R. O. JONES.

CENTRIFUGAL PUMP.

APPLICATION FILED NOV. 27, 1908.

955,168. **Patented Apr. 19, 1910.**

3 SHEETS—SHEET 1.

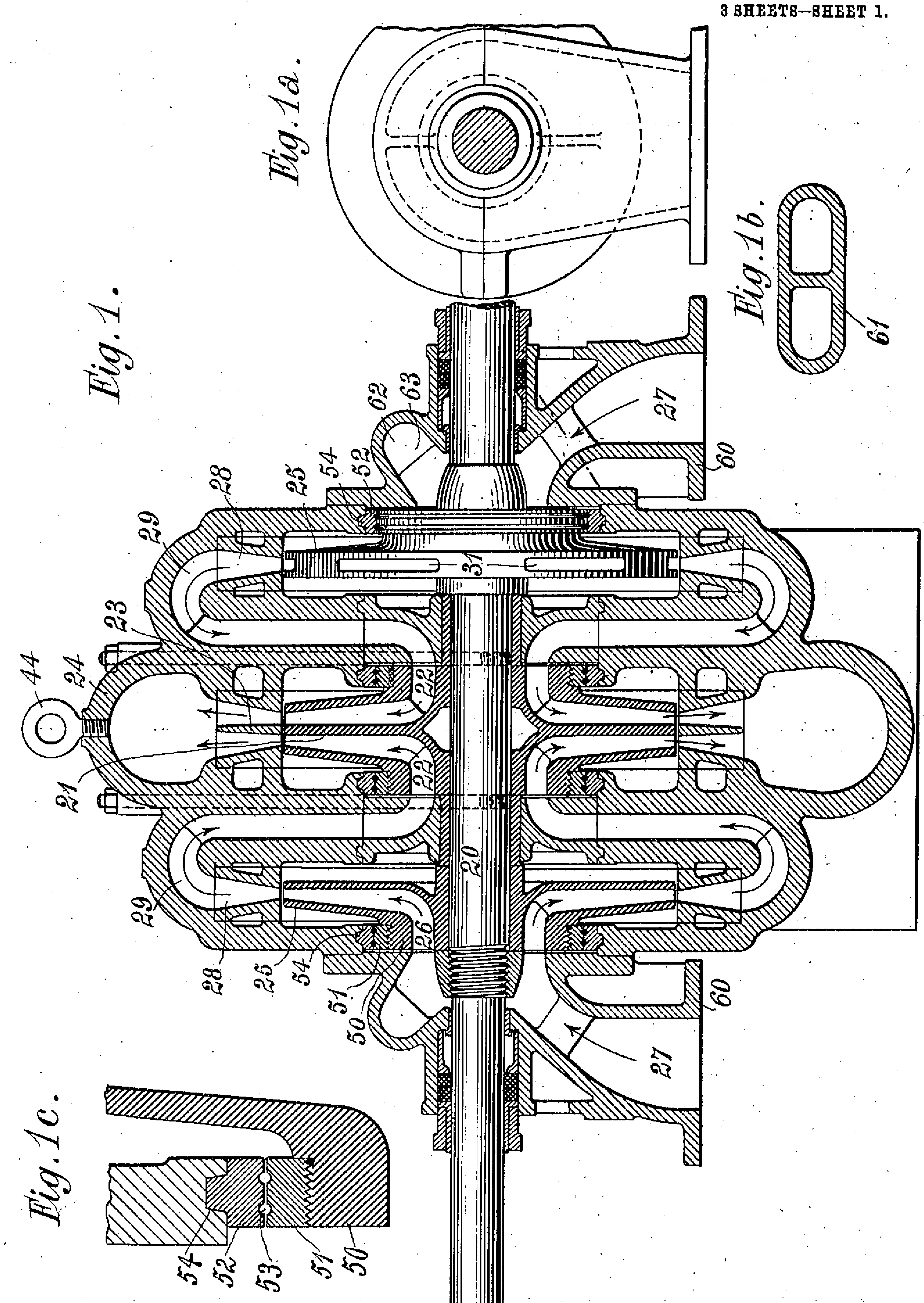

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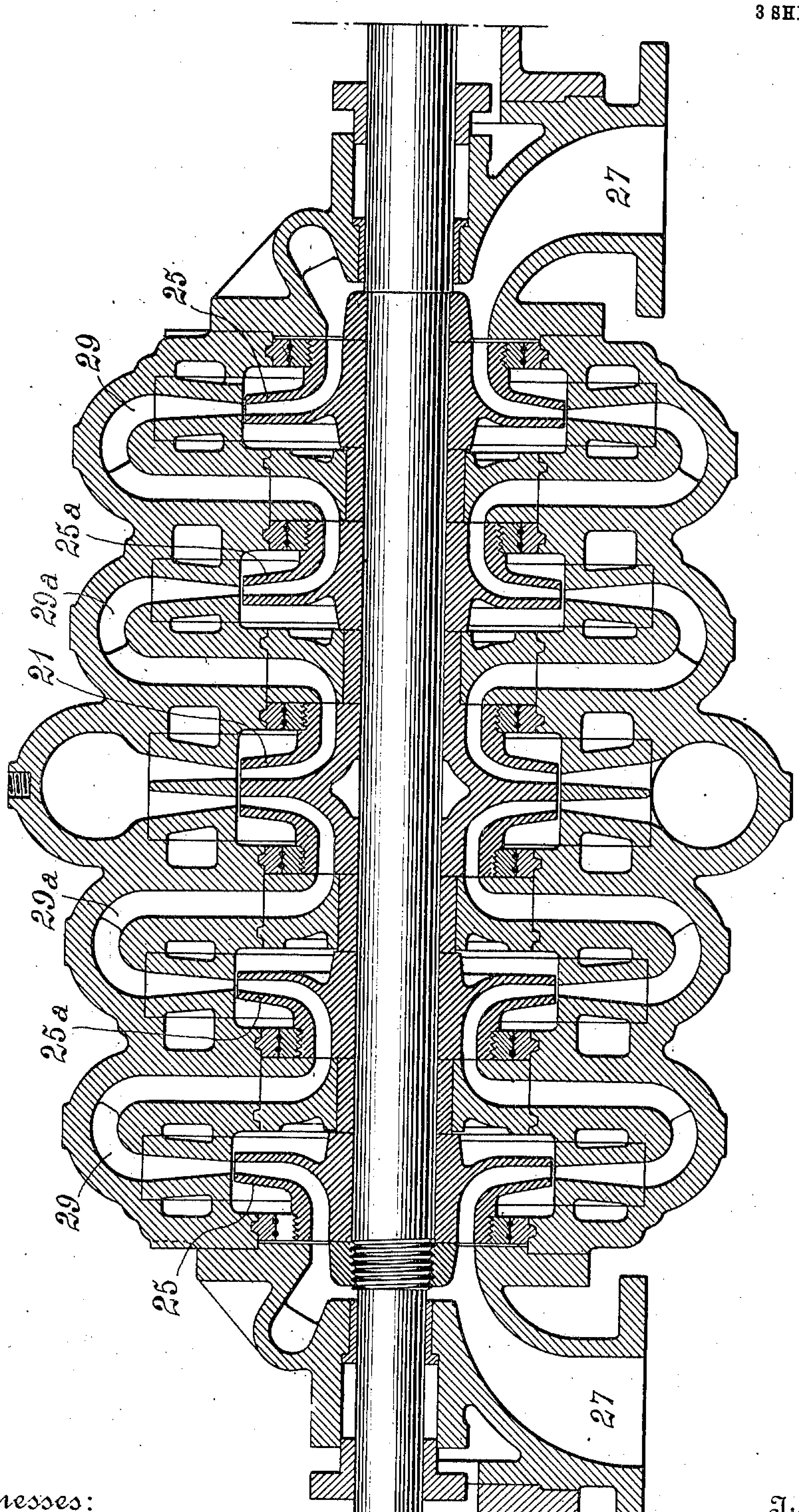
Fig. 2.



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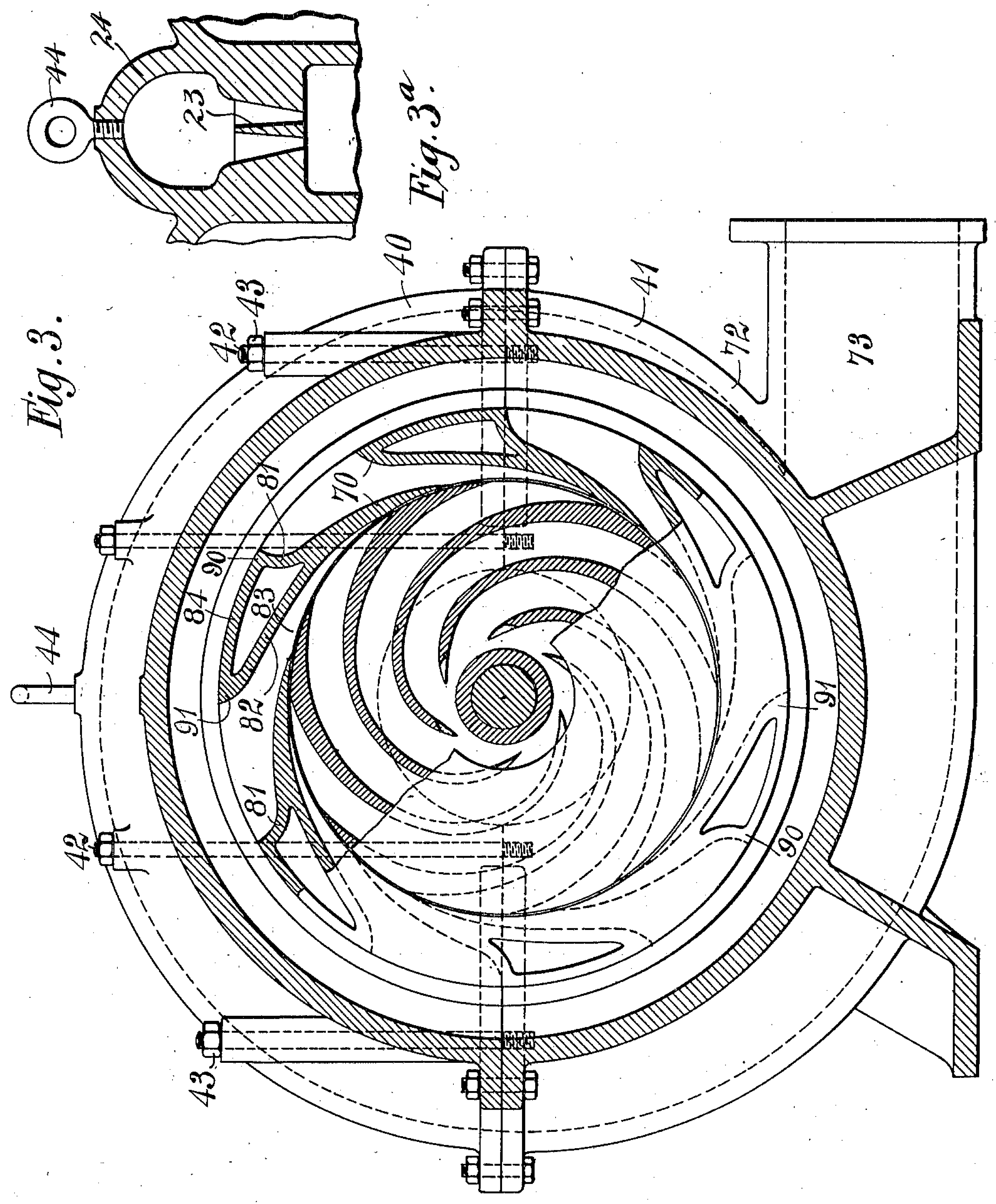

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UNITED STATES PATENT OFFICE.

RICHARD O. JONES, OF DAYTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE COMPUTING SCALE COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

CENTRIFUGAL PUMP.

955,168. Specification of Letters Patent. Patented Apr. 19, 1910.

Application filed November 27, 1908. Serial No. 464,700.

To all whom it may concern:

Be it known that I, Richard O. Jones, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a full, clear, and exact description.

This invention relates to centrifugal pumps and in certain respects these improvements relate to multistage or series pumps of this sort although certain of the inventions herein set forth are applicable alike both to single stage and multistage pumps.

Among the principal objects are to improve the construction of such pumps both in mode of operation and in structural details for the accomplishment of the purposes set forth below.

In the early designs of centrifugal pumps, only a low mechanical efficiency was secured, but the many advantages of the centrifugal pump have directed the progress of invention along the lines of securing a higher degree of mechanical efficiency. Moreover, in the wide field of use of these pumps, the demands of the market have emphasized the importance of simplicity, compactness, reliability and durability of construction, to withstand varieties of speed, rough usage, and the various working conditions; also the importance of accessibility for repair or inspection, renewability of parts and the adaptability for a wide range of pumping requirements.

While material progress has been made in inventions designed to accomplish the above objects, yet owing to the rather intricate theory of operation of these pumps, the lack of accurate knowledge and understanding of them, and the inability of inspecting the fluid action and the various phenomena incident to the pump operation, small steps in advance in this art are difficult to effect. Nevertheless these progressive steps may become of great value commercially in attaining one or another of these various objects. And therefore variations in the structural design and in the manner of combination of the various mechanical elements, become of vital importance in inventions designed to secure the fulfilment of these purposes.

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 drawings forming part of this specification.

Of said drawings, Figure 1 represents a cross-sectional view through a two-stage pump containing the present inventions. Figs. 1^a and 1^b show details of the suction pipe and inlet construction. Fig. 1^c represents a detail of the bearing rings. Fig. 2 represents a vertical cross-section of a three-stage pump. Fig. 3 represents a side elevation partly broken away and sectionalized to show the impeller and diffusion vanes. Fig. 3^a represents a detailed view of a portion of the diffusion ring and volute cast in one piece.

Referring to said drawings, in Fig. 1, 20 represents the transversely revoluble impeller shaft. This shaft is mounted in suitable bearings at the side and is driven by any desired means, such as a steam turbine, electric motor and the like. This impeller shaft 20 has mounted upon it the series of revoluble impellers inclosed within the multiple cylinder as will presently be described.

Centrally mounted on the shaft 20 is a double impeller 21 having intake openings 22 of equal size on its opposite sides. These intake openings are annular in form as usual, surrounding the shaft 20, and the water is discharged from the impeller 21 through the common diffusion ring 23 into the volute casing 24 thus constituting a main discharge of the water from the periphery of the central double impeller 21. This central impeller is designated as a double impeller because in reality it comprises two single closed impellers placed back to back and taking water from opposite sides at the intake opening 22 and discharging the water at the common periphery of the impeller. Mounted upon this same impeller shaft 20 are two single impellers 25 of equal size, one on each side of the central double impeller. These single impellers likewise having annular intakes or suctions 26 to receive water from the main suction pipes. The main suction pipes 27 are situated one on each side of the cylinder and constitute a double suction device conducting water to the respective intake openings 26 of the two single impellers.

For each of the single impellers 25 there is a diffusion ring 28 surrounding the periphery of the impellers in the usual manner. Thus the water which is taken in through the suction pipes 27 on opposite sides of the cylinder is conducted through the respective single impellers 25 and is thereby forced into the diffusion rings 28. The water then proceeds through the water channels 29 from the respective diffusion rings 28, into the aforesaid intake openings 22 of the central double impeller, the direction of the water flow being shown by the arrows.

The single impeller on the right in Fig. 1 is shown in full instead of in section, thereby showing the peripheral openings 31 between the impeller vanes and through which openings the water is discharged into the diffusion ring 28. These single impellers 25 are constructed of substantially the same size and with the same inside and outside diameter as the central double impeller, with the same size intake openings. The double suction pipes 27, delivering equal amounts of water on opposite sides of the cylinder, thereby deliver one-half of the total water capacity to each of the single impellers, so that one-half of this total capacity is delivered through the water channels 29 to each side of the central double impeller through its intake openings 22. Therefore, the central double impeller delivers the combined resultant or total capacity equal to the entire capacity of the pump. Likewise each of the two single impellers develops one-half of the total pressure of the pump and the central double impeller, being a double suction impeller, develops the other half of the required pressure or lift, so that thereby the water discharged from the central impeller through the volute 24 has the required total capacity and pressure. It results from this construction that the pair of single impellers 25 are balanced on the impeller shaft 20, one against the other, so as to do away entirely with any end-thrust, which is an important consideration in series pumps working against high pressures. Moreover, the central double impeller, because of its construction in the manner described, likewise neutralizes any end-thrust, being perfectly balanced as a double suction impeller. Thus the entire revolving mechanism is hydraulically balanced as to end-thrust and no thrust bearings are necessary.

In Fig. 2 this principle is shown as applied to a three-stage pump, in which there is the central double impeller 21 and there are four single impellers 25 and 25[a] on opposite sides of the central impeller. The water is driven by the opposite pair of single impellers 25 through the water channels 29 into the intake openings of the next pair of impellers 25[a] and then through the water channels 29[a] to the intake openings of the central impeller 21. In this three-stage pump, each of the double suction pipes 27 carries one-half of the total water capacity and the outside single impellers carry one-half the water and develop one-third the total pressure or lift. The next two single impellers carry one-half the total capacity and develop another one-third of the pressure, which added to the previous one-third pressure makes a resultant two-thirds pressure. Then the central double suction impeller having water delivered to both sides thereof, thereby carries the total capacity and in itself developing the remaining one-third pressure produces the resultant total pressure by adding its one-third pressure to the previous two-thirds pressure. It will be understood that this system may be carried on for series pumps of four, five or any number of desired stages. In any case the opposite series of single impellers each carry one-half the total water capacity to the central double impeller which carries the whole capacity. And the opposite pair of outside single impellers jointly develops a certain fraction of the total pressure, while the next evenly balanced pair of single impellers develops the same fraction of pressure, added to the pressure of the preceding impellers, and the central impeller develops this same fractional pressure cumulative over the preceding pressures thereby producing the resultant total pressure.

It may be desired in some cases to use a volute casing surrounding the central impeller, as shown in Fig. 1 and also Fig. 3, or if diffusion rings are used, the volute formation may be dispensed with and a central main discharge pipe used of uniform circular diameter, as shown in Fig. 2.

As shown in Fig. 3, the cylinder casing is split horizontally on the line of the impeller shaft into an upper casing 40 and a lower casing 41. Screwed into the lower casing are a series of upwardly extending bolts 42 which extend vertically upward parallel to each other and are adapted to enter corresponding apertures in the upper casing so as to guide the upper casing properly into place when it is lowered down into contact with the lower casing. These bolts are situated between the single impellers and the central double impeller (see Fig. 1) and after the upper casing is put in place, nuts 43 are screwed down upon the upper end of these bolts so as to fasten the upper casing firmly in place. A ring 44, fast to the upper casing 40, may be used to lift off the upper casing. By this means quick and easy access may be had to the revolving parts by lifting off the upper casing; and the suction pipes, together with the discharge pipe as later will be described, being connected with the lower casing, in no way interfere with this removal of the casing. In series pumps of this sort, since considerable pressure is developed within the casing, these tie bolts 42 prevent the casing from being warped out of shape and at the same time serve to guide the casing back into proper position when it is lowered into place.

In series pumps of this kind, the inside webs or partitions must be in perfect alinement. If the upper and lower casings are cast, then the question of shrinkage becomes important for the two parts of the casing must have the same shrinkage. Therefore, this difficulty is met with by casting both the upper and lower casings from the same ladle of molten metal. This results in equal shrinkage of the two parts of the casing and thus insures proper alinement of the halves of the casing.

Each of the impellers 25 and 21 is provided with bearing rings which will now be described. Referring to Fig. 1 and Fig. 1^c, it will be seen that on the side of the impeller there is a flange 50 which projects into or forms part of its intake opening. Threaded upon this flange 50 is a bearing ring 51, which ring is shown in cross section on the single impeller on the left of Fig. 1 and is shown in full upon the single impeller at the right in Fig. 1. Seated in the cylinder casing is another bearing ring 52 which is concentric with the impeller bearing ring 51. These two bearing rings are located in such proximity as to inclose a thin film of water between their confronting surfaces, the impeller ring 50 of course revolving with the impeller, and the stationary bearing ring 52 remaining fixed in the cylinder casing separated from the other ring by this water film. Grooves 53 are formed on the outer surface of the impeller ring 50 and the inner surface of the stationary ring 52. These grooves are matched so as to form circular water channels or grooves when the two rings are in place, as shown in Figs. 1 and 1^c.

The stationary bearing ring 52 has projecting from its outside diameter a beveled ring 54, this ring of course extending around the circumference of the bearing ring itself and in reality forming part thereof. The upper and lower halves of the cylinder casing, namely, 40 and 41, are at these points formed with inner circumferential grooves which are beveled corresponding to the beveled rings 54 just described, so as thereby to form a seat for these beveled rings in the cylinder casings. This construction becomes important in a structure of the present kind where the upper casing is removed at times from the lower casing, for when the upper casing is put back in place, it is necessary that there should be perfect alinement of the casings and that the upper and lower casings should join properly. By this means the beveled groove or recess in the upper casing and the beveled ring 54 aid in insuring the proper lateral adjustment and joining of the two parts of the casing.

When the impeller ring 50 and the stationary ring 52 become worn because of the presence of grit or other material in the fluid which is pumped, the upper casing can be removed and the impeller shaft lifted from place so as to permit the stationary ring 52 to be taken from its seat in the cylinder casing and replaced by a new one, and the impeller ring 50 can likewise be removed so that by this means slippage will be reduced to a minimum and the original efficiency restored.

The suction passages leading to opposite sides of the cylinder are of a peculiar shape which will now be described. The lower part of the suction pipe, as at the joint where the flange 60 is shown in Fig. 1 for joining the suction pipe 27 to the main supply pipe, is circular in cross section. Then just above this point, and just below the impeller shaft, the suction pipe is contracted laterally into substantially an elliptical cross section, as shown at 61 in Fig. 1^b, the cross section being taken across the direction of flow of the water. Then just above the impeller shaft, at the entrance of the impeller intake, this pipe is again made circular in cross section, that is, in the cross section taken likewise across the direction of flow of the water toward the impeller. The opening in this suction pipe, above the impeller shaft, is however distended into an enlarged recess 62 which extends diagonally upward away from the impeller intake and thereby forms an enlarged water chamber. In this chamber is formed a rib or partition 63 which serves as a supporting rib or wall and likewise to deflect and guide the water in its course into the impeller. This special shape of the suction pipe and elbow becomes important because of securing the desired control of the inlet velocity and direction of flow of the water and also insuring the even feeding of the water to the impeller, for it is of particular moment that all the impeller vanes should receive the same quantity of water at their intake edges. The above-described enlarged recess 62 aids in securing an accumulation of a larger volume of water at the upper half of the inlet so as to feed properly and evenly to the impeller throughout its entire diameter. Moreover, the contracting of the suction pipe laterally at this point enables the shaft bearings to be brought closer in toward the cylinder which is an added advantage in this construction. Fig. 1^a shows an end view of this portion of the suction pipe above referred to.

The construction of the diffusion rings and volute casing will now be described.

The diffusion rings, of which there is one for each impeller, surround the impeller in the usual manner and are provided with diffusion vanes 70 extending spirally from the periphery of the impeller to the outer periphery of the diffusion ring. The diffusion rings 28 for the single impellers 25 discharge into the aforesaid water channels 29 (see Fig. 1), and the diffusion ring 23 for the central impeller discharges into the volute casing 24 (Fig. 1). This volute casing is substantially circular in cross section throughout, but increases in diameter from its most contracted portion 72 to the enlarged portion at the lower part of the pump where it enters the discharge pipe 73. These diffusion vanes are so designed as to increase the volume of the water as slowly as possible to avoid shock and consequent loss in hydraulic efficiency, and the volute spiral casing having constantly increasing volume, gives a similar effect so that the combination of the diffusion ring with the volute spiral casing in the manner described is particularly advantageous in converting the velocity or kinetic energy of the water into pressure or static energy as is desired in a pump of this sort. I have also designed this combined diffusion ring and volute casing cast integrally as one piece which thereby gives added advantage in simplicity and economy of construction. When the cylinder casing is split horizontally as above described of course the diffusion ring and volute casing then would likewise be divided with the upper half forming an integral diffusion ring and volute and the lower half likewise an integral diffusion ring and volute.

The diffusion vanes 70 themselves are made of a particular shape, shown in Fig. 3. Each vane starts with a single web or wall as it leaves the inner circumference of the ring, but then branches or diverges toward the outer periphery into two branching walls 81 and 82 extending to the outer rim of the diffusion ring, the wall 82 being longer than the wall 81. This construction results in a series of openings 83 in the rim of the diffusion ring from which openings the water emerges, and the remaining portions 84 of the rim are solid, being the parts included between the adjoining branch walls 81 and 82.

It will be observed that the shorter wall 81 is curved abruptly to a radial direction at its outer extremity (as at 90) where it joins the rim of the diffusion ring; while the longer wall 82 extends farther in a continued spiral direction toward the rim and then is also turned to a radial direction (as at 91). The result of this construction is that the water starts through the water-channels of the diffusion ring in a spiral direction, but the radial turns of the vanes, as above described, deflect the course of the water to produce a radial flow at the rim from the diffusion outlets into the surrounding casing and thence into the discharge pipe. Such a construction has material advantages under certain working conditions.

Certain of the constructions shown in the present application are likewise shown and described in my copending application, Serial No. 464,356, filed Nov. 25, 1908, and are claimed in said other application.

While the form of mechanism shown and described in the present application is particularly adapted to secure the fulfilment of the objects set forth it is to be understood that various other forms might be used, all coming within the scope of the claims which follow.

I claim—

1. In a multistage centrifugal pump, the combination with a transverse impeller shaft carrying a plurality of revoluble impellers, of a multiple cylinder casing therefor split horizontally on the line of said impeller shaft, into upper and lower casings; a plurality of parallel guide and tie bolts seated in the lower casing and extending vertically upward through corresponding openings in the upper casing, to guide the upper casing into proper position of engagement with the lower casing, with nuts for said bolts to bind the upper casing in place; bearing rings detachably mounted on the sides of the said impellers to revolve therewith; a stationary bearing ring concentric with each impeller ring and located in such proximity as to inclose a thin film of water between the confronting surfaces of said bearing rings, said surfaces being formed with water-grooves therein; a beveled ring formed upon and projecting from the outer periphery of each of said stationary bearing rings; with corresponding beveled recesses formed in said upper and lower casings to receive and seat the beveled ring and insure proper lateral adjustment and joining of the upper and lower casings.

2. In a centrifugal pump, the combination with a transverse impeller shaft and a revoluble impeller mounted thereon, of a cylinder casing for said impeller split horizontally on the line of said impeller shaft into upper and lower casings; a flange projecting from said impeller at its intake opening; a bearing ring detachably mounted on the periphery of said flange to revolve therewith; a stationary bearing ring concentric with said impeller ring and located in such proximity as to inclose a thin film of water between the confronting surfaces of said bearing rings, said surfaces being formed with water grooves therein; and a beveled ring formed upon and projecting from the outer periphery of said stationary bearing ring, with corresponding beveled recesses in

said upper and lower casings to receive and form a seat for the beveled ring and to insure proper lateral adjustment and joining of the upper and lower casings.

3. In a centrifugal pump, the combination with the cylinder casing, and an impeller revolubly mounted therein and formed with a flange projecting into the suction opening, of a bearing ring detachably mounted upon the periphery of said projecting flange; and a stationary bearing ring concentric with the said impeller ring and detachably seated in said cylinder casing, said bearing rings being located in such proximity as to inclose a thin film of water between their confronting surfaces, and said surfaces being formed with water-grooves therein, substantially as and for the purpose described.

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

RICHARD O. JONES.

Witnesses:

W. A. CLARE,

J. B. HAYWARD.