

1,037,243.

A. E. GUY.
CENTRIFUGAL PUMP.
APPLICATION FILED MAR. 11, 1912.

Patented Sept. 3, 1912.

2 SHEETS—SHEET 1.

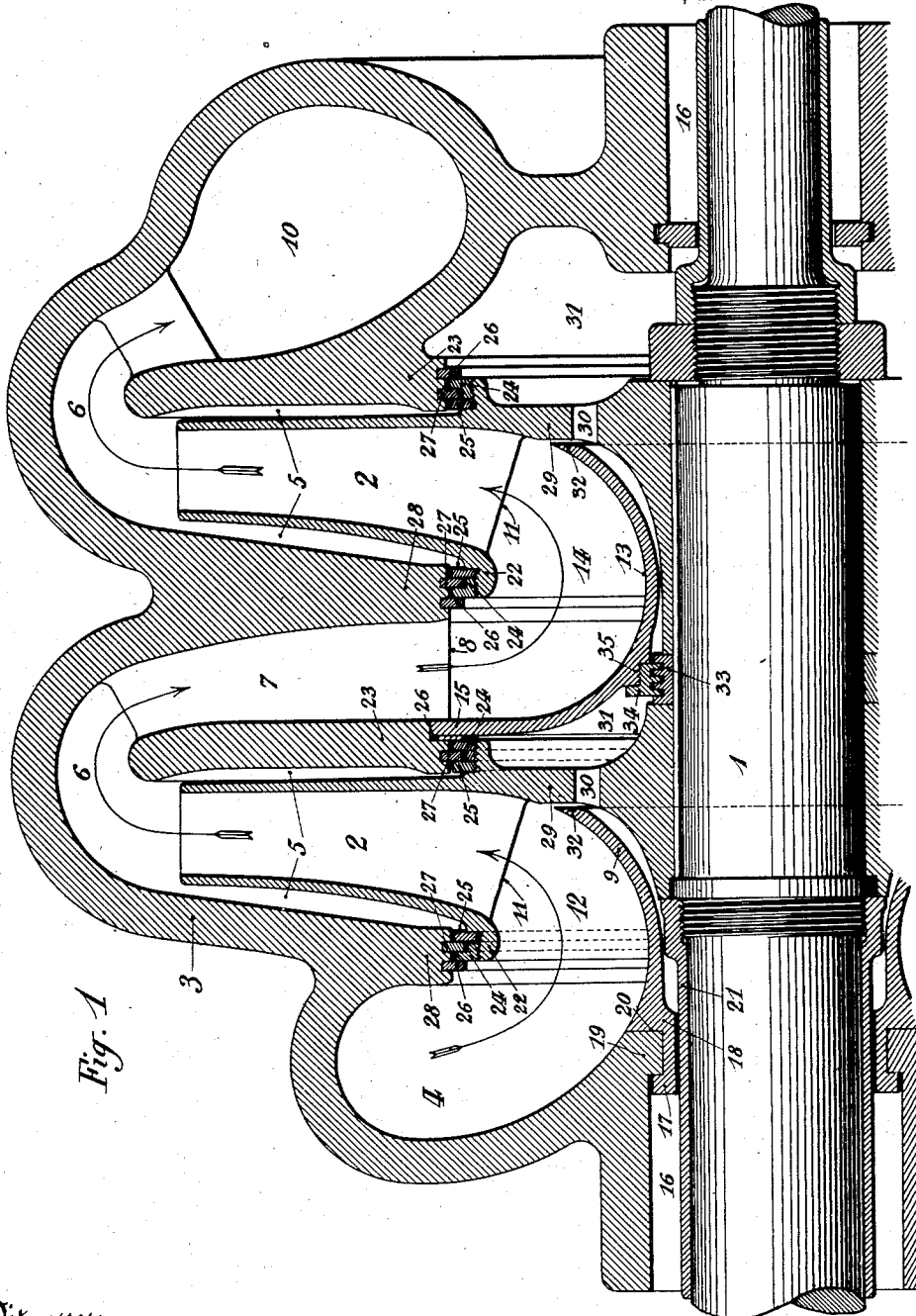


Fig. 1

Witnesses:
Chas. A. Colmbel
H. Wilson

Inventor:
Albert E. Guy

A. E. GUY.
CENTRIFUGAL PUMP.
APPLICATION FILED MAR. 11, 1912.

1,037,243.

Patented Sept. 3, 1912.

3 SHEETS—SHEET 2.

Fig. 2

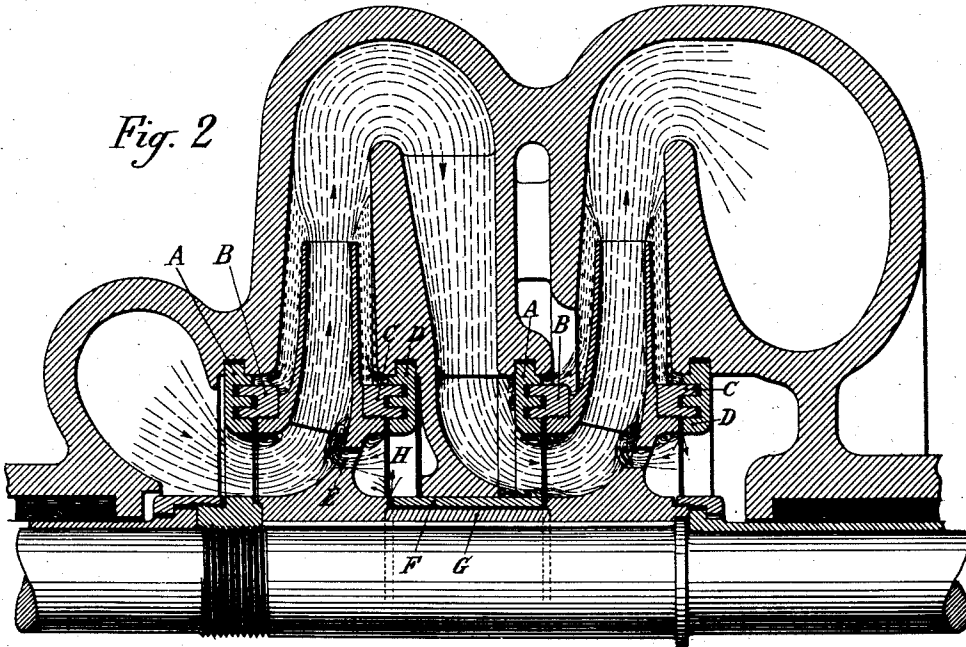
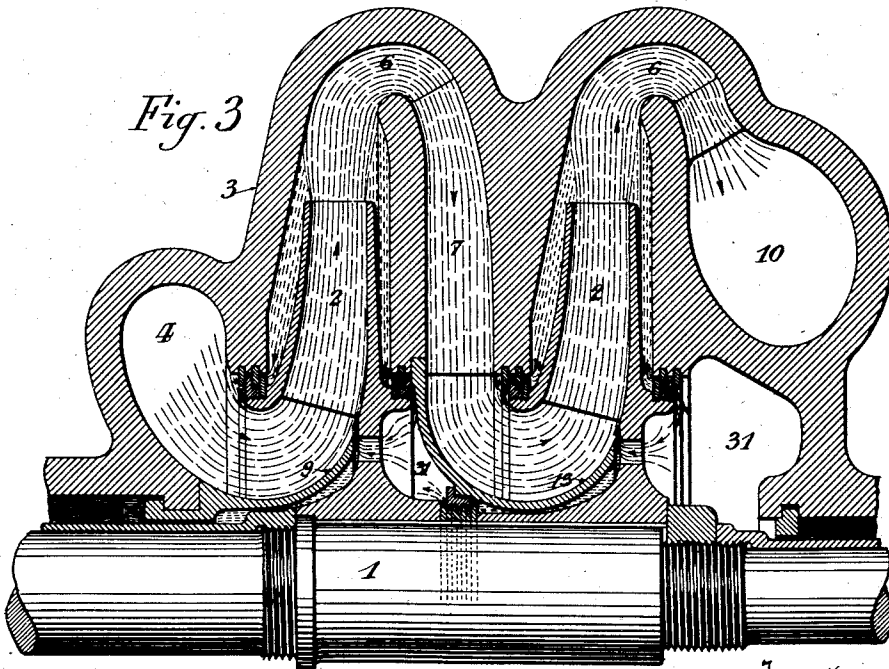


Fig. 3



Witnesses:
Chas. A. Colombel
H. Wilson

Inventor:
A. E. Guy

UNITED STATES PATENT OFFICE.

ALBERT E. GUY, OF TRENTON, NEW JERSEY.

CENTRIFUGAL PUMP.

1,037,243.

Specification of Letters Patent.

Patented Sept. 3, 1912.

Application filed March 11, 1912. Serial No. 682,967.

To all whom it may concern:

Be it known that I, ALBERT E. GUY, a resident of Trenton, in the county of Mercer and State of New Jersey, have invented a new and useful Improvement in Centrifugal Pumps, of which the following is a specification.

This invention relates to improvements in centrifugal pumps, and particularly in those types of pump in which the pump casing is made in two separable parts, joined on a plane parallel with the axis of the shaft, and also in which the rotating parts are maintained in a fixed position relatively to the stationary parts by means of a thrust bearing or its equivalent, and particularly to improvements in the tightening devices for the prevention of leakage at the running joints of such pumps.

The objects of my invention are first, to minimize leakage; second, to prevent the leakage currents from disturbing the main flow of the fluid entering the impeller or impellers of the pump; third, to properly direct the flow of the liquid into the impeller or impellers; fourth, to reduce friction at the tightening of the joints by avoiding contact between the fixed and the revolving parts; fifth, to economize material in, prolong the useful life and facilitate replacement of the tightening parts; and sixth, to improve the efficiency of such pumps.

In the accompanying drawings, Figure 1 represents part of an axial section of a two-stage pump, of the multi-stage type, embodying my invention; Fig. 2 is a diagrammatic view illustrating the defects which my invention is intended to remedy; and Fig. 3 is a view similar to Fig. 1 and showing the circulation of the liquid traversing a pump embodying my invention.

In Fig. 1, 1 designates the shaft upon which the impellers 2 are mounted. The pump casing 3 is split on a plane through the axis of the shaft 1 and is provided, preferably at the discharge end of the pump, with a suitable thrust bearing for the shaft. The arrangement of casing and thrust bearing may be varied but, preferably, are shown in my companion application, filed concurrently herewith, Serial No. 682,968. These features form no part of the present invention and no further description thereof is necessary. The pump casing 3 has on the suction side a main intake chamber 4, an

inlet chamber 12 then an impeller chamber 5, followed by a return bend 6, delivering into the return passage 7. In said return passage 7 are ribs or guide vanes 8, the purpose of which is to guide the liquid centripetally into the inlet bend leading to the second impeller. With this type of pump, to each impeller, except that adjacent to the discharge side there is an impeller chamber, a return bend, and a return passage provided with guide vanes and the combination of these parts constitutes one stage of the pump. The return bend of the last stage leads the liquid centripetally into a discharge chamber 10 provided with one or more flanged openings for connection to the discharge main. Hence, although Fig. 1 illustrates the application of my invention to a two-stage pump, it is understood that said invention may be applied to a pump having any number of stages. Said invention may also be applied to single stage pumps, either of the multi-stage type, or of the double suction type; in this latter type, the liquid is led simultaneously to both sides of the impeller.

There are two points of main importance to be considered in the construction of an otherwise well designed pump. One is that the direction and the velocity of the liquid at the point of contact with the first element 11 of the vanes, or vane inlet, are fundamental factors in the calculation and delineation of the shape of the vanes. Therefore, when anything occurs which deviates the direction and changes the velocity of the liquid at the vane inlet, the performance of the pump will be different from, and invariably not so good as was intended. The other is that, as the liquid leaves the impeller, nothing can add to the energy it possesses, and everything it contacts with, be it diffuser passage, diffuser vanes, free whirlpool, or easy return bend, will cause a reduction of said energy; but the greater loss of energy, however, in an otherwise well designed pump, is caused by leakage at the running joints. To cover these two important points I devised the invention described in my former application Serial No. 489,187, for which Patent No. 972,366 was granted. But while said invention has proven very useful, I have found by close observation, both in the laboratory and in the field, that it falls short of the purpose for which it was intended. The results of my observations

are best illustrated by Fig. 2, which is a sectional view similar to that filed with my application Serial No. 489,187, and to which have been added diagrammatically the stream lines representing the flow of liquid through the pump. The leakage issuing from the labyrinthine passage formed between the intermeshing flanges of the two wearing rings A and B, impinges normally onto the current of fluid entering the inlet chamber of the impeller thereby causing a contraction of the vein or stream of liquid and disturbing the flow. The leakage issuing from the labyrinthine passage formed between the intermeshing flanges of the two wearing rings A and B, impinges normally onto the current of fluid entering the inlet chamber of the impeller thereby causing a contraction of the vein or stream of liquid and disturbing the flow. The leakage issuing from the labyrinthine passage formed between the wearing rings C and D, at the rear side of the impeller, mingles with the leakage issuing from the annular clearance space formed between the rotating sleeve G and the fixed sleeve F, and the whole mass of such leakage passes from the balancing chamber H, on the rear of the impeller, through the holes E, drilled through the impeller web, and impinges against the current of fluid, just before said current contacts with the vane inlet. The result of such impact is a contraction of the vein or stream of liquid and a disturbance of the flow. The current of liquid entering the impeller comes into contact with the extensive curved surface of the impeller hub and web, extending from the suction end of the hub to the vane inlet; and as this surface is rotating at a high rate of speed, the mass of liquid directly in contact with said surface is entrained, and in turn, communicates gradually its motion to the various surrounding layers of liquid, thereby deviating the direction of the current of liquid. The net results of the three disturbing elements just described is that the liquid arrives at the vane inlet with velocity and direction different from those upon which the design of the impeller was established; consequently it is not possible to guarantee the exact performance of the pump until after said pump is thoroughly tested out in the laboratory; and uncertain prediction of the performance of a pump always proves a serious impediment in negotiating the sale of the apparatus. The intermeshing flanges of the companion wearing rings A and B, and of the companion rings C and D, were provided with ample axial clearance, and with but just sufficient peripheral clearance to insure free running of the rotating parts, the efficiency or tightness of the whole joint depending precisely on the closeness of said peripheral

clearance. I have observed, however, that because of the threaded assemblage of the rings B and C on the axially extended flanges of the impeller, it is not possible for said rings to revolve concentrically true. It was then found necessary to allow greater peripheral clearance between the intermeshing flanges so as to prevent actual rubbing and cutting of the neighboring surfaces, which rubbing and cutting takes place when the rings run untrue, because of their inherently defective mounting, and also, when the whole impeller runs out of true, due to sagging of the shaft, or to imperfect balance of the rotating mass. It is obvious that the efficiency of a labyrinthine joint is greatly impaired when the clearance is large, and also that the resulting increase in leakage flow is followed by increased erosion of the labyrinthine surfaces. It was also found that when the clearance had become excessive, since no adjustments could be made, complete sets of companion wearing rings had to be replaced, which proved to be an expensive proceeding, particularly so in mining districts where the liquid handled is acidulous and carries much grit, therefore necessitating frequent renewals of said rings. My present invention is therefore, intended to remedy the defects above enumerated.

It is a matter of common observation that when water flows from a straight pipe into a curved bend or elbow, the deviation of the stream generates centrifugal forces in the water, since intensities vary nearly as the radii of curvature of the stream lines. Therefore, the pressure in the cross section of the stream at any point in the elbow will not be uniform; it will vary throughout the cross section, having its greatest value where the radius of curvature is greatest, on the concave side of the elbow, and its least value at or near the convex side. The cross section contracts gradually from the beginning of the elbow, and becomes smallest at the end of the elbow. Strictly speaking, when the water flows rapidly through the bend, it is not in contact with the convex part of said bend. Now, in Fig. 1, the passage 9 connecting the main intake chamber 4, to the vane inlet 11 is in effect but an elbow; and the passage 13 connecting channel 7 to the vane inlet of the second impeller is also but an elbow. Consequently, the stream, when entering said elbow passages is deviated and the centrifugal forces thus developed cause the liquid to bear against the concave side of these elbows. The free surface of the stream (that having the smallest radius of curvature) affects the form of the convex side of an elbow, and comes smoothly into contact with the suitably located curved flange 22, of the impeller 2, just before the stream reaches the

vein inlet 11. Although the parts 9 and 13 affect, in their axial cross section, the shape of the concave wall of the pipe bend, they are in fact conoidal shells. The conoidal guide shell 9 surrounds part of the hub of the first impeller, and also the shaft 1 and its protecting sleeve 21; it is provided with an annular part 18 having a flange 17; between which and wall 20 a circular groove is formed. Said circular groove is fitted to flange 19, and flange 17 thus forms the end wall of the shaft packing space 16. In this manner, said shell 9 is held firmly in position, does not come into contact with the rotating parts, and, when properly adjusted, forms a smooth and effective guide for the liquid from the intake chamber 4, to a point very close to vane inlet 11. Said shell 9 is therefore the wall of the inlet chamber 12, for the impeller nearest to the intake or suction chamber 4. Conoidal guide shell 13 surrounds the hub of the second impeller, and is provided with a circular flange 15 which fits into a corresponding groove cut into partition wall 23, and the adjacent guide vanes 8. In this manner said shell 13 is fixed, does not come in contact with rotating parts, and forms a smooth and effective guide for the liquid, from the return passage 7 to vane inlet 11 of the second impeller 2. Said shell 13 is therefore the wall of an interstage inlet chamber 14. The liquid under pressure tends to flow from impeller chamber 5 into the inlet chamber 12, but it is intercepted by a tightening device forming a running joint between the casing wall 28 and the inlet flange of the impeller. Said tightening device is composed of the annular flanges 24, 25, 26 and 27. Flanges 24 and 25 are separately mounted on the external wall of the impeller inlet flange 22; and each of the flanges 26 and 27 is inserted into a circular groove cut into the casing wall 28, which surrounds completely the whole tightening device.

Between the external wall of flanges 24 and 25 and the bore of wall 28, and also between the inner wall of flange 27 and the bottom surface of the groove formed between flanges 24 and 25, ample play is provided so that radially neighboring surfaces cannot normally come into contact when, for instance, flanges 24 and 25, which rotate with the impeller, should be set concentrically out of true, or when the whole rotating mass should run out of true because of the sagging of the shaft or of the imperfect rotating balance of said mass. A slight lateral clearance, just sufficient to avoid rubbing contact and to allow free running of the rotating parts, is provided on each side of flange 24, and between the neighboring faces of flanges 25 and 27. The maintenance of said clearance is insured through the medium of a thrust bearing rigidly connected

to the exterior of the pump casing, said thrust bearing receiving one end of the shaft 1 in any of the usual ways, and holding it against axial displacement. The tightening of the joint is thus secured through the restriction of the lateral passages left free between adjoining faces of the stationary and rotating flanges. The liquid issuing past the tightening joint follows the free lateral surface of flange 24, and thence follows the rounded edge of the impeller flange 22, where said liquid mingles, without appreciable disturbance, with the main flow of the fluid on its way to the main inlet 11. The erosion produced by the flow of liquid through the joint affects only the neighboring faces of the flanges. Hence, when upon inspection of the interior parts of the pump it is found that erosion has increased the clearances beyond the permissible limit, it will suffice to renew the flanges 24 and 27, while each of the flanges 25 and 26 may be simply turned around, the uneroded faces of these latter now serving as walls for the restricted passages. Upon finding necessary another renewal of the flanges, all the flanges may then be removed and replaced by complete new sets. Had the set of stationary flanges been made in one piece, one new set would have been required at each renewal; the same remark applies to the rotating flanges. Whereas, it is seen that with separate flanges the whole tightening device lasts one and one-half as long as when solid sets of flanges are used. Besides, the material wasted in the renewals is insignificant as compared with that required for solid rings; and the shape and size of the flanges are such that they can easily be made by the user of the pump, the work requiring no special tools, jigs or gages.

On the rear of each impeller is a balancing chamber 31, and the pressure therein is substantially equal to that obtaining in the preceding inlet chamber, because communication between these two chambers is provided through a number of holes 30, drilled through impeller web 29. The liquid under pressure tends to flow from impeller chamber 5 also into balancing chamber 31, but it is intercepted by a tightening device similar to that on the inlet side of the impeller and forming a running joint between the partition wall 23 and the web of the impeller. Flanges 26 may be located in a separate groove, but I prefer to insert it conjointly with flange 15 into the same groove in partition wall 23.

Mounted on shaft 1, and tightly pressed between the hubs of two adjoining impellers, is a multi-flange ring 33, surrounding which another multi-flange ring 34, made in halves stationary with, but removably attached to shell 13, preferably as shown, threaded into a recess 35 inside said shell 13. The com-

bination of said rings 33 and 34 forms between balancing chamber 31 and inlet chamber 14, a tightening device which operates in precisely the same manner as those provided between the impeller and the pump casing, that is, the tightening of the joint is secured through the restriction of the lateral passages left free between adjoining faces of the stationary and rotating flanges. Ample clearance is provided radially so as to prevent contact in that direction under ordinary operating conditions. The leakage of liquid past the shaft tightening device 33-34, and the tightening device on the rear of the impeller tends to maintain in balancing chamber 31 a pressure greater than that obtaining in the preceding inlet chamber, but the liquid escapes through the holes 30 and thence, following a narrow passage formed between the end 32 of the conoidal guide shell and the impeller web 29, said liquid is guided in a direction substantially tangential with that of, and into, the liquid current passing from the inlet chamber proper into the vane inlet 11. In this manner the incoming liquid reaches the vane inlet with very little disturbance.

What I claim is:

1. A centrifugal pump comprising in combination a casing formed with an intake chamber and an impeller chamber, a shaft rotatable in said casing and carrying an impeller located in said impeller chamber, said impeller being formed on either side with an annular extension, a plurality of separately renewable annular flanges removably mounted on each extension and rotating with said impeller, and a plurality of separately renewable annular flanges removably and non-rotatably mounted in the bore of each wall of the impeller chamber, said rotating flanges, adjoining lateral faces of said stationary and of said rotating flanges forming walls of restricted passages for intercepting egress of liquid from the impeller chamber.

2. A centrifugal pump comprising in combination a casing formed with an intake chamber and an impeller chamber, a shaft rotatable in said casing and carrying an impeller located in said impeller chamber, said impeller being formed on either side with an annular extension and plurality of radially extending, separately renewable, spaced annular flanges removably mounted on each extension and rotating with said impeller, and a plurality of radially arranged, separately renewable spaced annular flanges removably but non-rotatably mounted in the bore of each wall of the impeller chamber and arranged to cooperate with said impeller flanges, adjoining radially extending faces of said stationary and of said rotating flanges forming walls of restricted passages

for intercepting egress of liquid from the impeller chamber.

3. A centrifugal pump comprising in combination a casing formed with an intake chamber and an impeller chamber, a shaft rotatable in said casing and carrying an impeller located in said impeller chamber, and a stationary but removable conoidal guide shell extending from said intake chamber to a point close to the web of said impeller and serving as a wall of a duct or inlet chamber, leading the incoming liquid smoothly and protecting said liquid from contact with the surface of the rotating parts until said liquid reaches the vane inlet.

4. A centrifugal pump comprising in combination a casing formed with an intake chamber and an impeller chamber, a shaft rotatable in said casing and carrying an impeller located in said impeller chamber, and a stationary but removable conoidal guide shell extending from said intake chamber to a point close to the web of said impeller and serving as a wall of a duct or inlet chamber, leading the incoming liquid smoothly and protecting said liquid from contact with the surface of the rotating parts until said liquid reaches the vane inlet, said conoidal guide shell being formed with a groove at one end, and an annular flange on the casing fitting into the groove of said conoidal guide shell.

5. A centrifugal pump comprising in combination a casing formed with an intake chamber and an impeller chamber, a shaft rotatable in said casing and carrying an impeller located in said impeller chamber, said casing being formed with a balancing chamber on the rear side of said impeller, and a stationary conoidal guide shell removably attached at one end of the wall of said intake chamber and extending from said intake chamber to a point close to the web of said impeller, and serving as the wall of a duct or inlet chamber, leading the incoming liquid smoothly and protecting said liquid from contact with the surface of the rotating parts until said liquid reaches the vane inlet, said conoidal guide shell forming with the web of said impeller, the walls of a passage for guiding the liquid issuing from the balancing chamber, through web holes in said impeller, in a direction substantially tangential with that of and into the liquid current reaching the vane inlet of said impeller.

6. A centrifugal pump comprising in combination a casing formed with an intake chamber and at least two impeller chambers and a return passage connecting one of said impeller chambers with the inlet chamber of the following impeller chamber, a shaft rotatable in said casing and carrying an impeller in each of said impeller chambers,

and a stationary but removable conoidal guide shell forming the wall of said inlet chamber and extending from said return passage to a point close to the web of the following impeller, said conoidal guide shell leading the incoming liquid smoothly and protecting said liquid from contact with the surface of the rotating parts until said liquid reaches the vane inlet.

7. A centrifugal pump comprising in combination a casing formed with an intake chamber and at least two impeller chambers and a return passage connecting one of said impeller chambers with the inlet chamber of the following impeller chamber, a shaft rotatable in said casing and carrying an impeller in each of said impeller chambers, and a stationary but removable conoidal guide shell forming the wall of said inlet chamber and extending from said passage to a point close to the web of the following impeller, said conoidal guide shell leading the incoming liquid smoothly and protecting said liquid from contact with the surface of the rotating parts until said liquid reaches the vane inlet, a partition wall separating one of said impeller chambers and its return passage and formed with an annular groove, one end of said conoidal guide shell being formed to fit said groove.

8. A centrifugal pump comprising in combination a casing formed with an intake chamber and at least two impeller chambers and a return passage connecting one of said impeller chambers with the inlet chamber of the following impeller chamber, a shaft rotatable in said casing and carrying an impeller in each of said impeller chambers, and a stationary but removable conoidal guide shell forming the wall of said inlet chamber and extending from said passage to a point close to the web of the following impeller, said conoidal guide shell leading the incoming liquid smoothly and protecting said liquid from contact with the surfaces of the rotating parts until said liquid reaches the vane inlet, said casing being formed with a balancing chamber on the rear side of said following impeller, a stationary but remov-

able conoidal guide shell forming the wall of said inlet chamber and extending from said return passage to a point close to the web of said following impeller, a partition wall separating one of said impeller chambers and its return passage, one end of said second named conoidal guide shell being removably connected to said partition wall and the other end forming with the web of the following impeller the walls of a passage for guiding the liquid issuing from said balancing chamber, through web holes of said following impeller, in a direction substantially tangential with that of and into the liquid current reaching the vane inlet of said following impeller.

9. A centrifugal pump comprising in combination a casing formed with an intake chamber and with at least two impeller chambers and a return passage connecting one of said impeller chambers with the inlet chamber of the following impeller chamber, a stationary but removable conoidal guide shell forming the wall of said inlet chamber and extending from said return passage to a point close to the web of said following impeller, a shaft rotatable in said casing and carrying an impeller in each impeller chamber, said casing being formed with a balancing chamber on the rear side of each of said impellers, a multi-flange ring mounted on and rotating with said shaft and secured between the hubs of adjoining impellers, and a stationary multi-flange ring removably mounted on the interior of said conoidal guide shell, adjoining laterally extending faces of said stationary and of said rotating multi-flange rings forming walls of restricted passage for the purpose of intercepting the egress of liquid under pressure from the inlet chamber of said following chamber into the balancing chamber of the preceding impeller.

In testimony whereof, I have hereunto set my hand.

ALBERT E. GUY.

Witnesses:

F. W. WINTER,
ELBERT L. HYDE.