June 28, 1966 J. C. WORST 3,257,955

FLOW CONTROL FOR TURBINE PUMP

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FIG. 1

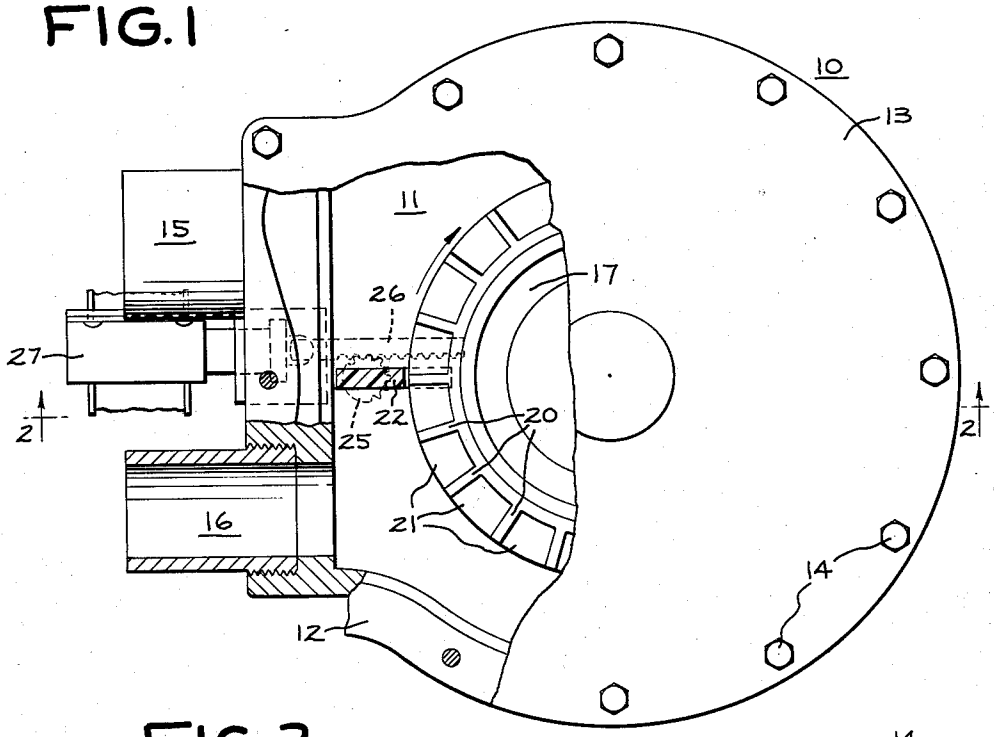
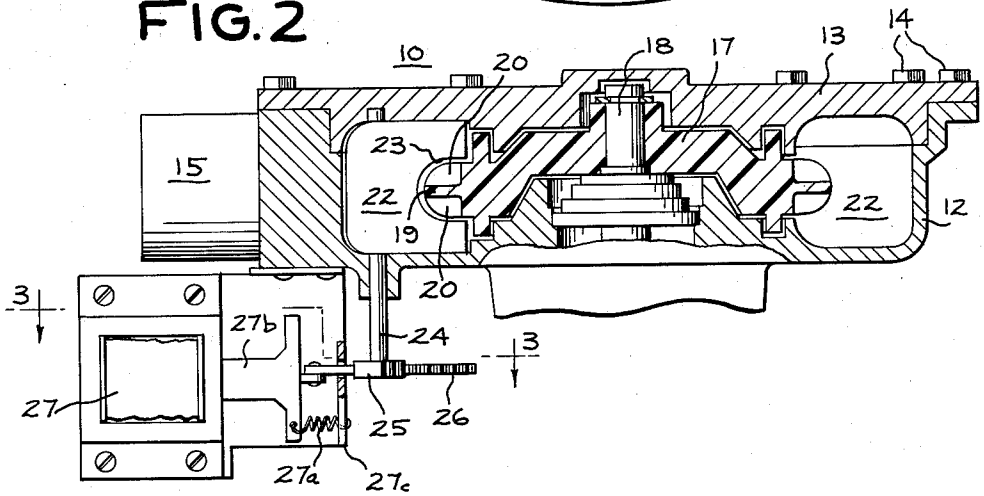


FIG. 2



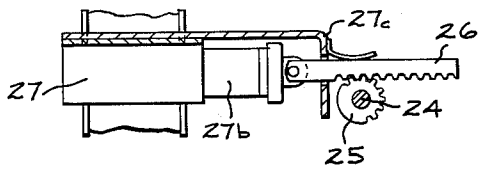


FIG. 3

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FIG. 4

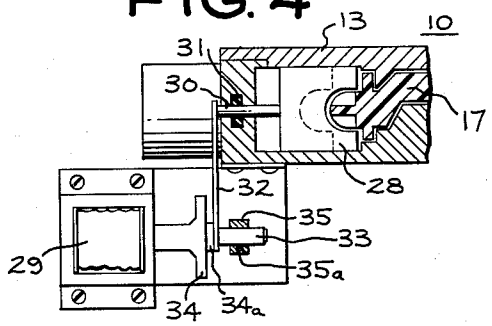


FIG. 5

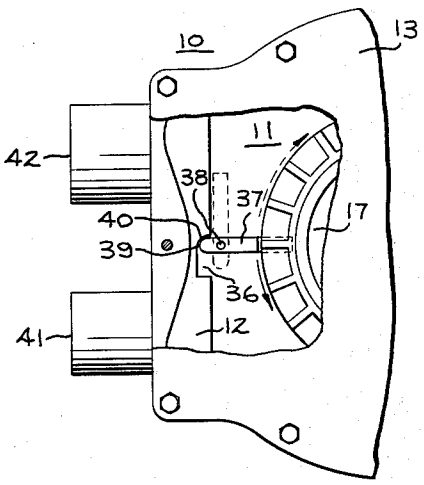


FIG. 6

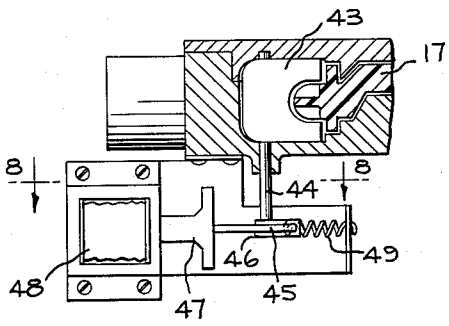
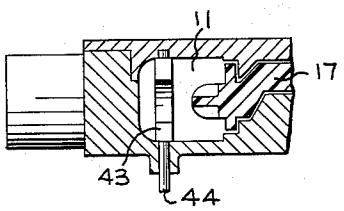


FIG. 7



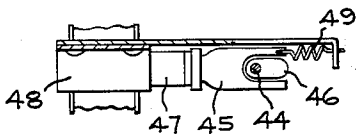


FIG. 8

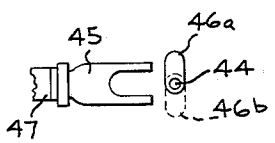


FIG. 9

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3,257,955

FLOW CONTROL FOR TURBINE PUMP

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Filed Feb. 4, 1964, Ser. No. 342,510
6 Claims. (Cl. 103—97)

My invention relates to pumps, and more particularly to a flow control for turbine pumps.

A turbine pump is that type of rotary pump having blades at the outer periphery of the impeller. Such rotary pumps move a pumped fluid along an annular path within a casing, from an inlet to an outlet. A dam is provided in the casing, adjacent the outlet, to direct the pumped fluid from the annular path to the outlet. Such pumps are often driven by a motor which performs more than one function, that is, it may drive some other mechanism as well as the pump. In such cases, it is often necessary to have the motor drive the mechanism but at the same time to avoid pumping action or to have less than full pumping action.

My invention provides a control over delivery of the pumped fluid which does not require stopping rotation of the impeller and the driving motor. It thus provides for greater flexibility in operation than prior art structures.

It is an object of the present invention to provide an improved flow control for a turbine pump.

It is a further object of the present invention to provide a flow control for such pumps which does not require stopping and starting of the impeller.

My invention is best understood when described in conjunction with the accompanying drawing, illustrative of one embodiment of the invention, in which:

FIGURE 1 is a plan view, partly broken away, of the turbine pump of the present invention;

FIGURE 2 is a sectional elevation view, taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a sectional plan view showing a detail, taken along the line 3—3 of FIGURE 2;

FIGURE 4 is a sectional elevation view of a portion of a turbine pump incorporating a modified form of flow control;

FIGURE 5 is a plan view, partly broken away, of a turbine pump showing another modified form of my invention;

FIGURE 6 is a sectional elevation view of a portion of a turbine pump illustrating another modification of my invention;

FIGURE 7 is a view of a portion of the pump of FIGURE 6 illustrating the flow control element in a different position;

FIGURE 8 is a sectional plan view taken along the line 8—8 in FIGURE 6, showing a detail of the modification shown in FIGURE 6;

FIGURE 9 is a view of a portion of FIGURE 8 showing the parts in different positions.

Briefly, the pump of my invention, in one form thereof, comprises a casing, within which an annular pumping chamber is formed, and an impeller mounted for rotation within the casing. The impeller has peripheral radially extending flat blades. When the impeller is rotated, the radial blades entrain the pumped fluid and move it around the annular pumping chamber. The flow of pumped liquid is controlled by a dam, disposed adjacent the outlet from the casing on the downstream side of the outlet. The dam is movable between a first extreme position in which the dam blocks the anular pumping chamber to direct the fluid to an outlet and a second extreme position in which the fluid is carried in an anular path within the casing and no fluid is pumped through the outlet, and the dam may occupy intermediate positions for throttling.

Turning to FIGURES 1 and 2 of the drawing, it may be seen that a pump embodying the present invention has a casing 10 which defines an annular pumping chamber 11. The casing 10 may be formed from a body element 12, and a cover plate 13 to facilitate assembly and any needed maintenance. These two elements are held in an assembled relation by any suitable means, such as by bolts 14. An inlet 15 is provided for admitting fluid from any desired source into the annular pumping chamber 11. Fluid is discharged from the annular pumping chamber 11 through an outlet 16.

Within the casing is an impeller 17, rotatable about the axis of a shaft 18. The impeller may be driven by any suitable power source (not shown), such as an electric motor. The impeller 17 has a generally disc-like shape, with a planar circumferential web 19 extending into the annular pumping chamber 11. On the upper and lower sides of the web 19, spaced peripheral radial vanes 20 are formed. Each vane 20, considered individually, has a shape approximately that of a quarter circle. Thus, when the quarter circular vanes are formed on the opposite sides of the web 19, the profile of the peripheral surface of the impeller assumes a semicircular outline. The portion of the impeller 17 which extends into the annular pumping chamber 11 thus approximates a half torus.

The radially directed vanes 20 and circumferential web 19 formed on the rotor define fluid entraining pockets 21 spaced about the periphery of the impeller. These pockets 21 serve to entrain the pumped fluid and move it with impeller rotation within the annular pumping chamber 11.

In order to control the flow of pumped fluid entrained by the impeller 17, I provide a dam 22. This dam is placed adjacent the fluid outlet 16, on the downstream side of the outlet and between the outlet 16 and the inlet 15. As illustrated in FIGURE 1, the dam may be positioned on a radial line relative to the impeller 17. The dam is so shaped that, when in the position shown in FIGURE 1, the annular pumping chamber 11 is blocked.

As best shown in FIGURE 2, the dam 22 has a semicircular notch or recess 23 formed to correspond to the semicircular or half-toroidal shape of the impeller web 19 and vanes 20 which extend into the pumping chamber. The provision of such a notch in the dam 22 permits continuous rotation of the impeller 17, while deflecting the greatest amount possible of the entrained fluid carried by the impeller. The dam 22 in the radial positions serves to deflect the pumped fluid from the annular chamber and discharge it through the outlet 16.

In order to provide for control over the flow from the pumping chamber 11, the dam 22 of my invention is movable between the radial position shown in the drawing and an alternate position. In the embodiment shown, movement is provided by mounting the dam 22 on a shaft 24 which defines an axis for rotation of the dam parallel to the axis of rotation of the impeller 17. When the dam 22 is rotated about the shaft 24 away from the flow-blocking position, the pumped fluid entrained by the impeller 17 is carried past the dam to circulate along an annular path within the pumping chamber 11. The preferred alternate position of the dam is approximately parallel to the flow stream lines, because it there presents the least resistance to annular flow. This position is perpendicular to a radial line on the impeller 17, or substantially parallel to a line tangential to the impeller. However, it may occupy any position which does not deflect the fluid to the outlet. If throttling operation is desired, the dam could be located at any intermediate position between the flow-blocking position and the position permitting circulation within the annular chamber 11.

While the pivotal position of the dam 22 may be controlled by any suitable means, an electrical solenoid oper-

ating a rack and pinion gear has been illustrated in FIGURES 2 and 3 as one possible means. As there shown, the dam shaft **24** carries a sector gear **25** at its end remote from the pump casing **10**. The sector gear **25** is engaged by a rack **26** which is actuated by a solenoid **27**. Control over actuation of the solenoid **27** may be exercised by any suitable switch, in response to any desired condition. Alternative actuation systems, such as hydraulic or pneumatic, might be employed

In operating the pump of my invention, the impeller **17** may be driven continuously by any suitable power source. Since the fluid entrained by the impeller **17** moves with the impeller in its direction of rotation, the direction of flow through the pump casing may be reversed by reversing the direction of rotation of the impeller **17**. The discussion here assumes rotation in the direction indicated by the arrow in FIGURE 1. With the impeller **17** rotating in the indicated direction and a suitable source of fluid to be pumped connected to the inlet **15**, fluid in the annular pumping chamber **11** is entrained by the vanes **20** and pockets **21** of the impeller **17** and carried around the pumping chamber. With the dam in the position shown in FIGURE 1, the entrained fluid contacts the dam **22** adjacent the outlet **16**. The fluid is deflected by the dam from the annular path on which it is carried by the impeller **17**, and is discharged from the pumping chamber **11** through the outlet **16**.

To discontinue pumping of fluid through the outlet **16**, solenoid **27** is energized to move the rack **26** to the left, thus rotating the dam member **22** to an alternate or flow-permitting position in which it does not block the flow of fluid in the annular chamber **11**, that is, preferably to a position parallel to a line tangential to the impeller. The fluid entrained by the impeller **17** is then permitted to circulate along an annular path within the pumping chamber **11**, and is not deflected to be discharged through the outlet **16**. Upon de-energization of the solenoid **27** the rack **26** is returned to the position indicated in FIGURE 2 by a spring **27***a*, which is connected between the movable element **27***b* of the solenoid and a stationary flange member **27***c*. This return movement of the rack rotates the dam **22** back to a flow-blocking position, again resulting in discharge of pumped fluid through the outlet **16**.

If throttling operation is desired the control element may be arranged to position the dam at any of a plurality of positions between the flow-blocking position and the flow-permitting position, thereby achieving a variable flow through the outlet **16**. For this purpose the rack **26** could be operated manually or indexed to a plurality of positions by any conventional indexing mechanism to thereby position the dam **22** selectively in any of a plurality of throttling positions. If operated manually, for example, the end of the rack could be slidably mounted in a bracket and held in any selected position by a set screw.

In FIGURE 4 there is shown a modified form of my invention. The control arrangement of FIGURE 4 differs from that in the form illustrated in FIGURES 1–3 in that the dam **28**, corresponding to the dam **22** in FIGURES 1–3, in lieu of being pivotally mounted for control is mounted for reciprocal movement in a radial direction in the pumping chamber **11**. In the position shown in solid lines in FIGURE 4, the dam **28** blocks flow of fluid in the pumping chamber and hence causes pumping of fluid through the outlet in the same manner as the dam **22** when that dam occupies its flow-blocking position. The dam **28** is movable in a radial direction to a flow-permitting position shown by dotted lines in FIGURE 4.

In order to effect movement of the dam between the flow-blocking position and the flow-permitting or circulating position, that is, between the solid line and dotted line positions respectively, the solenoid **29**, corresponding to the solenoid **27** in FIGURES 1–3, is connected with the dam **28** by a suitable linkage. Specifically, the dam **28** includes a rod **30** which extends radially outwardly through a seal **31** in the casing **10**. The solenoid **29** is connected with the rod **30** by a link **32**. The link **32** is mounted at one end to an extension **33** of the movable element or actuator **34** of the solenoid, a spacer **34***a* being placed between the link **32** and the actuator **34**. The other end of the link **32** is connected to the rod **30**.

In the form shown in FIGURE 4 the solenoid may be moved between the extreme positions illustrated by the solid and dotted lines, that is, between a position in which the flow within the annular chamber is blocked by the dam and a position in which fluid is circulated within the chamber. To state it another way, the dam is moved between the solid line position in which full flow is provided from the outlet of the pump and the dotted line position in which minimum or no flow is provided.

By the arrangement shown in FIGURE 4, intermediate, or throttling, positions may also be achieved Specifically, a collar **35** is adjustably mounted on the extension **33** of the actuator by means of a set screw **35***a*. When the collar is in the position shown in FIGURE 4 motion is provided before the collar engages the link **32** as the actuator **34** is moved to the left upon energization of the solenoid. Therefore, with the same length of stroke of the actuator a lesser movement of the dam is secured, and the dam is therefore moved only to a position intermediate the extreme positions illustrated by the solid and dotted lines. In this intermediate position circulation of fluid within the annular chamber is permitted, but on a reduced scale; part of the fluid is pumped through the external circuit and a throttling operation of the pump is achieved. The collar, of course, may be mounted in any desired position along the extension **33** to achieve different degrees of throttling. When an on-off type of operation is desired, the collar **35** is moved directly into engagement with the link **32** so that full movement of the dam between its extreme positions, that is, movement between the solid line and dotted line positions, is achieved.

In FIGURE 5 there is shown another modified form of my invention wherein the need for external power actuation of the dam is eliminated and control of the position of the dam is effected by change in direction of rotation of the impeller. For convenience the elements which are similar to those used in FIGURES 1–3 have been given the same reference numerals. In this form of my invention the turbine casing, and specifically the portion **12** thereof, is formed to provide a recess **36** adjacent to the dam. The dam **37** is pivoted at **38** for movement between the solid line position and the dotted line position shown in FIGURE 5. The dam **37** is positioned off-center of the recess **36** so that, in the solid line position, the end **39** of the dam engages a shoulder **40** which forms a wall of the recess. This engagement of the dam and the shoulder holds the dam in the solid line position. The solid line position of the dam is achieved when the impeller **17** is driven in a counterclockwise direction indicated by the solid arrow in FIGURE 5. The force of the fluid pumped moves the dam in a clockwise direction about its pivot **38** until the end **39** engages the shoulder **40** to retain the dam in its flow-blocking position. In this condition of operation it will be apparent the direction of rotation of the impeller **17** is such that the passage **41** acts as the inlet and the passage **42** acts as the outlet of the pump.

When the pump is driven in the opposite direction, that is, in the clockwise direction indicated by the dotted arrow, the force of the fluid pumped causes the dam **37** to be pivoted about the pivot point **38** to the dotted line position shown in FIGURE 5. The dam is then essentially parallel to the flow of fluid and offers a minimum of resistance to the flow thereof. Accordingly, the fluid is merely circulated within the chamber **11** by the pump. With the device of FIGURE 5 essentially full capacity of the pump is secured when the impeller is driven in the counterclockwise direction and essentially zero capacity when the impeller is driven in the clockwise direction.

If desired, a differential pump could be provided with the general arrangement shown in FIGURE 5, that is, a pump which provides pumping action in both directions of rotation but gives a greater pumping action in one direction than in the other. This result could be achieved by providing a stop to limit the movement of the dam in the counterclockwise direction short of the dotted position shown in FIGURE 5. Under these circumstances full capacity of the pump would still be achieved when the impeller was rotated in the counterclockwise direction, fluid being taken in at passage **41** and discharged at passage **42**. On the other hand, when the impeller was rotated in the clockwise direction the dam would only partially block the flow of fluid in the chamber **11**, resulting in a lesser pumping of fluid through the external connections. In this case the fluid would enter the pump through the passage **42** and would be discharged through the passage **41**.

In FIGURES 6–9 there is illustrated still another form of my invention in which the dam is moved by internal hydraulic pressure but the amount of movement thereof is determined by an external control. The dam **43**, corresponding to the pivoted dam **22** in the form illustrated in FIGURES 1–3, is pivotally mounted on a shaft **44** extending downwardly through the turbine casing. The dam is illustrated in FIGURE 6 in the flow-blocking position where full pumping capacity is secured in FIGURE 7 in the flow-permitting or circulating position where the the fluid is merely circulated in the chamber **11**. Movement of the dam from the positon shown in FIGURE 6 to that shown in FIGURE 7 is effected by the force of the fluid being moved by the impeller **17**. This movement of the impeller in a direction corresponding to the counterclockwise direction in FIGURE 5 tends to move the dam from the flow-blocking position illustrated in FIGURE 6 to the circulating position shown in FIGURE 7. Movement of the impeller in the clockwise direction tends also to move the dam to a circulating position, 180° from that shown in FIGURE 7.

The dam is maintained in the flow-blocking position shown in FIGURE 6 by a forked element **45** which is arranged to engage elongated member **46** mounted on the shaft **44**. The forked element is connected to the movable element or actuator **47** of the solenoid **48**. The forked element is biased to the right by a spring **49**, corresponding to the spring **27***a* of FIGURE 2. In this position the elongated member **46** is received between the bifurcation of the forked element **45** and the dam is maintained in the flow-blocking position against the hydraulic force exerted thereon by the impeller. Full pumping action is thereby achieved.

To permit movement of the dam **43** to the circulating position under the influence of the hydraulic force exerted by the impeller, the forked element may be moved to the left by energization of the solenoid **48**. Upon energization of the solenoid the forked element **45** is moved to the position shown in FIGURE 9, where it can be seen that the forked element is beyond the shaft **44** which forms the pivot axis of the elongated member **46**. The elongated member is then free to move either to the position shown at **46***a* or in the position shown at **46***b* in FIGURE 9. Specifically, if the impeller is rotated in the clockwise direction the elongated member assumes the position shown in solid lines at **46***a*; conversely, if the impeller is rotated in the counterclockwise direction the elongated member assumes the position shown in dotted lines at **46***b*. In either of these cases the dam **43** occupies a position which permits circulation of fluid within the chamber **11** and no pumping action occurs.

In the form of invention illustrated in FIGURES 6–9, therefore, the power for shifting from full pumping operation to non-pumping operation is furnished by hydraulic forces within the pump. The actual shifting is controlled by the external solenoid **48** in cooperation with the forked element **45** and spring **49**.

While this invention has been described by reference to a particular embodiment, it is to be understood that numerous modifications may be made by those skilled in the art without departing from the spirit of my invention. It is therefore, the purpose of the appended claims to cover all such variations as come within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A turbine pump comprising:
(a) a casing defining an annular pumping chamber,
(b) an impeller mounted for rotation within said casing,
(c) said casing having an inlet through which fluid enters said pumping chamber,
(d) said casing having an outlet through which fluid is discharged from said pumping chamber,
(e) a dam pivotally mounted in said pumping chamber adjacent said outlet,
(f) and selectively operable means connected to said dam for moving said dam between a first position, in which it blocks said pumping chamber to direct liquid into said outlet, and a second position, in which fluid is circulated along an annular path within said pumping chamber.

2. A turbine pump comprising:
(a) a casing defining an annular pumping chamber,
(b) an impeller mounted for rotation within said casing,
(1) said impeller having a planar circumferential web and spaced peripheral radial vanes on said web for entraining fluid within said chamber,
(c) said casing having an inlet through which fluid enters said pumping chamber,
(d) said casing having an outlet through which fluid is discharged from said pumping chamber,
(e) a dam pivotally mounted in said pumping chamber adjacent said outlet,
(f) and selectively operable means connected to said dam for moving said dam between a first position disposed along a line radial to said impeller, in which it blocks said pumping chamber to direct fluid to said outlet, and a second position, in which fluid is circulated along an annular path within said pumping chamber.

3. A turbine pump comprising:
(a) a casing defining an annular pumping chamber,
(b) an impeller mounted for rotation about an axis within said casing, said impeller having a planar circumferential web and spaced peripheral radial vanes on said web for entraining fluid within said chamber,
(c) said casing having an inlet through which fluid enters said pumping chamber,
(d) said casing having an outlet through which fluid is discharged from said pumping chamber, and
(e) a dam adjacent said outlet, said dam being pivotably mounted for movement about an axis parallel to that of said impeller,
(f) and selectively operable means connected to said dam for moving said dam between a first position disposed along a line radial to said impeller, in which it blocks said pumping chamber to direct fluid to said outlet, and a second position, in which fluid is circulated along an annular path within said pumping chamber,
(g) said dam having a recess therein conforming to the periphery of said web and said vanes when said dam is in its first position.

4. A turbine pump comprising:
(a) a casing defining an annular pumping chamber,
(b) an impeller mounted for rotation within said casing,
(c) said casing having an inlet through which fluid enters said pumping chamber,

(d) said casing having an outlet through which fluid is discharged from said pumping chamber,
(e) a dam adjacent said outlet,
(f) a shaft for pivotally mounting said dam for movement about an axis parallel to the axis of said impeller between a first position relative to said impeller in which fluid is directed by said dam to said outlet and a second position in which fluid is circulated along an annular path within said pumping chamber, said shaft having a portion extending externally of said casing,
(g) a sector gear mounted on said external portion of said shaft,
(h) a rack external of said casing engaging said gear, and
(i) means for actuating said rack to effect rotation of said gear for moving said dam between said first and second positions.

5. A turbine pump comprising:
(a) a casing defining an annular pumping chamber,
(b) an impeller mounted for rotation within said casing,
(c) said casing having an inlet through which fluid enters said pumping chamber,
(d) said casing having an outlet through which fluid is discharged from said pumping chamber,
(e) said casing having a shoulder therein,
(f) a dam pivotally mounted in said chamber adjacent said shoulder and between said inlet and said outlet,
(g) a portion of said dam engaging said shoulder in one direction of rotation of said impeller to retain said dam in a first position wherein said dam directs fluid from said chamber to said outlet, and
(h) said dam being moved to a second position by the fluid in response to the other direction of rotation of said impeller so that the fluid is circulated within said chamber.

6. A turbine pump comprising:
(a) a casing defining an annular pumping chamber,
(b) an impeller mounted for rotation within said casing,
(c) said casing having an inlet through which fluid enters said pumping chamber,
(d) said casing having an outlet through which fluid is discharged from said pumping chamber,
(e) a dam pivotally mounted in said chamber for movement between a first position relative to said impeller in which fluid is directed by said dam to said outlet and a second position in which fluid is circulated along an annular path within said chamber,
(f) said dam being urged toward said second position by hydraulic pressure developed by movement of said impeller, and
(g) selectively operable stop means external of said casing for limiting the movement of said dam by said hydraulic pressure to determine said second position.

References Cited by the Examiner

UNITED STATES PATENTS

1,652,659	12/1927	Brady	103—96
2,277,210	3/1942	Cook	103—96
2,455,552	12/1948	Bower	103—97
2,883,843	4/1959	Bochan	103—3
2,969,739	1/1961	Clearman	103—3

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