

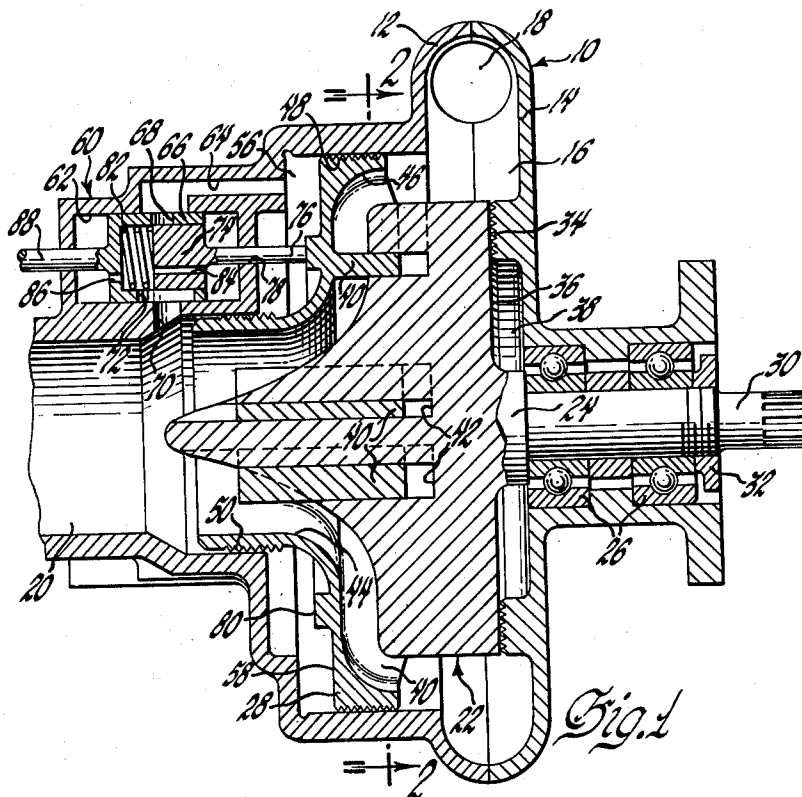
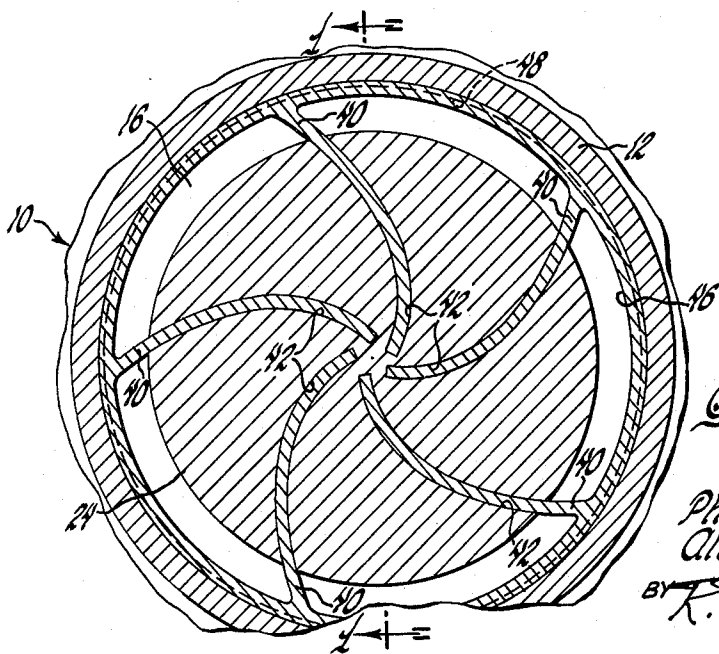
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CENTRIFUGAL PUMP

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CENTRIFUGAL PUMP

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The present invention relates to an improved type of variable capacity centrifugal pump. More specifically this invention relates to an impeller type pump of the axial inflow-radial outflow type in which pump capacity is varied by varying the impeller inlet cross section.

The subject pump includes a multi-part impeller including a rotatable hub member and a shroud member having impeller blades formed thereon. Additionally, the shroud member is adapted to coact with the hub member to form an annular fluid inlet-outlet passage the cross section of which may be varied by moving the shroud relative to the hub. The shroud and hub are mounted within a casing member and the shroud coacts therewith to provide a servo chamber adapted to receive pump outlet pressure. The pump outlet pressure acts on the movable shroud to move the latter in a direction tending to decrease the cross section of the inlet as said pump pressure increases.

A servo valve device is provided for controlling the bleed of the high pressure fluid from the servo to control the axial movement of the shroud relative to the hub and accordingly the cross section of the pump inlet. By reducing the rate of bleed from the servo the pump pressure will build up and reduce the pump inlet cross section and similarly reduce the pump output. On the other hand, increasing the rate of bleed from the servo will cause the pump discharge pressure to move the shroud to increase the pump inlet opening and thereby increase the pump capacity.

The details as well as other objects and advantages of the present invention will be apparent from a perusal of the detailed description which follows.

In the drawings:

Figure 1 is a sectional view of the subject pump; and Figure 2 is a view along line 2—2 of Figure 1.

A variable capacity pump is indicated generally at 10 and includes a pair of casing members 12 and 14. Casings 12 and 14 coact to define an annular chamber 16 from whence fluid under pressure is adapted to be discharged through an outlet 18. Casing 12 includes a fluid inlet passage 20.

A pump impeller is indicated generally at 22 and includes hub portion 24 rotatably supported on bearing members 26 within casing 14 and an adjustable shroud portion 28 fixed for rotation with the hub. Hub 24 includes an input shaft 30 formed integrally therewith and extending exteriorly of casing 14 to be driven by any suitable driving means. A collar 32 is threadably mounted on shaft 30 and abuttingly engages outer bearing 26 to prevent leftward movement of hub 24 as viewed in Figure 1. An annular spiral seal 34 is formed on casing 14 proximate face 36 of hub 24 and coacts therewith to keep chamber 38 at low pressure and thus reduces leakage through bearings 26.

Shroud 28 is mounted for axial movement relative to casing 12 and hub 24. Shroud 28 has impeller blades 40 formed integrally therewith and which blades are

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adapted to extend within corresponding grooves or slots 42 formed within rotor hub 24.

Shroud 28 coacts with rotor hub 24 to define a flow passage having an axial inlet 44 and a radial outlet 46. As the impeller is rotated, fluid will be drawn in through inlet passage 20, pressurized by the rotation of impellers 40 and discharged through outlet 18.

The outer peripheral portion 48 of shroud 28 coacts with casing 12 to provide a high leakage rate seal. The smaller diameter peripheral surface 50 of the shroud coacts with a corresponding surface of casing 12 to provide a low leakage rate seal.

Before describing the means whereby the axial movement of shroud 28 relative to hub 24 is achieved, it is well to note that as the shroud is moved toward the hub the cross sectional area of inlet 44 is decreased thereby decreasing the output capacity of the pump. Conversely, as the shroud is moved away from the hub the increased cross section of flow passage 44—46 increases the pump output capacity. Thus it is the axial movement of the shroud that determines the pump output capacity.

Casing 12 and shroud 28 coact to define a servo chamber 56 which is in communication with the pump output pressure chamber 16 through the high leakage rate seal surface 48. Since the pressurized chamber 56 is charged from the highest pressure area in the pump, the mean effective pressure within the chamber acting on the left or back side 58 of the shroud ring is greater than the mean effective pressure acting on the opposite side and the shroud ring would tend to be forced to its extreme right position to restrict the output capacity of the pump. However, the actual axial position of the shroud ring is controlled by bleeding a portion of the pressure within chamber 56 through the low leakage rate seal 50 and the balance through a servo control mechanism indicated generally at 60.

Servo control mechanism 60 includes a cylinder 62 formed in casing 12 and communicating through a passage 64 with servo chamber 56. A servo control valve member 66 is slidably disposed within cylinder 62 and includes a port 68 in communication with the high pressure passage 64 and an elongated port 70 in communication with the fluid inlet passage 20 through a casing port 72. Further a piston member 74 is slidably disposed within valve member 66 and includes a stem 76 extending through an opening 78 in the end wall of cylinder 62 to engage with an annular rim 80 formed on face 58 of shroud ring 28. A spring member 82 is disposed between servo valve member 66 and piston 74 to maintain the latter in engagement with shroud rim 80.

In order that piston 74 and valve member 66 are not responsive to fluid pressure acting thereon longitudinal passages 84 and 86 are respectively formed therethrough equalizing the pressure forces acting on the opposite faces thereof.

The operation of the pump is as follows: as the pressure builds up within servo chamber 56 there is a tendency for shroud ring 28 to move to the right or output decreasing direction. As such movement occurs, shroud rim 80 tends to move away from piston stem 76. However, spring 82 maintains the piston stem in engagement with the rim. In so doing, however, piston 74 uncovers port 68 in the servo valve member 66 and thereby bleeding high pressure fluid to the inlet or low pressure side of the pump. In this manner the pressure in chamber 56 will be diminished sufficiently to maintain shroud 28 in an essentially constant position relative to hub 24. In the event it is desired to increase the pump output capacity, servo valve member 66 is moved to the left to increase the bleed opening between piston 74 and port 68 whereby the pressure within servo chamber 56 will be diminished. The pressure drop within cham-

ber 56 results in a pressure differential across shroud ring 28 causing the latter to be moved to the left increasing the pump inlet area and, in turn, the pump output capacity.

Correspondingly to decrease the pump capacity, the servo valve member 66 is moved to the right blocking bleed port 68 and increasing the pressure within servo chamber 56 sufficiently to move the shroud ring to the right to reduce the flow capacity of passage 44-46. After shroud 28 has moved to the right a predetermined amount, piston 74 will again uncover bleed port 68. Piston 74 cooperating with servo valve member port 68 thus provides a self-centering or follow-up control to limit movement of the shroud ring. In other words, once the position of servo valve member 66 is set the position of shroud ring 28 remains substantially constant. This type of operation is best appreciated by considering the shroud ring with the servo control elements in the position as shown in Figure 1. Thus, with the valve member 66 set as shown, any increase in servo chamber pressure will tend to move shroud ring 28 to the right at which time bleed port 68 will be uncovered reducing the pressure in chamber 56 sufficiently to limit movement of the shroud ring.

Depending on the environment in which the subject pump is intended for use, control of servo valve member 66 may occur manually or automatically through any suitable control mechanism operatively connected to valve stem 88.

We claim:

1. A variable capacity centrifugal pump comprising casing means having an axial inlet and a radial outlet, a hub member rotatably supported within said casing means, a shroud member mounted for rotation with said hub member and axially movable relative thereto, said shroud member having vanes formed thereon, said shroud and said hub coacting to define a fluid flow passage having an inlet and an outlet respectively communicating with said casing inlet and outlet, said shroud and said casing means coacting to define a servo chamber, said shroud member 40 coacting with said casing means to provide a seal through which the pump discharge pressure may be communicated with said servo chamber, said shroud member also coacting with said casing means to provide a second seal through which said chamber is communicated with the 45 inlet side of said pump, the pressure within said servo chamber tending to move said shroud member toward said hub member to decrease the cross sectional area of

said pump fluid flow passage, and a servo valve control mechanism adapted to bleed the pressure within said servo chamber to the inlet side of said pump to control the axial position of said shroud relative to said hub.

2. A variable capacity centrifugal pump of the type set forth in claim 1 in which said hub includes a plurality of axially extending grooves corresponding in number and shape to said shroud vanes, said vanes being slidably supported within said grooves for axial movement relative thereto.

3. A variable capacity centrifugal pump as set forth in claim 1 in which the servo valve control mechanism includes passage means communicating the servo chamber with the pump inlet and a valve device in said passage means for bleeding pressure from the chamber to the inlet side of the pump and thereby controlling the axial position of said shroud.

4. A variable capacity centrifugal pump as set forth in claim 3 in which said valve device includes a cylinder communicating with said passage means, a valve element slidably disposed within said cylinder, first and second ports in said valve element respectively adapted to communicate with said passage means and said pump inlet, and a piston member slidably disposed within said valve element, said member adapted to coact with said element to control the pressure bleed through said first port, said piston member being movable with said shroud member.

5. A variable capacity centrifugal pump as set forth in claim 4 in which said piston includes a stem extending 30 through said cylinder to engage said shroud.

6. A variable capacity centrifugal pump as set forth in claim 5 in which said shroud includes an annular rim disposed within said servo chamber in axial alignment with the piston stem, and a spring element biasing said stem 35 into engagement with said rim.

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