March 23, 1948. R. G. HOLT 2,438,442

PUMP WITH DIFFERENTIAL IMPELLER CONTROL

Filed Dec. 21, 1944

Fig. 1

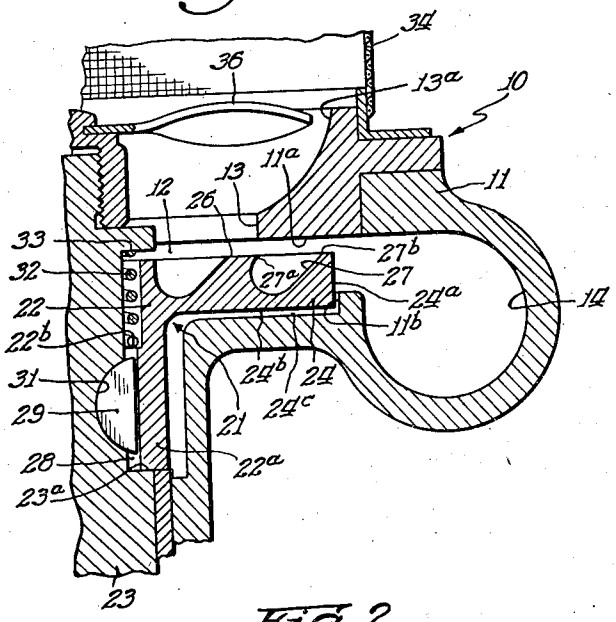


Fig. 3

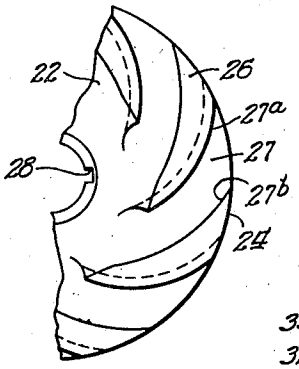
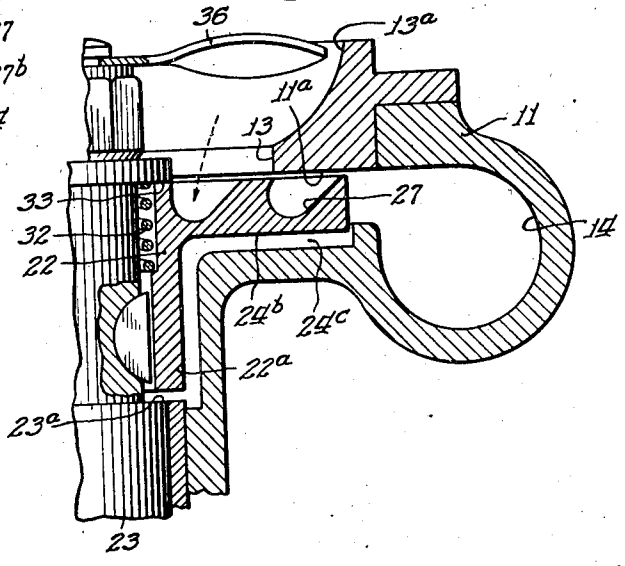


Fig. 2



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PUMP WITH DIFFERENTIAL IMPELLER CONTROL

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7 Claims. (Cl. 103—97)

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This invention relates to centrifugal impeller pumps and particularly to an improved arrangement for adjusting the position of the impeller.

Centrifugal impeller pumps are being used to an increasing extent as standby booster pumps located in or adjacent the fuel tanks of aircraft, the driving motor being cut on and off depending upon the demand for pressure. While the centrifugal type of impeller permits of flow therethrough when stationary the same nevertheless offers some obstruction to the free passage of fluid thereby.

I have found that this problem can be effectively solved by forming a portion of the fluid channel defining means as part of the housing and forming the remainder of the channel in the rotating impeller together with a novel arrangement of means for effecting the axial adjustment of the impeller in such a way that when the impeller is not being rotated the same is withdrawn away from the housing portion defining part of the fluid channel whereby to reduce the obstruction to fluid flow through the pump. I have provided means responsive to the development of a pressure differential by the rotation of the impeller effective to move the same axially to bring the pumping channels formed in the impeller into closely spaced relation to that portion of the channel defining means formed as part of the housing, whereby to improve the pumping efficiency of the impeller when the same is being driven.

It is, therefore, the primary object of this invention to provide an improved and novel centrifugal pump arrangement effective to carry out the above mode of operation, which arrangement is both efficient in its operation and practicable of manufacture and installation.

Other objects, advantages, and uses of the present invention will become apparent from a reading of the following specification taken in connection with the accompanying drawing which forms a part thereof and wherein:

Fig. 1 is a broken away cross-sectional view taken on the general axis of a centrifugal pump incorporating a preferred embodiment of the invention and showing the impeller in the retracted position occupied thereby when not being rotated;

Fig. 2 is a view similar to that of Fig. 1 but showing the impeller in the axially adjusted position to which the same is moved in response to the fluid pressure generated thereby; and

Fig. 3 is a broken away plan view of the impeller showing the arrangement of open-sided spiral pumping grooves formed therein.

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Referring in greater detail to the figures of the drawing, there is indicated generally at 10 the essential elements of a centrifugal booster pump incorporating a preferred form of the invention. Pump housing 11 includes impeller chamber 12 having a coaxial fluid inlet 13 and a surrounding volute discharge chamber 14. Received within pumping chamber 12 is a special impeller and supporting arrangement indicated generally at 21 to which the present invention is particularly directed.

The special impeller arrangement 21 preferably includes impeller proper 22 mounted in splined or keyed relation on rotatable shaft 23 adapted to be driven by a suitable motor (not shown). Impeller proper 22 includes a radially extending disc-like portion 24 formed in the inlet face 26 thereof with a plurality of spirally extending grooves or channels 27 beginning adjacent the axis and communicating with the outwardly disposed volute chamber 14. The curved channel defining walls merge with inlet surface 26 at points 27*a* and 27*b* to define the open sides of the channels. Surrounding inlet 13 is a generally transversely extending wall surface 11*a* complementary to impeller inlet surface 26 and functioning when impeller 22 is in closely spaced relation to this surface 11*a* to define a substantial closure for the radially outward portion of the channels 27 disposed opposite thereto. This relation is important to the development and maintenance of a pressure differential between inlet 13 and volute chamber 14. The spacing between impeller 22 and transverse surface 11*a* in the pumping position indicated in Fig. 2 is preferably maintained at a very small value of the order of only several ten-thousandths of an inch. This position of the impeller with reference to transverse surface 11*a* shown in Fig. 2 will be referred to for the purpose of description as "the first axial position" of the impeller. The outer periphery of impeller 22 is preferably generally parallel to the axis of rotation as indicated at 24*a* and given a limited small clearance with reference to cylindrical-like portion 11*b* of housing 11 to thus define with the housing and the undersurface 24*b* of impeller 22 a pressure responsive motive means for effecting the axial adjustment of the impeller into said first position. The limited clearance between cylindrical wall 11*b* of the housing and the cooperating periphery 24*a* of the impeller functions to admit pressure fluid from volute chamber 14 to motive chamber 24*c*.

The splined or keyed driving relationship between shaft 23 and impeller 22 preferably includes an axial tubular extension 22*a* on impeller 22 internally splined at 28 for cooperation with key 29 received in arcuate recess 31 of shaft 23. Coil compression spring 32 acts between shoulder 33 on shaft 23 and shoulder 22*b* on impeller extension 22*a* for urging the impeller from said first position into telescoping position within chamber 24*c* with the inner terminal of tubular portion 22*a* in contact with stop 23*a* on shaft 23, which position will be referred to as the "second axial position." In this second position impeller 24 is sufficiently removed axially from transverse surface 11*a* to eliminate the impeller as an obstructing influence in the path of fluid flow between inlet 13 and volute chamber 14 at such time as when fluid is being drawn through the pump with impeller 22 remaining stationary.

In addition to the above described structure, I contemplate the provision of the necessary additional elements for complete and satisfactory operation including preferably a screen 34 surrounding the inlet, a converging inlet guide 13*a* and cooperating beater 36 which may be threadably fastened to the terminal of shaft 23.

In the normal manner of employing the present arrangement the pump 10 will be located in or adjacent the fuel tank remote from and in series with the engine driven pump (not shown). At such time as the pressure condition in the supply line to the engine driven pump is satisfactory booster pump 10 will be allowed to remain stationary and under such conditions impeller 22 will remain in said second or retracted position shown in Fig. 1 so that impeller will impose no significant or appreciable obstruction to the passage of fluid or fuel from the tank through the pump 10 and to the engine driven pump. However, should the pressure in the system require the operation of pump 10 the same will be placed into operation by suitable conventional means and immediately upon impeller 22 being rotated a pressure differential will be created between inlet 13 and volute chamber 14. This pressure in volute chamber 14 is directed between cylindrical wall 11*b* and the periphery 24*a* of the impeller into motive chamber 24*c* where the same acts upon pressure responsive piston-like surface 24*b* forcing the impeller away from said second position shown in Fig. 1 into said first position shown in Fig. 2 wherein the transverse housing wall surface 11*a* functions to substantially close the radial outer portion of the open side of spiral pumping channels 27 to thus improve the pumping effectiveness of impeller 22. As long as impeller 22 is being driven the pressure differential between inlet 13 and that existing in volute chamber 14 and motive chamber 24*c* will be sufficient to maintain impeller 22 in the position shown in Fig. 2 with the impeller in engagement with stop 33 on shaft 23. When this condition no longer exists and shaft 23 has been stopped as by cutting off the energy to the driving motor then coil compression spring 32 becomes effective to shift impeller 22 to said second position with the terminal of tubular extension 22*a* in contact with stop 23*a* on shaft 23.

While I have described my invention in connection with a specific embodiment thereof, it will be understood that this is by way of example rather than limitation and that the invention is to be defined by the appended claims.

I claim:

1. In a centrifugal impeller pump arrangement including a housing having an impeller chamber therein, a rotatable centrifugal impeller received within said chamber, a surrounding volute discharge chamber for receiving fluid from said impeller, means for drivingly supporting said impeller providing for limited axial adjustment within said pumping chamber between a first extended position and a second retracted position, means for shifting said impeller to one of said respective positions, and means defining a motive chamber in which said impeller rotates, said chamber being adapted to receive pressure fluid generated by said impeller upon rotation thereof to shift said impeller to the other of said respective positions.

2. In a centrifugal impeller pump arrangement including a housing having a centrifugal impeller chamber therein, a rotatable centrifugal impeller within said chamber, said housing having a coaxial inlet delivering to said impeller and a surrounding volute chamber for receiving fluid from said impeller, said impeller being formed with open spiral pumping channels extending from the central portion of said impeller outwardly and discharging into said volute chamber, said opened sides of said channels facing in the general direction of said inlet opening, said pumping chamber being defined in part by a generally transverse surface surrounding said inlet in complementary opposed relation to a radially outward portion of said channels defining a closure therefor, means defining an axially adjustable support for said impeller and means for adjusting said impeller axially to either a first position in closely spaced relation to said transverse surface or to a second position axially removed therefrom, said first position being effective to improve the pumping efficiency of said impeller and said second position being effective to remove said impeller as an obstruction to flow between said inlet and said volute chamber.

3. In a centrifugal pump including a housing having a central inlet, a coaxially located rotatable impeller for receiving fluid through said inlet and formed with open spiral pumping channels, a surrounding volute chamber outlet for receiving fluid from said channels, a housing surface surrounding said inlet and extending transversely of the axis of said impeller, the combination therewith of means for supporting said impeller for axial adjustment to either a first position with said impeller in closely spaced relation to said transverse surface or to a second position with said impeller removed axially away from said transverse surface, means for normally urging said impeller in the direction of said second position when said impeller is not being rotated and means responsive to pressure generated by the rotation of said impeller effective to move the same to said first position whereby to improve the pumping effectiveness of said impeller.

4. In a centrifugal pump arrangement including a housing having a central inlet, a rotatable centrifugal impeller disposed coaxially of said inlet and formed in the inlet base thereof with open spiral pumping channels extending from the central portion thereof radially outwardly, a volute discharge chamber for receiving fluid from said impeller, means defining a surface about said inlet opening extending transversely to the axis of said impeller, at least a portion of which surface is effective to form a substantial closure

for the open pumping channels turning adjacent thereto, the combination therewith of axially adjustable supporting means for said impeller providing for supporting the same in a first axial position in closely spaced relation to said transverse surface and for supporting the same in a second position removed axially away from said first position, means for resiliently urging said impeller in the direction of said second position and means responsive to the pressure developed by said impeller for moving the same into said first position and maintaining the same in said first position.

5. In a centrifugal impeller pump arrangement including a housing, a rotatable centrifugal impeller in said housing, a coaxial inlet in said housing for delivering fluid to said impeller, a surrounding volute discharge chamber for receiving fluid from said impeller, said impeller being formed with open spiral pumping channels facing in the general direction of said inlet and extending from the central portion of said impeller spirally outwardly into communication with said chamber, a surface surrounding said inlet and extending generally transversely to the axis of said impeller in complementary relation to the adjacent portion of said impeller, said surface cooperating with radially outwardly disposed open portions of said channels to form a substantial closure therefor for directing fluid centrifugally outwardly into said volute chamber when said impeller is in a first position, the combination therewith of means for adjustably supporting said impeller in either said first position or a second position removed axially away from said first position with said impeller separated from said transverse surface, said means including a coil compression urging said impeller in the direction of said second position to thus reduce the obstructing effect of said impeller to the flow of fluid when the same is stationary and pressure responsive means effective to cause axial movement of said impeller into said first named position, and means for delivering the pressure fluid generated by said impeller upon the rotation thereof to said pressure responsive means.

6. In a centrifugal impeller pump arrangement including a housing having an impeller chamber, a rotatable centrifugal impeller wheel of disc-like construction received in said chamber, a coaxial inlet for delivering fluid to said impeller and surrounding volute discharge chamber for receiving fluid from said impeller, a plurality of open-sided spiral pumping channels in the inlet face of said impeller extending from the central portion thereof spirally outwardly, said housing pumping chamber including a surface extending generally transversely to the axis of rotation of said impeller and in complementary opposed position to the open radially outer portion of said open channels forming a substantial closure therefor and defining part of the confining path of flow of fluid outwardly into said volute chamber, the combination therewith of means for supporting said impeller for axial adjustment to either a first position in closely spaced relation to said transverse surface or to a second axial position spaced from said first position, said means including a driving shaft for said impeller and spline defining means connecting said shaft and impeller for axial relative movement but preventing relative arcuate movement, a coil compression spring interposed between said impeller and said supporting shaft normally urging said impeller into said second position, stop defining means carried by said supporting shaft defining the limit of movement of said impeller in said second position, and means defining with the underside of said impeller a pressure responsive motor for moving said impeller in the direction of said first named position when the same is rotated to develop a differential of pressure between the inlet and the volute chamber and means for directing the pressure in said volute chamber to said motive means.

7. A centrifugal pump comprising a housing having a central inlet; a volute chamber having an outlet; a rotatable impeller formed with spiral pumping grooves having terminals opening in the direction of said inlet; a transverse wall surface confronting said groove terminals; means for adjustably supporting said impeller with said groove terminals in predetermined spaced relation to said inlet and said transverse surface, said means normally urging said impeller axially away from said surface when said impeller is stationary to reduce obstructing effect of said impeller in the path between said inlet and said volute chamber, said means also including a motive chamber in coactive relationship to said impeller for effecting axial movement of said impeller in the opposite direction; and means for delivering the pressure fluid generated by the rotation of said impeller to said motive chamber whereby to move said impeller into closely spaced relation to said transverse wall surface to improve the pumping efficiency of said impeller.

RAY G. HOLT.

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