coöperating with said impeller to preserve the same in positive hydraulic balance by creating a variable pressure chamber between said impeller and combined wearing and balancing ring.

8. A centrifugal pump comprising a casing provided with volute-shaped suction and discharge chambers and having an impeller chamber communicating with and arranged between said suction and discharge chambers, a rotary shaft, an impeller on said shaft in said impeller chamber, a balancing ring interposed between the impeller and suction chamber constructed and arranged to keep the impeller in positive hydraulic balance, and a bearing head on each side of the casing closing the suction chamber and provided with a wing on its inner side near the shaft of such shape as to form a continuation of the volute of the suction chamber for the purpose of preventing the liquid in the suction chambers entering the impeller from whirling around the shaft.

9. In a centrifugal pump, the combination of a casing having suction chambers and a discharge chamber arranged between said suction chambers, a rotary double suction impeller with blades having helical surfaces interposed between the suction and discharge chambers, balancing chambers formed between the outer surfaces of the impeller and a combined wearing and balancing ring consisting of a plate with central opening and an inner ring surrounding the impeller and thereby providing passages for a flow of fluid from said discharge to said suction chambers, whereby the impeller and the opposing faces of the balancing ring are adapted to meet and alternately close said passages and automatically equalize the opposite axial pressures acting on the impeller.

10. In a centrifugal pump, the combina-

tion of a casing having suction chambers, and a discharge chamber arranged between said suction chambers, a rotary impeller with blades of helical form and mounted between the suction and discharge chambers, balance rings carried by said casing and interposed between said suction chambers and impeller and each ring having a radial and a cylindrical surface opposing similar surfaces on the periphery of the impeller and coöperating in such a manner as to provide passages through which fluid may flow from said discharge chamber into the suction chambers, said passages constructed, arranged and adapted to meet and close alternately, whereby the pressure in the discharge chamber will act and equalize the opposite axial pressures acting on the impeller.

11. In a centrifugal pump, the combination of a casing, having suction and discharge chambers, shaft bearings, a rotary shaft supported in said bearings, adjustable collars on said shaft adjacent to the bearings, an impeller on the shaft, movable sleeves on the shaft for holding and adjusting the impeller in central position, a combined wearing and balance ring seated in the casing on opposite sides of the impeller and each ring having a radial contact surface adjacent to and oppositely formed to those of the impeller, whereby the adjacent surfaces of the impeller and balance rings may be adjusted into their proper position by locating the collars against the bearings.

12. A centrifugal pump comprising a casing having a discharge passage and a suction passage on each side of said discharge passage, a rotary impeller within said casing and providing communication between said suction and discharge passages and having portions of its periphery arranged as radial and cylindrical surfaces, a balance ring attached to said casing on each side of said impeller and having a radial and a cylindrical surface arranged to coöperate with similar surfaces on said impeller to maintain it in positive hydraulic balance by creating a variable pressure chamber between said impeller and balance ring.

13. In a centrifugal pump, the combination of a casing, shaft bearings, a rotary shaft supported in said bearings, adjustable collars on said shaft and adjacent to said bearings, a double suction impeller on the shaft having portions of its periphery arranged as radial and cylindrical surfaces, combined wearing and balancing rings held in said casing on each side of said impeller, and each having a radial surface for contact with the impeller and a cylindrical surface surrounding said impeller, and means for setting said collars for contact with said bearings at the instant of contact between said radial surfaces on the wearing ring and impeller in case of axial movement of said shaft for maintaining positive hydraulic and axial balance of said impeller.

In testimony whereof I affix my signature.

CHARLES V. KERR.