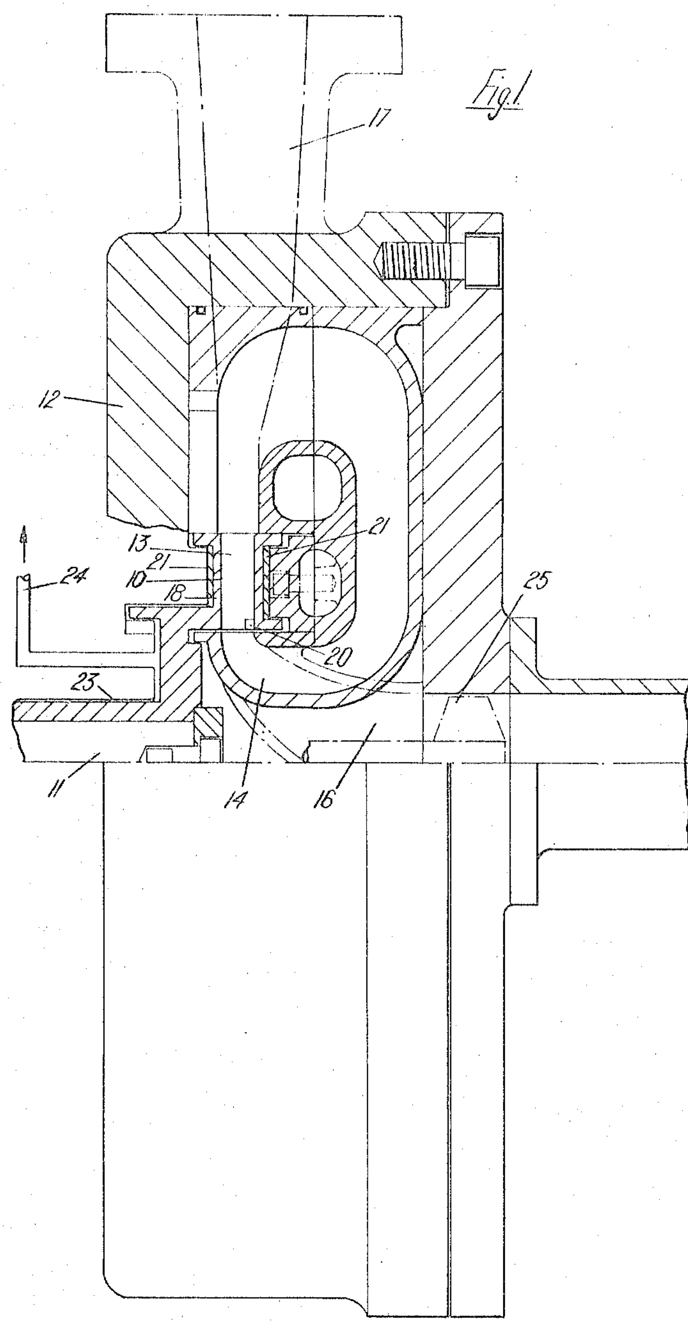
Jan. 10, 1967 G. F. ARKLESS ET AL 3,296,972

FLUID OPERATED MULTI-STAGE MACHINE

Filed April 20, 1965 2 Sheets-Sheet 1



Inventors
GEORGE FREDERICK ARKLESS &
HAROLD HENRY ANDERSON
By Mason, Fenwick & Lawrence
Attorneys

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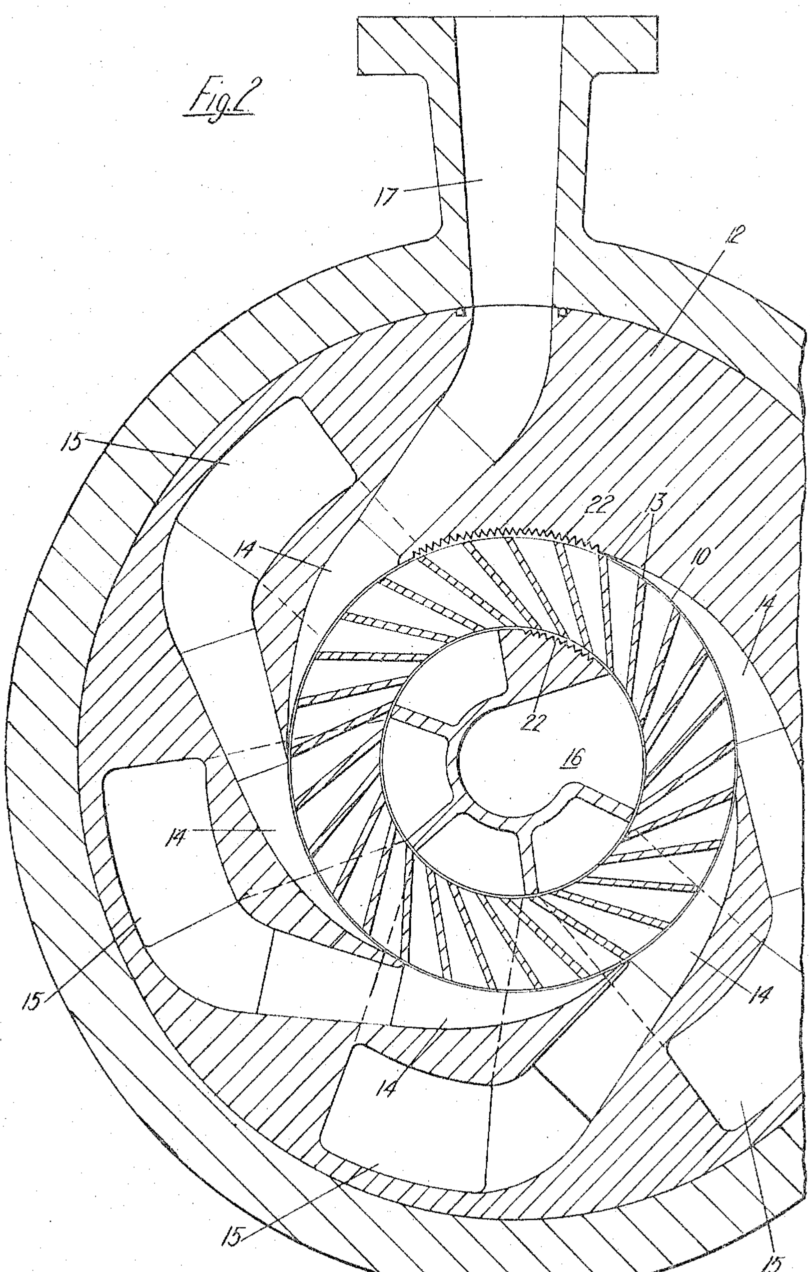
Fig. 2



Inventors
GEORGE FREDERICK ARKLESS &
HAROLD HENRY ANDERSON
By Mason, Fenwick & Lawrence
Attorneys

United States Patent Office

3,296,972
Patented Jan. 10, 1967

3,296,972

FLUID OPERATED MULTI-STAGE MACHINE

George Frederick Arkless and Harold Henry Anderson, both of Cathcart, Glasgow, Scotland, assignors to G. & J. Weir Limited

Filed Apr. 20, 1965, Ser. No. 449,452
Claims priority, application Great Britain, June 4, 1964, 23,120/64
7 Claims. (Cl. 103—103)

This invention relates to improvements in a fluid operated multi-stage machine, intended to operate as a pump or a turbine.

According to the present invention there is provided a fluid operated multi-stage machine including a rotatable shaft, a casing, a fluid impeller within said casing and rotatable with said shaft, the impeller having a peripheral ring of vanes concentric with the shaft, adjacent vanes defining fluid passes, a plurality of diffuser passages in the casing and spaced around the outer periphery of the impeller vanes, each diffuser passage communicating at one end with the outer ends of a number of fluid passes, and the vanes serving to seal adjacent diffuser passages from one another, a number of return passages being provided to enable fluid communication between the other end of each diffuser passage and the inner ends of the fluid passes which are in communication with the next successive diffuser passage, and fluid inlet and outlet passages into and out of said casing, said inlet passage communicating with the fluid passes in communication with the first stage diffuser and said outlet passage communicating with the diffuser of the last stage when the machine is operating as a pump.

Preferably, the impeller is provided with shroud plates to form the sides of the fluid passes.

Preferably, at least one of the shroud plates is removably attached to the impeller.

Preferably, the casing is provided with annular rings of a soft material, the rings being co-axial with the shroud plates and abutting the shroud plates.

Preferably, the part of the casing separating the diffuser passage of the last stage from the diffuser passage of the first stage and the part of the casing separating the return passage of the last stage from the inlet passage to the first stage are provided with a plurality of separate axially extending grooves.

Preferably, the shaft rigidity is such as to avoid any rubbing contact between rotating and stationary parts.

Preferably, when the machine is acting as a pump the inlet passage is co-axial with the shaft and an axial flow impeller is provided in this passage to impose the necessary inlet pressure on the fluid.

One embodiment of the present invention will now be described merely by way of example with reference to the accompanying drawings in which:

FIG. 1 is a sectional end elevation of the fluid operated multi-stage machine, and

FIG. 2 is a sectional front elevation of the fluid operated multi-stage machine.

In the embodiment the multi-stage fluid operated machine is acting as a pump.

A centrifugal impeller **10**, mounted rigidly on a shaft **11**, is rotatable in a clockwise direction with said shaft within a casing **12**, said impeller having a peripheral ring of vanes **13** concentric with the shaft, adjacent vanes defining fluid passes.

A plurality of diffuser passages **14**, in the casing **12**, are spaced around the outer periphery of the impeller vanes **13**, each diffuser passage communicating at one end with the outer end of a group of fluid passes, and at the other end with a return passage **15** which communicates

with the inner ends of the fluid passes which are in communication with the next successive diffuser passage.

The extreme vanes of each group of fluid passes serve as pressure walls, sealing adjacent diffuser passages from one another.

The casing **12** is provided with an inlet **16** and an outlet passage **17**, said inlet passage supplying fluid to the fluid passes in communication with the first stage diffuser and said outlet passage communicating with the diffuser of the last stage.

The impeller is provided with shroud plates **18**, **19** which form the sides of the fluid passes. One of the shroud plates **19** is removably attached to the impeller **10** to facilitate assembly and to enable the performance of the pump to be adjusted by varying the width of the impeller being used in the machine. The detachable shroud plate **19** is provided with small vanes **20** which ensure that said detachable shroud plate is concentric and in line with the vanes of the impeller **10**.

Annular rings **21**, of a soft material, are attached to the casing **12** such that they are concentric with the shroud plates **18**, **19** and abut the shroud plates, losses of higher pressure fluid passing into regions of lower pressure are thus mitigated.

The parts of the casing **12** separating the diffuser passages of the first and last stages, and the inlet to the first stage and return passage of the last stage are provided with a plurality of axially extending grooves **22** which cause turbulence in any fluid attempting to leak from the last stage to the first stage and thus minimises any leakage.

The shaft **11** on which the impeller **10** is attached is of relatively large thickness and short length and the clearance **23** between the shaft **11** and the casing **12** is great enough, for example 20 thousandths of an inch, to permit the machine to be run dry without seizure, the pump can thus be self-primed. The clearance **23** between the shaft and the casing also allows air to be discharged to atmosphere during the priming period, and a suitable drain **24** is also provided to assist with this discharging.

The inlet **16** to the pump is coaxial with the shaft **11** and is provided with an axial flow impeller **25** to impose the necessary inlet pressure on the fluid entering the first stage.

A machine according to the present invention could generate a pressure defence at zero flow in order to serve as a gland and prevent leakage where a rotating shaft passes through the wall of a pressure vessel. The suction of the machine would be connected to the atmospheric side of the pressure vessel and the discharge of the machine would be connected to the interior of the pressure vessel. The machine will thus serve as a gland and obviate leakage from the pressure vessel along the shaft to the atmosphere.

In operation fluid entering the casing **12** is given an initial pressure rise by the axial flow impeller **25** in the inlet passage **16**, this pressure rise being sufficient to cause the fluid to enter the fluid passes of the first stage of the rotating impeller **10**.

The fluid is delivered from the fluid passes to the diffuser passage **14** of the first stage and flows to the fluid passes of the second stage through the first stage return passage **15**. The fluid is then delivered by the impeller **10** to the second stage diffuser, and thence through the successive fluid passes and diffusers **14**, until, at a greatly increased pressure, it reaches the diffuser passage of the last stage which communicates with the discharge passage **17** out of the casing **12**.

In the turbine version of the machine the fluid flow is reversed and high pressure fluid is supplied to the diffuser passage of the last stage, the direction of rotation of the impeller in this case being anti-clockwise.

We claim:

1. A fluid operated multi-stage machine including a rotatable shaft, a casing, a fluid impeller within said casing and rotatable with said shaft, the impeller having vanes which, together with shroud plates define fluid passes, a plurality of diffuser passages in the casing and spaced around the periphery of the impeller vanes, each diffuser passage communicating at one end with the outer ends of a number of fluid passes, and the vanes serving to seal adjacent fluid passages from one another, a number of return passages being provided to enable fluid communication between the other end of each diffuser passage and the inner ends of the fluid passes which are in communication with the next successive diffuser passage, and fluid inlet and outlet passages into and out of said casing, said inlet passage communicating with the fluid passes in communication with the first stage diffuser and said outlet passage communicating with the diffuser of the last stage when the machine is operating as a pump, the impeller being overhung from the shaft and being annular, said return passages communicating with the inner periphery of the impeller, said diffusers with the outer periphery of the impeller.

2. A fluid operated multi-stage machine as claimed in claim 1 in which at least one of the shroud plates is removably attached to the impeller.

3. A fluid operated multi-stage machine as claimed in claim 1, in which the casing is provided with annular rings of a soft material, the rings being co-axial with the shroud plates and abutting the shroud plates.

4. A fluid operated multi-stage machine as claimed in claim 1, in which the part of the casing separating the diffuser passage of the last stage from the diffuser passage of the first stage is provided with a plurality of separate axially extending grooves.

5. A fluid operated multi-stage machine as claimed in claim 1 in which the part of the casing separating the return passage of the last stage from the inlet passage to the first stage is provided with a plurality of separate axially extending grooves.

6. A fluid operated multi-stage machine as claimed in claim 1 in which the shaft rigidity is such as to avoid any rubbing contact between rotating and stationary parts.

7. A fluid operated multi-stage machine as claimed in claim 1, in which the inlet passage is co-axial with the shaft and an axial flow impeller is provided in this passage to impose the necessary inlet pressure on the fluid when the machine is acting as a pump.

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DONLEY J. STOCKING, *Primary Examiner.*

HENRY F. RADUAZO, *Examiner.*