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CENTRIFUGAL PUMP

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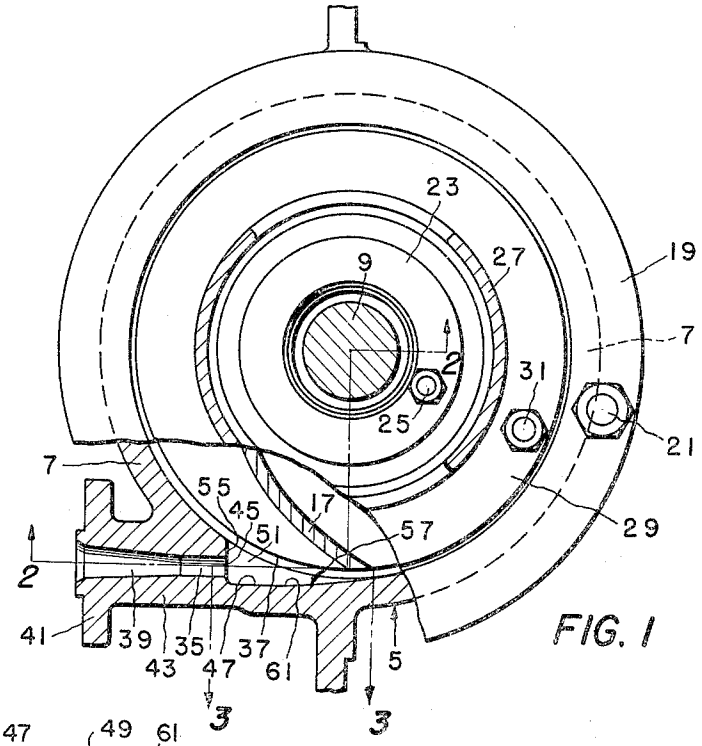



FIG. 1

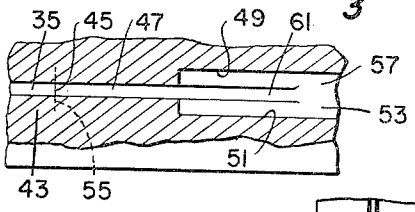



FIG. 3

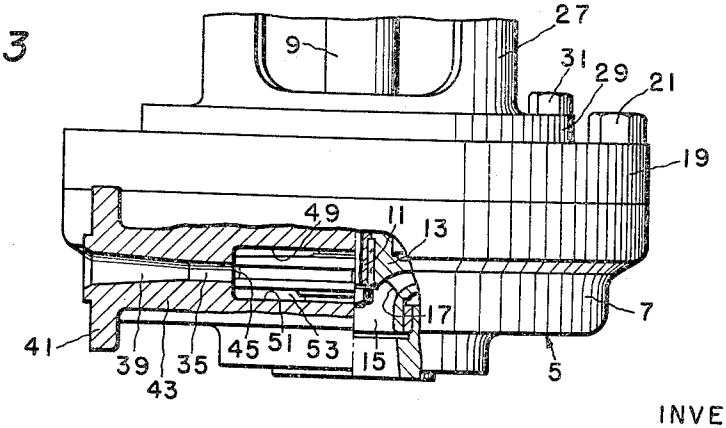



FIG. 2

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# CENTRIFUGAL PUMP

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This invention relates to centrifugal pumps and particularly to centrifugal pumps for delivering fluid over a relatively wide range of capacity against a substantial head.

The invention more particularly relates to the problem of improving the head-capacity relationship at relatively low capacity of a centrifugal pump with a circular volute casing.

It is recognized in conventional centrifugal pumps of this type that as the volume of fluid discharged is decreased, the head against which discharge can be effected increases until a maximum head is reached at an intermediate capacity and that with further reduction of volume the head then falls off.

It is an object of the invention to provide a centrifugal pump of such construction that, in the characteristic curve of head and volume, the head will rise or will not fall off substantially as the volume or capacity is continuously reduced into a relatively low range.

It is a further object of the invention to provide a centrifugal pump with a characteristic curve of this form which will have a generally flat slope, so that the head, although continuously rising or not falling substantially as the volume is decreased, is maintained within a relatively narrow range over a substantial variation of volume.

It is another object of the invention to accomplish these purposes in a pump of simple construction and one in which the cooperating parts for the most part are made in the conventional manner.

It is significant in the invention that it has been found that a novel form of a portion of the casing or of parts connected thereto adjacent the outlet or discharge opening thereof may be provided which fulfills the objects of the invention and provides the rising or flat head at low capacity characteristic referred to. The constructive feature of the invention is provided by so forming the casing of the pump or the parts connected thereto adjacent the discharge or outlet flow passage thereof that the fluid moving from the impeller at the periphery of the impeller toward the discharge is caused to flow through a flow chamber before reaching the discharge passage. A novel form for this chamber in consideration of its disposition in relation to the discharge passage has been discovered and the line of flow through this chamber and the discharge passage are so disposed in relation to the periphery of the impeller, and particularly as a line of flow tangent to the impeller, that the desired rising characteristic of the head-capacity curve is secured.

It is a particular feature of the invention with respect to this flow chamber that a surface is provided which has a portion extending in the same general direction as the line of flow through the discharge which preferably is tangential to the impeller periphery. This portion of the surface of the chamber is offset with respect to the inlet opening of the discharge in the direction proceeding outwardly with respect to the axis of rotation of the impeller in the plane of this impeller. In some cases this flow chamber may provide an area of flow toward the inlet opening of the discharge which is greater than the area of flow through the discharge and especially greater than the area of the inlet opening thereof. The chamber thus may provide a wall having an inner surface which extends about the line of flow through the chamber and through the discharge to define the greater area of flow through



the chamber and also to dispose the portion of the surface referred to spaced outwardly in relation to the line of flow a distance greater than the radius of the inlet opening of the discharge, this distance and this radius being taken in the plane of the impeller which is perpendicular to the axis of rotation thereof.

With these and other objects and features in view, the nature of which will be more apparent, the invention will be more fully understood by reference to the drawings, the accompanying detailed description and the appended claims.

In the drawings:

FIG. 1 is a view, partly in section, transverse to the axis of rotation of a centrifugal pump, the section being taken in the plane of the impeller of a pump constructed in accordance with this invention,

FIG. 2 is a section taken on line 2—2 of FIG. 1, in part in the plane tangent to the periphery of the impeller, and

FIG. 3 is an enlarged sectional view taken on line 3—3 of FIG. 1 and illustrates a portion of the discharge flow path from the impeller chamber of the pump.

Referring to the drawings in detail, this invention as illustrated is embodied in a centrifugal impeller pump designed to maintain a high head curve at low capacity.

In FIGS. 1 and 2 the casing 5 provides a wall 7 extending about the axis of rotation of the impeller shaft 9. As shown, a shrouded impeller 13 is carried on the end 11 of the shaft 9 for rotation therewith and about its axis. The impeller 13 has an inlet opening or eye 15 connected to the flow passages leading to the impeller spaces defined by vanes between the shrouds such as the vane 17, FIG. 1. The impeller 13, its shrouds and vanes may be of conventional form.

The casing 5 may be closed by a cover 19 secured to the casing by bolts 21, this cover being broken away in FIG. 1 to show the vanes 17 and the portion of the casing adjacent the discharge therefrom of the fluid under pressure developed by the rotation of the impeller. The cover 19 may support in cooperating relation to the shaft a conventional stuffing box and packing gland having a flange 23 secured in place by bolts 25, FIG. 1. A rigid frame 27 also is secured to the cover 19 at its flange 29 by bolts 31, this frame serving to support the pump in proper relation to a driving element or motor, not shown.

In FIGS. 1 and 2 is shown a structure providing a discharge passage 35, which in the embodiment being described, is of circular cross-section and is disposed with its axis on a line which is tangential to the periphery 37 of the impeller 13. The discharge flow passage 35 in this embodiment also comprises a nozzle portion 39 which diverges in the direction of flow from the outlet of the flow passage 35 to an opening about which a flange 41 is formed that is connected to the casing 5 by a wall 43 which defines the flow passage 35 and the nozzle 39. The flange 41 serves for connecting the discharge of the pump to any suitable discharge conduit, not shown.

The wall 43 is connected to the wall of the casing 5. A flow passage or chamber 53 is disposed between the inlet opening 45 of the flow passage 35 and a point of a cylindrical wall 57 within the casing 5 at which the line of flow through the flow passage 35 is tangent to the impeller periphery 37. The fluid impelled by the impeller 13 is discharged from the casing 5 into this chamber 53 through which it must flow in moving to the inlet opening 45 of the passage 35. The wall 43 defines a surface extending about the tangential line of flow and provides a portion 47 of this surface which has been found is of particular significance in securing the desired head-capacity characteristic in a centrifugal pump.

The surface 47 is displaced from the cylindrical wall 57 encircling impeller 13 and with the surfaces 49 and 51 extends generally in the same direction as, or generally

parallel to, the line of flow along the tangent line toward the inlet opening 45 of the passage 35. These surfaces 47, 49, 51 define an area of flow which is of U-shape in cross section and is enlarged with respect to the cross-sectional area of flow through the inlet 45. The disposition of the surface 47, however, essentially determines the improved head-capacity characteristic desired in the pump. Within the scope of the invention the surfaces 49, 51 may be closer together, as clearly shown in FIG. 3, to provide an area of flow in the chamber 53, defined by the surfaces 47, 49 and 51. In this case, the area of flow will have a width which is equal to the width of the inlet opening 45 of the passage 35 and a height which is greater than the inlet opening 45. The width of the area of flow will also be equal to the space between the shrouds of the impeller at its periphery. While the cross-sectional area of flow through the chamber 53 is greater, as shown, than the area of flow through the passage 35, it is essential for the invention in any case that the portion 47 of the chamber surface which extends generally in the same direction as the line of flow through the chamber or passage 53 and the passage 35, whether or not the center line of this flow is tangential to the periphery 37 of the impeller 13, shall be displaced outwardly in a plane transverse to the axis of shaft 9 with respect to the inlet opening 45 of the flow passage 35. That is to say, the surface 47 of the chamber 53 shall be angularly offset outwardly along and tangential thereto beyond the periphery of surface 57 and the inlet opening 45 of the flow passage 35, so a shoulder 55 is formed in the surface 47 of the wall 43 which is normal to the line of flow through the chamber 53 and passage 35, and which extends about the opening 45 of passage 35.

It has been found by test, when the surface 47 is disposed in this manner to provide the wall or shoulder 55, the desired rising characteristic of the head-capacity curve is secured in a centrifugal pump which is provided with the flow chamber 53 disposed between the discharge flow passage 35 and the cylindrical inner surface 57 of the casing 5 through which the fluid is impelled by the impeller 13. The inner surface 57 of the casing 5 provides an inlet into the chamber 53 defined in part by a surface 61 and in part by planar walls 49 and 51. Surface 61 provides a smooth flow surface from the cylindrical wall 57 to the surface 47. In accordance with a significant feature of the invention, the shoulder surface or wall 55 which is normal to the tangential line of flow through the passage 35 is disposed along the line of flow from the point of tangency with the impeller 13 a sufficient distance determined by chamber 53, having regard to the desired disposition of the surface portion 61 of the chamber 53, thus the shoulder 55 is formed in a smooth flow surface 47 and 61 rather than one with a sharp edge portion adjacent the inner surface 57 of the casing, in order to secure the desired characteristic of the pump.

In the illustrated embodiment, the inner surface 57 of the casing is preferably of circular contour, specifically a cylindrical surface concentric from the axis of the shaft 9 with periphery 37 of the impeller 13 which, in this embodiment, also is circular about a center on the axis of the shaft 9 and is spaced inwardly from the casing 5. Within the scope of the invention, however, the inner surface 57 of the casing may be of a volute outline forming a scroll providing for increasing the spacing between the circular periphery of the impeller and the inner surface of the casing and for increasing the area of flow of the fluid about the axis of rotation terminating in a flow path with its axis tangent to the impeller periphery, in accordance with conventional practice.

It is a further feature of the invention that the portion 47 of the surface defining the chamber 53 is connected by a smooth curve 61 to the inner surface 57 of the casing, whether this inner surface be of circular, cylindrical or spiral contour. By connecting the portion 47 of the surface of the chamber 53 to the inner surface 57 of the casing by a surface 61 along a smooth curve, the fluid discharged from the impeller is moved smoothly into the chamber 53 until it is required by meeting the shoulder 55 more or less abruptly to change its direction of movement inwardly toward the tangential line of flow and then to enter the inlet opening 45 of the flow passage 35. These forms and dispositions of the surfaces of the chamber 53 in connection with the discharge passage 35 and its inlet opening, especially where the line of flow of the fluid through the flow passage 35 is tangential to the impeller periphery, have been found to secure in a pump of the type referred to the desired improved characteristic curve of head and volume.

Within the scope of the invention modifications may be made in the disposition of the surfaces 49, 51 and of the transverse surface 55 and of the smoothly connecting portion 61 while maintaining the essential disposition of the portion 47 which has been described above. Various modifications also may be made in the construction of the casing and of the impeller of the pump while maintaining the essential features of the invention. Such modifications are intended to be included within the scope of the appended claims.

We claim:

1. In a fluid pump having a centrifugal impeller with a circular periphery and rotatable to impel fluid, a casing having an annular impeller chamber about said impeller, said casing having a discharge passage terminating in a discharge nozzle, a flow chamber in said casing between said discharge passage and said impeller chamber, said discharge passage being circular in cross-section and having an axis tangent to the periphery of the impeller throughout its length, said flow chamber being of U-shape in cross-section with the open side of the U in direct communication with said impeller chamber, the U-shaped flow chamber terminating in an end wall lying in a plane normal to the axis of the discharge passage and containing an inlet to said discharge passage, said end wall extending above and below the inlet and having a surface area that exceeds the cross-sectional area of the inlet to said discharge passage, and said end wall forming an abutment in the flow path from the impeller and having an axial width substantially equal to the inlet diameter of the discharge passage.

2. In a fluid pump having a centrifugal impeller with a circular periphery and rotatable to impel fluid, a casing having an annular impeller chamber about said impeller, said casing having a cylindrical discharge passage terminating in a discharge nozzle which diverges in the direction of flow, said discharge passage and discharge nozzle being circular in cross-section and having an axis tangent to the periphery of the impeller throughout their length, a flow chamber in said casing between said discharge passage and said impeller chamber, said flow chamber being of U-shape in cross-section with the open side of the U in direct communication with said impeller chamber, the U-shaped flow chamber terminating in an end wall lying in a plane normal to the axis of the discharge passage and containing an inlet to said discharge passage, said end wall extending above and below the inlet and having a surface area that exceeds the cross-sectional area of the inlet to said discharge passage, and said end wall forming an abutment in the flow path from the impeller and having an axial width substantially equal to the inlet diameter of the discharge passage.

3. In a fluid pump having a shrouded centrifugal impeller with a circular periphery, said impeller having vanes spacing the shrouds and being rotatable to impel fluid, a casing having an annular impeller chamber about said impeller, said casing having a discharge passage terminating in a discharge nozzle, a flow chamber in said casing between said discharge passage and said impeller chamber, said discharge passage being circular in cross-section and having an axis tangent to the periphery of the impeller throughout its length, said flow chamber being

of U-shape in cross-section with the open side of the U in direct communication with said impeller chamber, the U-shaped flow chamber terminating in an end wall lying in a plane normal to the axis of the discharge passage and containing an inlet to said discharge passage, said end wall extending above and below the inlet and having a surface area that exceeds the cross-sectional area of the inlet to said discharge passage, and said end wall forming an abutment in the flow path from the impeller and having an axial width substantially equal to the inlet diameter of the discharge passage, and to the axial space between the shrouds.



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