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Onal

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[54] **CENTRIFUGAL PUMP WITH INTEGRAL SEAL PRESSURE BALANCE**

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[52] **U.S. Cl.** **415/111**, 415/199, 415/219

[51] **Int. Cl.**.....**F01d 11/00**, F01d 1/02, F01d 25/24

[58] **Field of Search**.....415/104, 105, 106, 108, 134, 415/138, 199, 111, 112, 219

[56] **References Cited**

UNITED STATES PATENTS

1,221,822	4/1917	Bodinson	415/111
1,485,504	3/1924	Hollander	415/112
1,980,337	11/1934	Hollander	416/186

FOREIGN PATENTS OR APPLICATIONS

956,731	4/1964	Great Britain	415/199 R

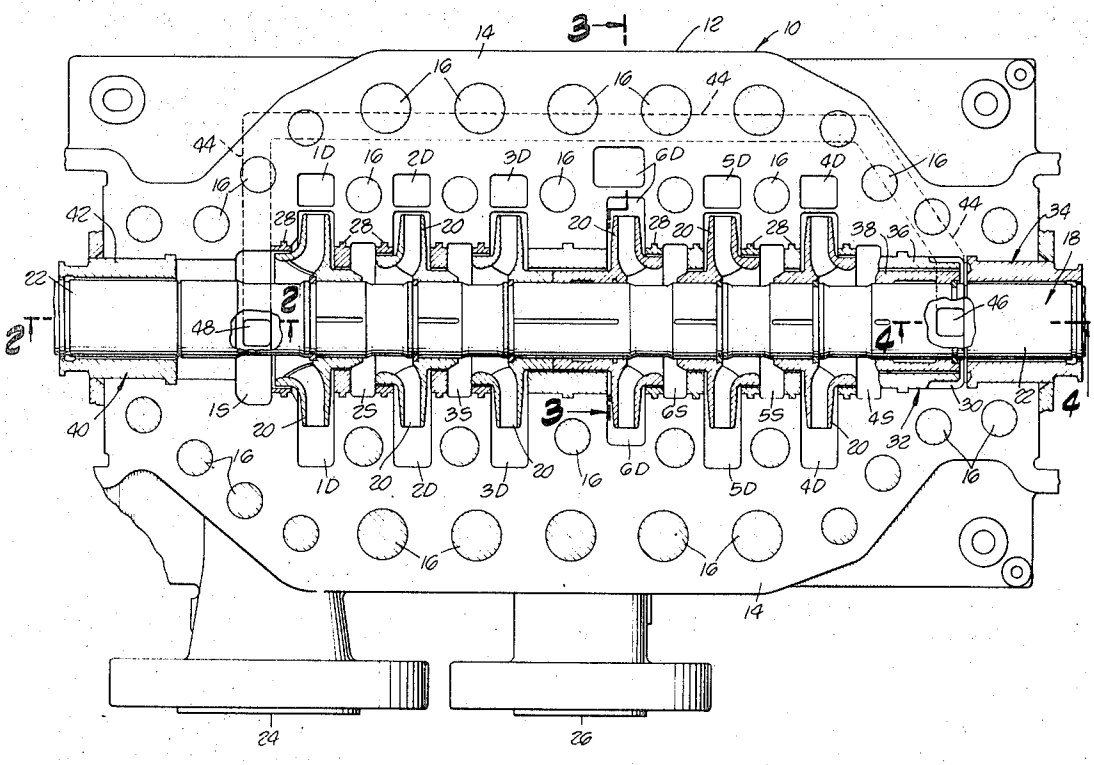
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[57] **ABSTRACT**

An axially balanced multistage centrifugal pump having an impeller assembly of plural impellers fixed on a shaft which is rotatably and axially mounted within an elongated divided pump case formed of first and second cast metal housings and having fluid pressure stage dividers disposed between the impellers to form fluid pressure stages, whereby the pump in operation will contain fluid at a lower pressure at a first end of the housing and fluid at a higher pressure at the second end of the housing and fluid at a higher pressure at the second end thereof; first and second rotary fluid flow restriction seals mounted between the assembled case and the impeller shaft at the first and the second ends of the casing respectively to restrict fluid flow therebetween; a rotary fluid flow restriction baffle mounted pressure and around the shaft near the second rotary seal to define a seal pressure chamber. The improvement comprises an integral fluid pressure balance passageway integrally defined and incorporated within the wall of one of the housings, which passageway will be in fluid communication with the fluid under pressure contained in the seal chamber at the second end of the pump and with the lower pressure fluid contained at the first end of the pump, whereby fluid pressure exerted against the second seal and the first seal will be equalized at the same lower pressure contained at the first end of the pump.

6 Claims, 5 Drawing Figures



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SHEET 1 OF 2

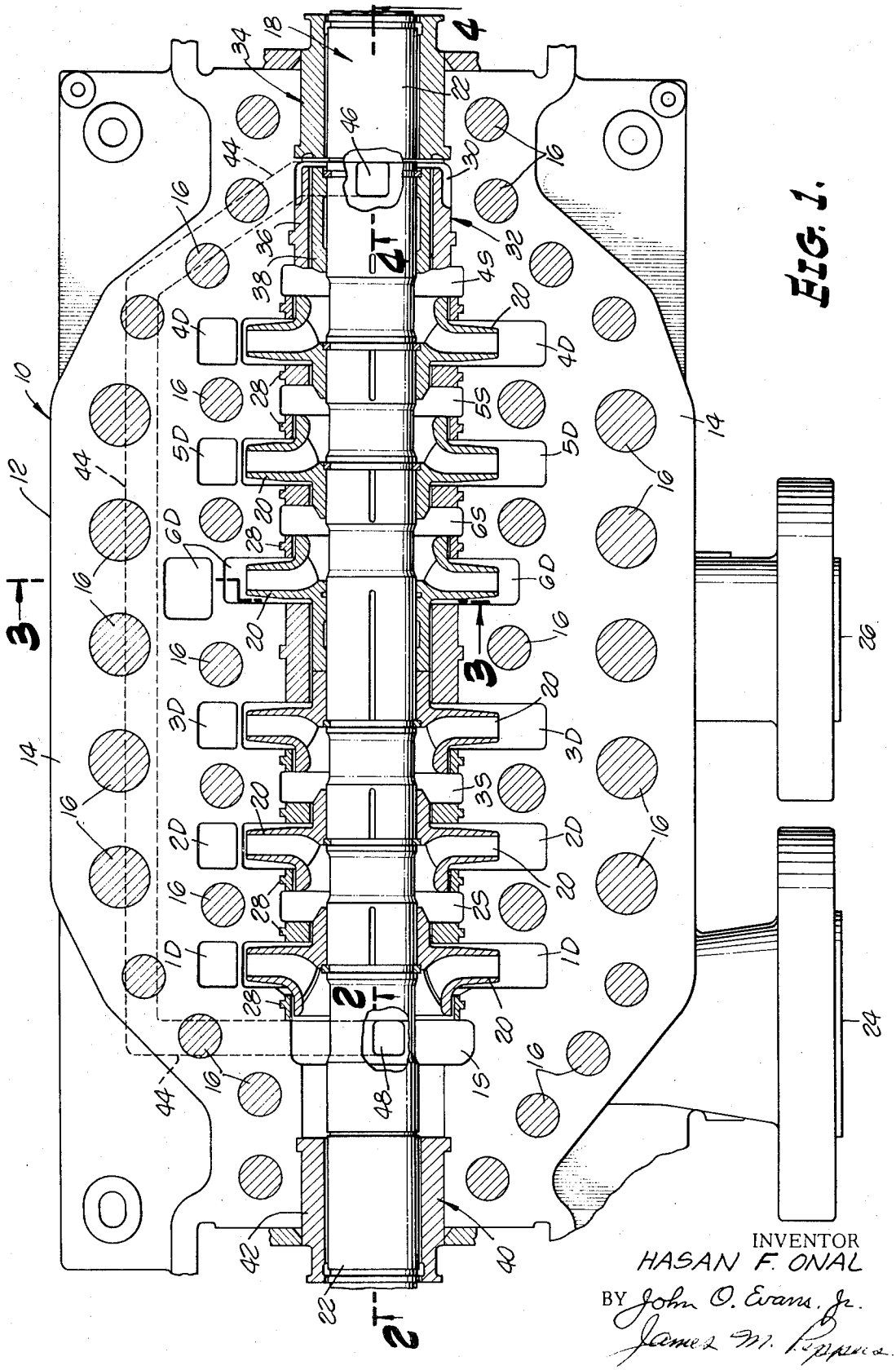


FIG. 1.

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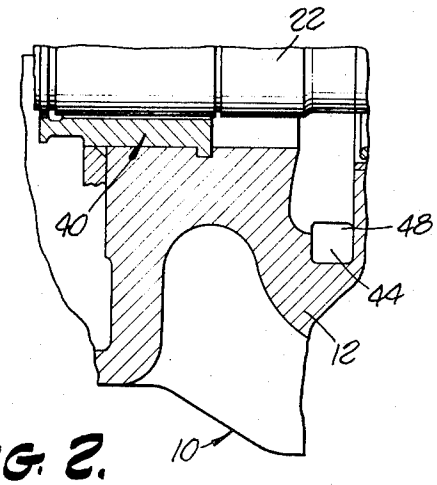
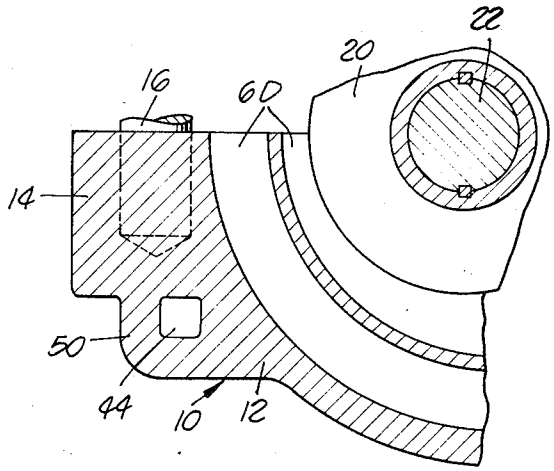


FIG. 2.

FIG. 3.



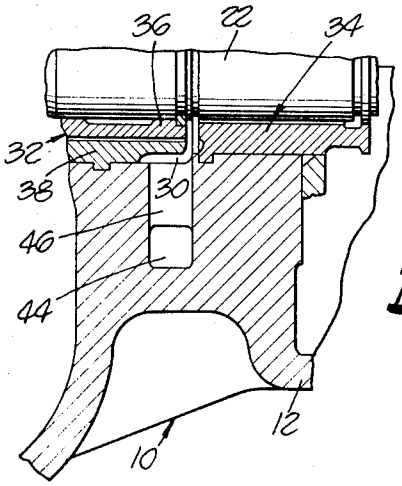
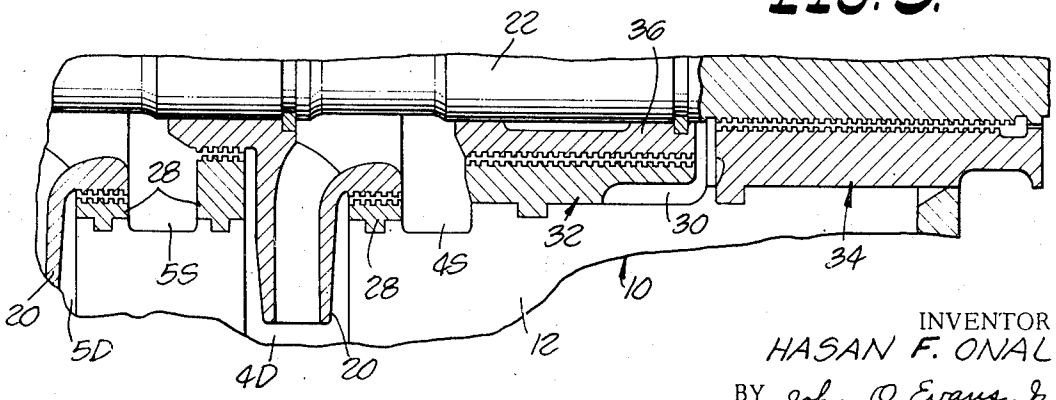


FIG. 4.

FIG. 5.



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CENTRIFUGAL PUMP WITH INTEGRAL SEAL PRESSURE BALANCE

BACKGROUND OF THE INVENTION

This invention generally pertains to multistage centrifugal pumps and more particularly to axially balanced multistage pumps having lower fluid pressure at the suction end of the pump than at the other end of the pump which pumps are equipped with a seal chamber at the high pressure end which is in fluid communication with the suction end of the pump whereby the fluid pressure differential across the low pressure seal and the high pressure seal remains equalized, creating an axial balance of forces imposed on the impeller assembly.

Such pumps generally have a case comprised of a first and a second cast metal housing. The prior art manner of providing fluid communication to equalize the high pressure seal chamber with the suction fluid chamber is to drill holes in one of the pump housings and equip the housing with external piping connected together and into the shell by threaded pipe connection, soldering, brazing or the like. Such external piping may be subject to damage from impacts from extraneous sources and also to damage from fatigue and failure from vibration during operation of the pump and its coupled power source (such as a piston engine). Additionally, such external piping may cause inconveniences in installation and maintenance of the pump in limited spaces.

Summary of the Invention

The principal object of this invention is to provide an axially balanced multistage pump having fluid pressure equalized seals in which the fluid equalizing passageway is substantially immune to damage from vibration or external sources of impacts.

Another object of this invention is to provide a multistage pump with no external pressure equalizing piping which can be obstructive during installation or maintenance.

A further object of this invention is to provide a multistage pump which can be fabricated without the usual labor and material expense required for external pressure equalizing piping.

The foregoing and other objects and advantages are attained with a multistage centrifugal pump having an impeller assembly of plural impellers fixed on a shaft which is rotatably and axially mounted within an elongated divided pump case formed of first and second cast metal housings. The pump case includes fluid pressure stage dividers disposed between the impellers to form fluid pressure stages, whereby the pump in operation will contain fluid at a lower pressure at a first end of the housing and fluid at a higher pressure at the second end thereof. First and second rotary fluid flow restriction seals are mounted between the assembled housing and the impeller shaft at the first and the second ends of the case respectively to restrict fluid flow thereacross. A rotary fluid flow restriction baffle is mounted within the second end of the case containing the higher fluid pressure and around the shaft near the second rotary seal to define a seal pressure chamber. The case defines an integral fluid pressure balance passageway within the wall of one of the housings, which passageway will be in fluid communication with the fluid contained in the seal chamber at the second end of the pump and with the lower pressure fluid contained at the first end of the pump. With the foregoing arrangement, the fluid pressure exerted across the second seal and across the first seal will be equalized at the same lower pressure contained at the first end of the pump.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a partially sectional plan view of a multistage centrifugal pump taken at the juncture of the upper and lower housings and along the axis of the pump impeller assembly.

FIG. 2 is a section taken along the line 2—2 in the direction of the arrows shown in FIG. 1.

FIG. 3 is a section taken along the line 3—3 in the direction of the arrows shown in FIG. 1.

FIG. 4 is a section taken along the line 4—4 in the direction of the arrows shown in FIG. 1.

FIG. 5 is a partially sectional detail of the plan shown in FIG. 1 at the right and below the axis of the impeller assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a partly sectional plan view of a multistage pump is shown having a case **10**, an upper housing (not shown) and a lower housing **12**. Lower housing **12** is seen to include a parting flange **14** which matches the parting flange of the upper housing. The housings are connected together in fluid tight relation by a pattern of fastener studs **16**, shown in cross section. Case **10** is equipped with suitable journal boxes and bearings (not shown) which rotatably and axially support an impeller assembly **18** within the case. Impeller assembly **18** includes a plurality of impellers **20** mounted on an impeller shaft **22**. Each impeller **20** is tightly fitted on shaft **20** and connected to the shaft by means of suitable keys and retainer rings and disposed in alignment within stage discharge chambers 1D to 6D as shown with the suction throat of each impeller in communication with respective suction chambers 1S to 6S. Case **10** is equipped with a fluid suction inlet **24** and a fluid discharge outlet **26**.

Passageways (not shown) are defined in case **10** to connect the successive stages of chambers as follows: chamber 1D to chamber 2S; chamber 2D to chamber 3S; chamber 3D to chamber 4S; chamber 4D to chamber 5S; and chamber 5D to chamber 6S. Passageways (not shown) are also defined in case **10** to connect suction inlet **24** with suction chamber 1S and discharge chamber 6D with discharge outlet **26**.

Grooved inserts **28** are mounted in case **10** between the suction and discharge chambers and about the throats and hubs of impellers **20**. The hubs and throats of the impellers have complementary grooves as shown in FIGS. 1 and 5 to create fluid flow restriction labyrinths to limit fluid leakage from discharge chambers to suction chambers to a selected and acceptable rate.

As also shown in FIGS. 1 and 5, a seal pressure chamber **30** is defined by case **10**, shaft **22**, a fluid flow restriction baffle structure **32** and a seal structure **34**. As later discussed, pressure chamber **30** is provided with fluid communication to suction chamber 1S

whereby fluids leaking through baffle structure 32 from suction chamber 4S (which, in operation of the pumps, is at the same pressure as discharge chamber 3D) may flow back into suction chamber 1S to permit the fluid pressure in pressure chamber 30 (which is imposed across seal structure 34) to be equalized with the suction pressure found in suction chamber 1S and at suction inlet 24.

Baffle structure 32 is comprised of a sleeve 36 mounted in sealed relation on shaft 22 and an insert 38 concentrically mounted about the sleeve and within case 10. The exterior of sleeve 36 and the interior of insert 38 are equipped with complementary grooves as shown to define a fluid flow restriction labyrinth which serves to limit fluid leakage from suction chamber 4S into pressure chamber 30 to a selected and acceptable rate.

At the other end of shaft 22 adjacent suction chamber 1S is a seal structure 40 concentrically mounted about the shaft and within case 10. The construction and operation of seal structures 34 and 40 are alike and as shown in FIG. 5. A sealing sleeve 42 is concentrically mounted about shaft 22 and within case 10. The portion of shaft 22 confined within sleeve 42 and the interior of the sleeve are provided with complementary grooves which form a fluid flow restriction labyrinth to limit fluid leakage through each seal to an acceptable minimum rate. Labyrinth seals of the type shown are exemplary only and could be substituted by lapped face mechanical seals, packed glands, etc., as appropriate under suitable conditions conditions.

Referring now to FIGS. 1 – 4, fluid communication between seal pressure chamber 30 and suction chamber 1S is shown to be provided by a passageway 44 opening through a port 46 into pressure chamber 30 and through a port 48 into suction chamber 1S. As shown, passageway 44 is defined as an integral element of lower housing 12 of case 10 which is formed by a core during the casting of the housing. As best shown in FIG. 3, passageway 44 may be formed within a boss 50 extending generally along and below the edge of parting flange 14. With passageway 44 defined within case 10 as shown, no external piping is necessary to provide equalization of fluid pressure across seals 34 and 40 and consequent equalization of opposing axial forces created by such fluid pressure on the cross-sectional area of shaft 22. This provision not only eliminates the possibility of external piping which might be damaged but also eliminates the space requirements of such piping.

The foregoing description and drawing may suggest other embodiments or variations to those skilled in the art, all of which are intended to be included in the spirit of the invention as set forth herein.

That being claimed is:

1. A multistage centrifugal pump having an impeller assembly of at least two impellers fixed on a shaft which is rotatably and axially mounted within an elongated divided pump case formed of a first unitary, cast metal housing and a second unitary, cast metal housing and having at least one pressure stage divider disposed between the impellers to form fluid pressure stages, whereby said pump in operation will contain lower pressure fluid at a first end of said case and a higher pressure fluid at a second end thereof; a first and a second rotary fluid seal mounted between said case and said impeller shaft at said first and said second end of said case, respectively; a rotary fluid flow restriction baffle mounted within said second end of said case and around said shaft near said second rotary seal to define a seal pressure chamber, the improvement comprising:
   a. one of said unitary, cast metal housings having a continuous portion cast integrally therewith and defining a fluid pressure balance passageway entirely within a wall of said one of said unitary, cast metal housings; and
   b. said passageway being in fluid communication with fluid contained in said seal chamber and with said lower pressure fluid contained at said first end of said pump, whereby the fluid pressure exerted against said second seal and said first seal will be substantially equalized at said lower pressure.

2. The pump of claim 1 wherein said one of said housings includes a parting flange, and said passageway is defined in association with said parting flange.

3. The pump of claim 1 wherein said one of said housings includes a boss, and said passageway is defined within said boss.

4. The pump of claim 1 wherein said one of said housings is disposed below the other, and said passageway is defined within the lower housing.

5. The pump of claim 2 wherein a boss extends from said parting flange, and said passageway is defined within said boss.

6. The pump of claim 5 wherein said one of said housings is disposed below the other, and said passageway is defined in the lower housing.

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