Nov. 23, 1948. O. JACOBSEN 2,454,390

CENTRIFUGAL PUMP

Filed Aug. 23, 1944 2 Sheets-Sheet 1

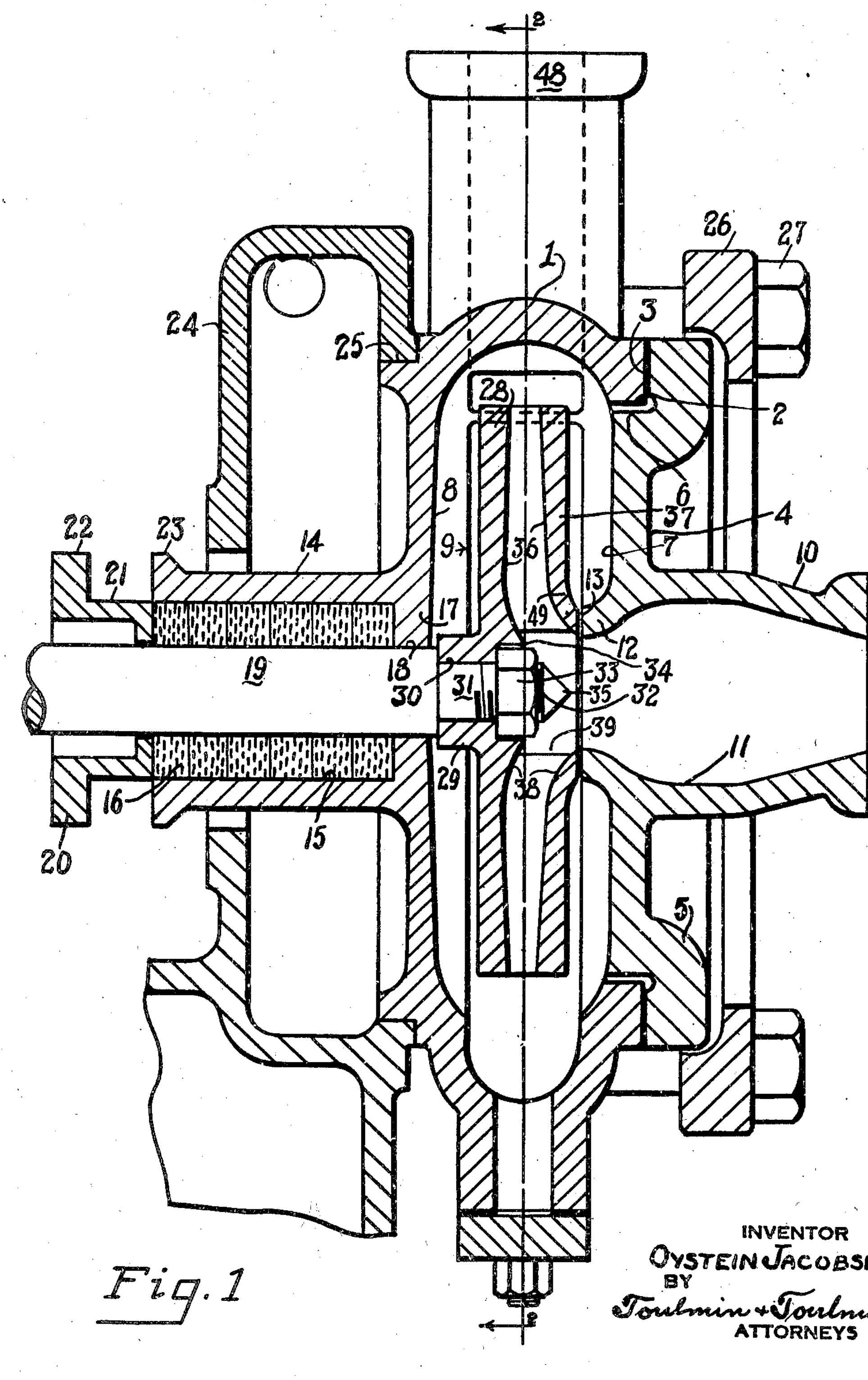

Fig. 1

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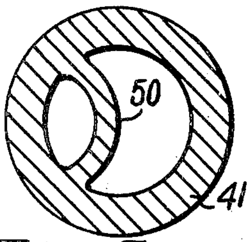

Fig. 3

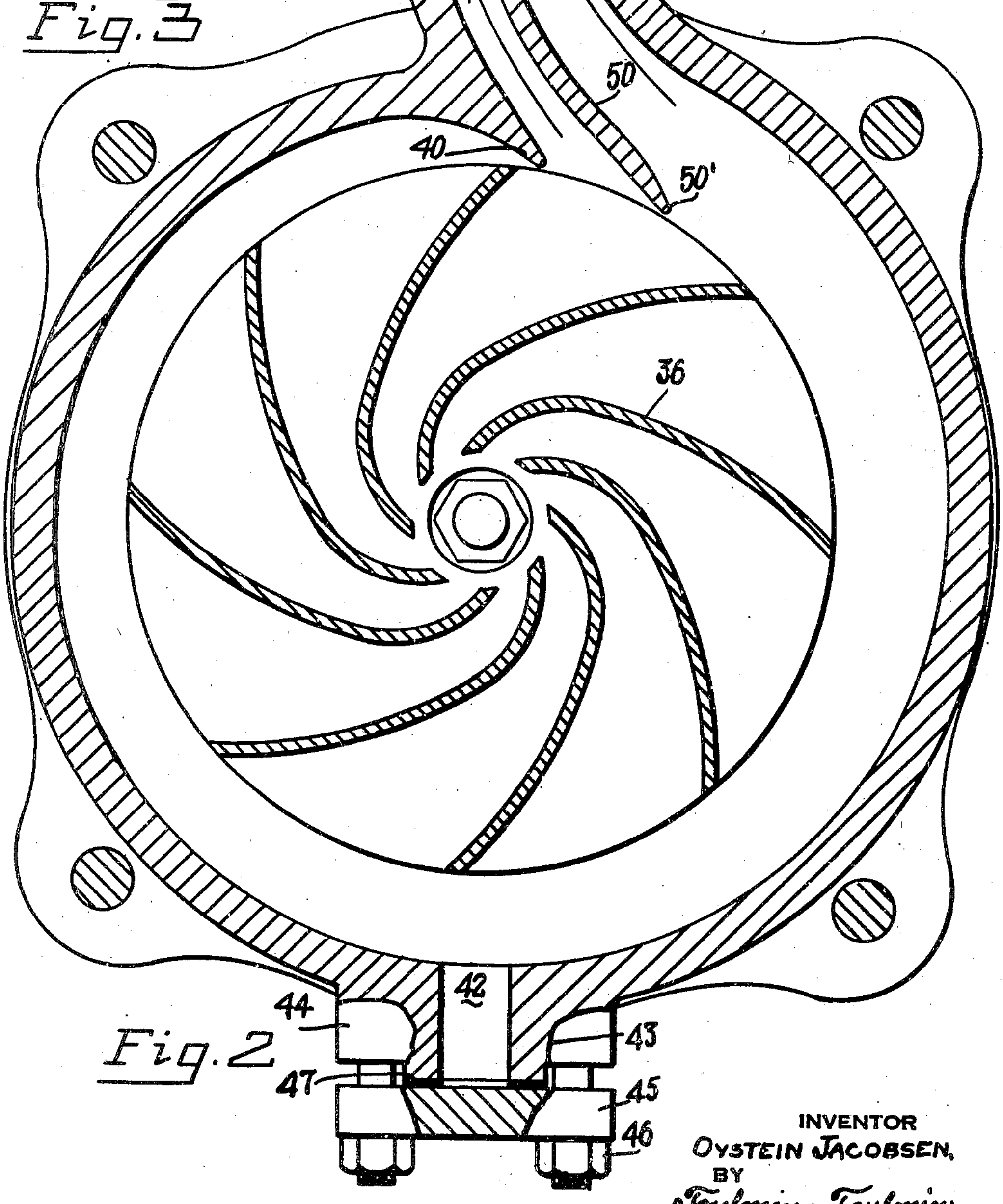

Fig. 2

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CENTRIFUGAL PUMP

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6 Claims. (Cl. 103—103)

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The present invention relates to centrifugal pumps and more particularly to those having a circular runner rotatable in a volute casing and in which the fluid is forced out through a single neck in the casing.

In centrifugal pumps of the volute chamber type, it is the usual practice to draw liquid or gas through a central inlet port leading to the hub portion of the impeller and to discharge the fluid by centrifugal force from the impeller through a tangential port or neck in the wall of the casing. This port is generally of circular shape and is given a somewhat curvilinear shape to extend gently away from the periphery of the impeller in order to reduce as far as possible eddy currents or turbulence within the fluid which is being forced out of the pump.

Nothwithstanding the extreme care taken in the design of the casing outlet to give it the maximum stream-line effect, it has been found that there is still a sufficient amount of whirling present which disturbs the orderly flow of fluid through the restricted neck opening and these eddy currents materially reduce the efficiency of the pump. After considerable investigation of this old but hitherto unsolved problem, I have found that the turbulence effect, in the case of a circular column of fluid, originates at the central part of the column. This may be due to the retarding effects offered by the walls of the outlet passageway to the fluid but which do not affect the central portion of the fluid column thus tending to permit the various parts of the column to travel at different velocities. Moreover, the interior surfaces of the outlet conduit or neck of the pump serve effectively to guide that portion of the fluid near these surfaces but the interior portions of the fluid column must provide their own guiding effects since they are considerably removed from the guiding surfaces.

The primary object of the invention is to provide an improved centrifugal pump having an outlet passageway arranged tangential to the impeller and in which turbulence and other retarding circulatory effects within the fluid moving between the impeller and the external surface of the casing are entirely removed. Thus the general object of the invention is to improve the efficiency of pumps which employ impellers rotating within a volute casing.

These objects are attained in brief, by separating the outgoing column of fluid into two or more portions and providing separate guide-ways for each fluid column in order to constrain every portion of the outgoing fluid to a predetermined

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path. These guide-ways are contained in the usual pressure outlet of the casing to form individual passageways which communicate solely with the high pressure side of the impeller. Thus the fluid flows through all of the passageways formed by the guides under substantially equal pressures and at relatively the same velocities. For practical purposes, the guides for controlling the interior portions of the fluid column may be formed integral as by casting with the usual neck of the casing.

The invention will be better understood when reference is made to the following description and the accompanying drawings in which Figure 1 represents a longitudinal section of the improved pump with a few parts shown in elevation for clearness.

Figure 2 is a cross-sectional view of the pump taken along line 2—2 in Figure 1 and looking in the direction of the arrows.

Figure 3 is a cross-sectional view taken across the neck of the casing as represented by the line 3—3 in Figure 2.

Referring to the drawings, reference character 1 designates the main casting of the centrifugal pump, this casing taking on generally a volute shape as indicated in Figure 2. The right-hand side of the casing as seen in Figure 1 is provided with a large circular opening 2 and terminates in a bearing surface 3. A cover plate 4 has a flanged portion 5 which bears against the surface 3 and is provided with a shoulder 6 which fits loosely within the opening 2 of the casing. A large packing washer may be inserted between the bearing surface 3 and the flange portion 5 in order to prevent leakage at this point.

The interior surface 7 of the cover 4 together with interior surface 8 of the casing 1 provides a pumping chamber or compartment in which the impeller of the pump generally designated 9 rotates. The cover member 4 is provided with a long, outwardly extending cylinder 10 positioned at the center of the cover and provided with an internal passageway 11 tapered to a smaller diameter at the outer end of the cylinder. At the opposite or inner side of the cover a cylindrical extension 12 is also provided but of considerably less length than the cylinder 10. This extension terminating in a flat surface 13 in clos proximity to the front side of the impeller. Th passageway 11 constitutes the inlet of the pum and is given a stream-line or Venturi shape ir order to reduce any eddy currents therein. Ii desired, guiding vanes (not shown) may be provided within the passageway, these vanes extending longitudinally thereof in order to further minimize eddy current loss.

The casing is provided opposite the cylinder 10 with an outwardly extending cylinder 14 preferably formed integral with the casing. The cylinder is hollow as indicated at 15 to receive a large number of packing rings 16 for preventing leakage of fluid at this point. The depth of the opening 15 is less than the length of the cylinder 14 in order to leave a wall portion 17 having an opening 18. This opening snugly but slidably receives a shaft 19 on which is mounted the impeller 9. The packing rings 16 which are contained within the annular space between the shaft 19 and the opening 15 are placed under pressure by a gland 20 which has a turned down portion 21 of slightly less diameter than the opening 15. Pressure may be exerted on the gland by means of a clamping device (not shown) embracing the flange 22 of the gland and an enlargement 23 on the cylinder 14.

The main portion 1 of the casing is supported in a heavy frame member 24 which fits within a shouldered portion 25 of the casing. The latter and the cover 4 are secured together by means of a clamping ring 26 and bolts 27 which threadedly engage the frame 24.

The impeller may be of the double shrouded type as illustrated, or an open runner and, in general, comprises a heavy circular plate 28 which is provided at the center with a hub 29 having an opening 30 for receiving the turned down portion 31 of the shaft 19. The shaft portion 31 is threaded at the end indicated 32 for engaging a nut 33 which fits within a countersunk opening 34 formed in the hub. The innermost end of the shaft portion 31 is preferably tapered to a point indicated at 35 in order readily to direct the fluid which flows through the inlet opening into the passageways formed by the blades of the impeller.

As shown in Figure 2, these blades may constitute a number of curvilinear sheet-like projections 36 extending integrally upward from the plate 28 with which they may be cast. The blades have a rounded shape of varying degrees of curvature and in general are much more flat at their outer edges than near the center. They extend from a position conforming to a circle at the center of the plate 28 to an outer position which coincides with the edge of the plate. There is a second plate or shroud 37 preferably secured to the edges of the blades 36 and both plates 28, 37 together with the blades 36 constitute the impeller. The shrouds 28 and 37 at their inner edges are provided with curved surfaces 38 and the outer plate or shroud 37 has an opening 39 which coincides with the inlet passageway 11.

The interior surface of the casing takes the shape of a volute, as shown in Figure 2, and there is considerable space between the outer edge of the shrouds 28, 37 and the interior surface of the casing. In order to divide the suction and pressure effects of the impeller, the casing is provided with a relatively sharp inwardly projecting portion 40 which terminates quite close to the periphery of the impeller. The output of the pump is taken through a single neck 41 which extends upwardly and has curvilinear shape so that the interior surface of the neck can gradually merge with the interior space of the pump in a tangential direction. At the opposite or lower side of the casing a drainage hole 42 is taken out through a boss 43 having lugs 44. A closure plate 45 is bolted as indicated at 46 to these lugs for closing off the opening when not in use. A leakage gasket 47 may be interposed between the boss and the closure plate.

In operation, the shaft 19 which is suitably carried in outboard bearings (not shown) rotates the impeller 9 at an extremely fast speed and suction is created in the passageway 11 which draws fluid through the passageway and thence into the space between the blades 36. The fluid is discharged through the opening in the neck 41, usually into a large pipe or conduit (not shown) clamped to the enlarged portion 48. In order to constrain all of the fluid which finds its way into the annular space between the impeller and the volute casing to pass through the vane passageways, the outer shroud 37 is curved outwardly as indicated at 49 and terminates at a position quite close to the flat surface of the cover extension 12. The projection 40 of the casing tends to reduce the amount of fluid which continuously circulates within the pump so that the maximum amount of fluid is caused to enter the outlet passageway.

Notwithstanding the extreme precautions taken to eliminate all sharp corners and to provide the passageways with gentle curves designed to offer the minimum amount of resistance to flow, it has been found that severe turbulence or eddy current loss still exists in the lower or throat portion of the neck 41. While I do not desire to be limited to any theory, it is believed that this eddy current loss or interference with free flow is due in part to the skin effect of the interior surfaces of the neck which affects the outer portions of the stream greater than those on the interior.

In accordance with my invention there is provided within the usual neck 41 of the casing a guide vane 50 which, in general, conforms to the shape of the opening within the neck as can be seen in Figure 2 and also terminates in a position indicated at 50^1 which is quite close to the outside periphery of the impeller. This guide vane preferably extends throughout the entire length of the neck 41 to form two passageways for the fluid which is being discharged by the pump. As shown in Figure 3, the guiding vane 50 can be given a curvilinear shape as seen in cross-section and, therefore, can be made integral as the casting within the casing neck. It will be noted in Figure 2 that each of the projections 40 and 50^1 extend in relatively the same direction and point tangentially with respect to the impeller in the pressure zone created by the impeller. Thus, as the impeller is rotated, the fluid which may be water, an acid containing solution or gas, is caused to flow in part through the first passageway encountered, namely 51, in the neck 41 and the remaining portion of the fluid is caused to flow through the passageway 52 which is also positioned in the same neck portion. By properly stream-lining the guide vane 50 and carefully determining its lateral position within the neck 41, all loss in head by turbulence or eddying which normally takes place at the position where the annular space about the impeller merges with the opening in the neck is eliminated. The effectiveness of the guide vane 50 in facilitating the flow through the neck 41 is so pronounced that the output of the pump is greatly increased, notwithstanding the inevitable obstruction introduced in the neck by the end portion of the guide vane.

It will be noted that the use of this vane introduces no complication of design because the neck 41 is of standard shape and size and the only difference of structure necessitated by my invention is that the guide vane 50 is cast within the neck or secured thereto in any other suitable manner. Due to the fact that the entrances to the passageways 51 and 52 are positioned near the periphery of the impeller, close together, and are separated only by the thickness of the partition 50^1, both passageways 51 and 52 deliver pressure fluid in an outward direction as indicated by the arrows. The entire interior of the neck 41 with the exception of the partition is available for carrying fluid pumped by the impeller into the discharge pipe.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully set forth and described my invention, what I claim as new and desire to secure by United States Letters Patent, is:

1. In a pump, a casing of volute shape and having a single inlet and a single outlet passageway, an impeller mounted in the casing to force fluid from the inlet to the outlet passageway, a plurality of vanes mounted on said impeller, and means for preventing turbulence between the outlet passageway and the area immediately surrounding the impeller at the position where the passageway merges with the inter-vane space at the periphery of the impeller, said means including a guide vane extending through the outlet passageway and beginning at a position near the periphery of the impeller closest to the outlet passageway, and a projection extending inwardly from the casing as far as the impeller to separate the suction and pressure effects of the impeller.

2. A pump comprising a casing of volute shape and having a volute chamber, a circular impeller provided with curvilinear blades mounted within the casing to leave a space of varying width between the periphery of the impeller and the interior of the casing, a single inlet passageway entering the casing at about the center thereof, an outlet passageway merging tangentially with the space between the impeller and the casing, and a single guide vane extending the entire length of the outlet passageway and terminating at a position adjacent the periphery of the impeller and nearest to the outlet passageway, and a projection extending inwardly from the casing as far as the impeller to separate the suction and pressure effects of the impeller.

3. A pump comprising a casing of volute shape and having a single inlet passageway at its center, said casing being provided with an outwardly extending hollow neck which forms the outlet passageway, an impeller in the casing including a plurality of vanes, the inner portions of the inter-vane compartments communicating with the inlet passageway, the outer portions of the inter-vane compartments communicating with the interior of the casing neck, and a single guide vane in said neck terminating at a position where the outlet passageway merges with the nearest outer portions of the inter-vane passageways, and a projection extending inwardly from the casing as far as the impeller to separate the suction and pressure effects of the impeller.

4. A pump comprising a casing of volute shape and having a single inlet passageway at its center, said casing being provided with an outwardly extending hollow neck which forms the outlet passageway, an impeller in the casing including a plurality of vanes, the inner portions of the inter-vane compartments communicating with the inlet passageway, the outer portions of the inter-vane compartments communicating with the interior of the casing neck, and a guide vane in said neck terminating at a position where the outlet passageway merges with the nearest outer portions of the inter-vane passageways, said guide vane having a curvilinear shape in cross-section and being integrally secure to the interior of said neck, and a projection extending inwardly from the casing, substantially parallel to said guide vane as far as the impeller to separate the suction and pressure effects of the impeller.

5. A pump comprising a casing of volute shape and having a single inlet passageway at its center, said casing being provided with an outwardly extending hollow neck which forms the outlet passageway, an impeller in the casing including a plurality of vanes, and a partition extending across the interior of said neck only as far as a point on the periphery of said impeller and a projection extending inwardly from the casing, substantially parallel to said partition as far as the impeller to separate the suction and pressure effects of the impeller.

6. A pump comprising a casing of volute shape and having a single inlet passageway at its center, said casing being provided with an outwardly extending hollow neck which forms the outlet passageway, an impeller in the casing including a plurality of vanes, and a single curvilinear partition extending across the interior of said neck only as far as a point on the periphery of said impeller and a projection extending inwardly from the casing, substantially parallel to said partition as far as the impeller to separate the suction and pressure effects of the impeller.

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