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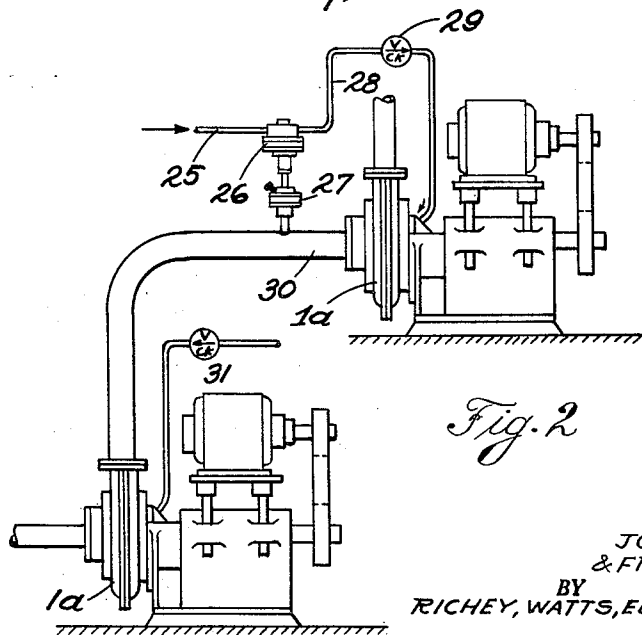
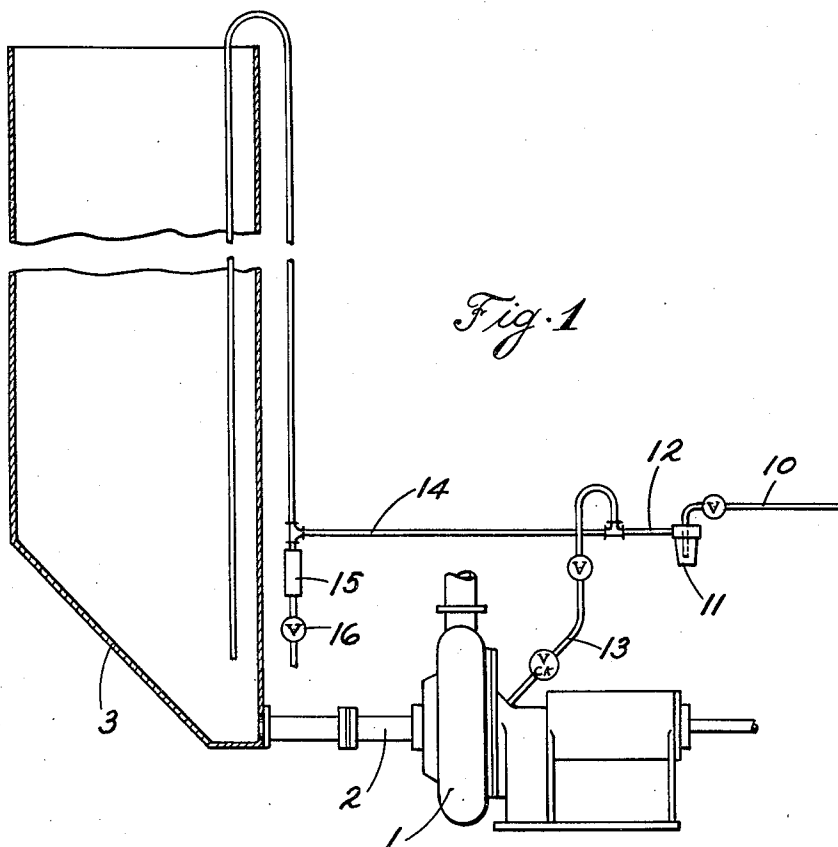
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CENTRISEAL PUMP

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2 Sheets-Sheet 1



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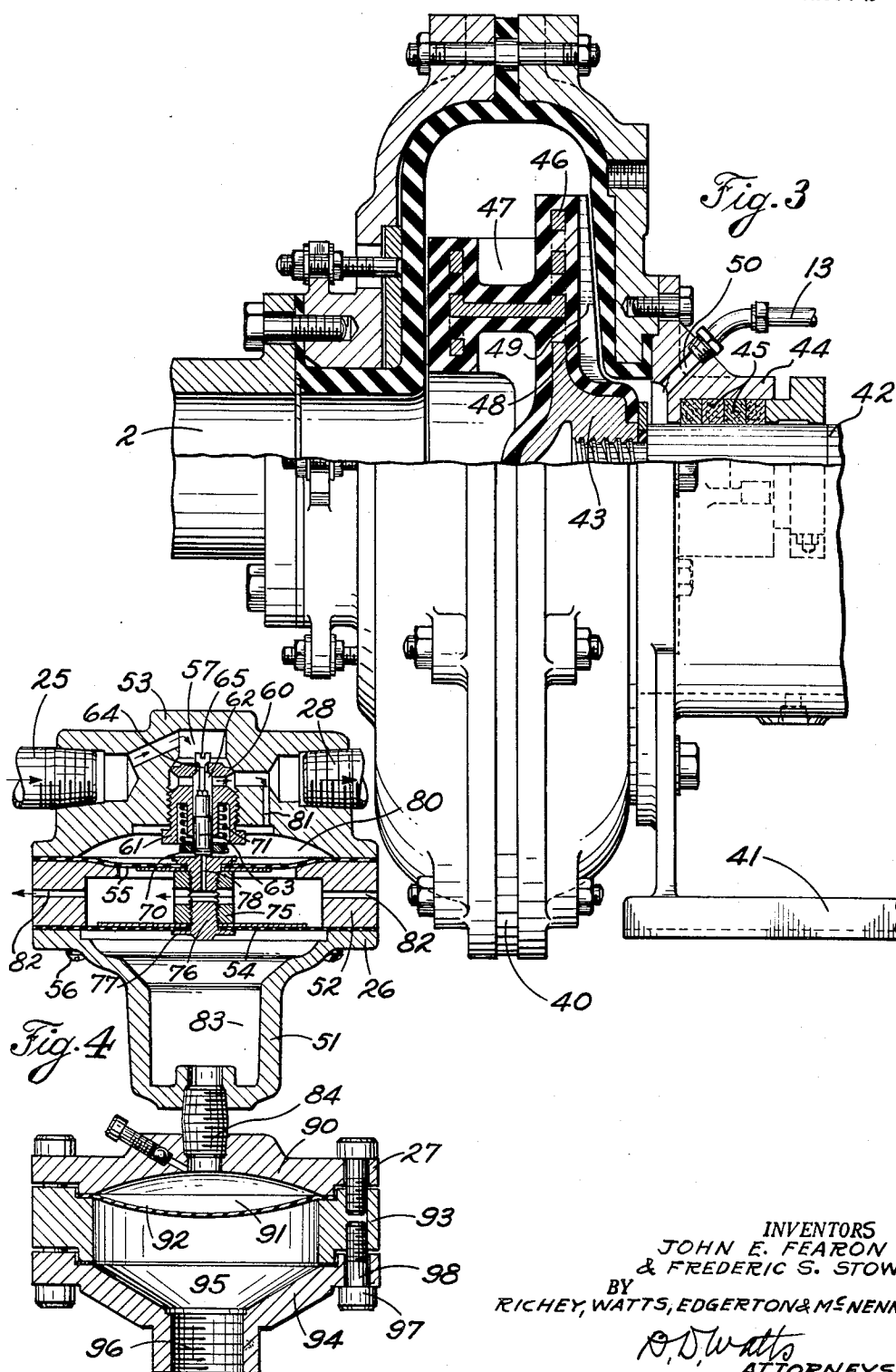
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CENTRISEAL PUMP

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This invention relates to the art of centrifugal pumping and is particularly concerned with a new method of, and apparatus for, protecting the gland seal of a centrifugal pump against the materials being pumped.

Centrifugal pumps customarily have stuffing boxes in the casing around the impeller shaft to prevent materials being pumped from escaping from the pump housing along the impeller shaft. Various expedients have heretofore been resorted to for the purpose of protecting parts of the pump against harmful action of the materials being pumped. One such expedient was to discharge clear water into the pump housing on the shaft side of the impeller shroud. In some instances the effect of this water was supplemented by auxiliary vanes on the shaft side of the shroud and projecting outwardly beyond the outer ends of the main impeller vanes. U.S. Patents Nos. 1,967,182; 1,999,163; 2,003,168; 2,021,346; 2,220,669; 2,232,648; and 2,431,221 show pumps having these protecting means. The function of these auxiliary vanes was to create a liquid pressure in the auxiliary vane chamber which would partially balance the pressure in the main chamber, composed of the pressure developed by the main vanes and the pressure at the suction inlet, and thereby limit the extent of penetration of liquid into the auxiliary vane chamber.

Such pumps have worked satisfactorily in commercial use, but have certain limitations and disadvantages. The practical range of clear water pressures was rather narrow and often the water pressure available, even when supplemented by the auxiliary vanes, was insufficient to prevent penetration of the material being pumped through the auxiliary vane chamber to the stuffing box where abrasives or corrosive substances in the material being pumped could cause damage to the impeller, housing, shaft or packing in the stuffing box. Such damage was frequently encountered when corrosive liquids or heavy, abrasive slurries were being pumped. Moreover it was frequently undesirable to bring water into the housing for these purposes because of its diluting effect on the material being pumped.

Various efforts have been made to solve this problem heretofore, but so far as we are aware none of the proposals which have been made have been entirely satisfactory.

We have discovered that the foregoing disadvantages and shortcomings of the prior art can be avoided and the range of usefulness of centrifugal pumps having auxiliary vanes may be considerably extended by the use of a gas under pressure. When a gas under pressure is delivered into the interior of a centrifugal pump housing near the shaft on the shaft side of the impeller shroud, the diluting effects of the clear water previously used will be avoided, and the stuffing box and adjacent parts of the impeller and housing may be protected throughout a wide range of liquid pressures at the suction intake by varying the pressure of the gas. In this manner the pressure developed by the auxiliary vanes plus the air pressure may be made sufficiently high to prevent the

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liquid being pumped from filling completely the auxiliary vane chamber of the pump and entering and causing damage to the stuffing box and the packing therein.

The present invention takes advantage of those discoveries and aims to provide a method of, and apparatus for, preventing damaging contact with the stuffing box and adjacent parts of a centrifugal pump of materials being pumped by such a pump within wide limits of pressure at the suction inlet and yet to avoid dilution of the material being pumped.

The present invention achieves the foregoing aims by delivering a gas into the auxiliary vane chamber of the pump housing, i.e., near the shaft on the shaft side of the impeller shroud and varying the pressure of that gas in response to variations in the pressure of the liquid at the suction inlet of the pump, thereby maintaining a pressure in the auxiliary vane chamber which will be sufficient to prevent the liquid being pumped from completely filling that chamber and contacting the stuffing box; and by providing apparatus associated with the pump which is responsive to variations in the liquid pressure in the suction inlet for varying the pressure of gas admitted into the auxiliary vane chamber of the pump. Preferably the gas is maintained at a pressure which is equal to, or a little lower than, the pressure of the liquid in the suction intake, and the liquid pressure created by the auxiliary vanes should be such as to permit penetration of liquid being pumped into the outer parts of the auxiliary vane chamber but the combined gas and liquid pressures should prevent penetration of the liquid to the stuffing box.

The present invention will be better understood by those skilled in the art from the following specification and the accompanying drawings, in which:

Fig. 1 is a schematic drawing showing one form of the present invention;

Fig. 2 is a similar drawing of another form of the invention;

Fig. 3 is a side elevational view partly in section of a centrifugal pump such as that shown in Figures 1 and 2; and

Fig. 4 is a side elevational view partly in section of an air ratio relay and gauge protector device of Fig. 2.

In the modification of the present invention shown in Fig. 1 the centrifugal pump 1 has a conduit 2 connecting the suction inlet of the pump with the lower part of a tank 3 which contains the material to be pumped. This material may be a liquid or a slurry containing solids which may be abrasive in character. It will be understood that the surface level of the material in tank 3 may vary throughout substantially the full height of the tank.

A conduit 10 is provided for connection to a source of gas under pressure, for example, air, and this conduit opens into a bubble glass 11 so that the flow of gas through the conduit 10 may be readily observed at all times. A conduit 12 leads from the bubble glass 11 and has two branches. One branch 13 leads through the housing of the stuffing box of pump 1 and into the auxiliary vane chamber, i.e., on the shaft side of the shroud of the impeller. This connection will be better understood by reference to Fig. 3, presently to be described. The other branch conduit 14 extends up over the top edge of tank 3 and down to a point near the bottom thereof or near the level of the suction inlet to the pump housing. A trap 15 positioned at the lower end of the upwardly extending vertical part of conduit 14 serves to collect moisture which may condense in the conduit and this moisture may be withdrawn from the trap by opening valve 16. Valves V may be used to control the flow of air or other gas through conduits 10 and 13. The flow through conduit 10 is indicated by the bubbles

in glass 11. Check valve VCK in conduit 13 may be used to prevent liquid from entering the conduit 12 when the pump is stopped or the gas pressure fails. Valve V in conduit 13 is normally open but is closed when it is necessary to blow an obstruction out of conduit 14 by admitting high pressure air.

The operation of the apparatus of Fig. 1 is substantially as follows:

When the shaft of pump 1 is rotating the impeller, the main vanes of the impeller will draw liquid from tank 3 through pipe 2 into the suction inlet of the pump housing and will discharge it from the periphery of the latter creating a pressure in the shell due to the pressure developed by the vanes plus the pressure at the pump intake.

The auxiliary vanes will develop a balancing pressure in proportion to the distance the liquid is forced back into the auxiliary vane chamber by the shell pressure.

The vanes are proportioned so that the auxiliary vanes will develop a greater pressure than the main vanes, but excessive pressure at the pump intake will cause a shell pressure greater than can be developed by the auxiliary vanes and liquid will fill the auxiliary vane chamber completely and will enter the stuffing box.

The device described above and shown on Fig. 1 uses the air pressure in conduits 12, 13, and 14, to balance the shell pressure to the extent that it is caused by pressure at the pump intake, and in that way, prevents liquid from being forced into the stuffing box.

With the liquid at any level in tank 3, the pressure in conduits 12, 13, and 14, will be equal to the pressure due to the depth of liquid above the end of the conduit 14 so that at all times, the auxiliary vanes must develop a pressure equal to that produced by the main vanes and the liquid will enter the auxiliary vane chamber as far as is necessary to do this. The additional shell pressure is balanced by the gas pressure in the stuffing box.

The embodiment of the present invention shown in Fig. 2 includes a centrifugal pump 1a which may be substantially like that shown in Fig. 1. A source of gas under pressure (not shown) may be connected to conduit 25 which passes through an air ratio relay 26, which is controlled by a gauge protector 27, and then through pipe 28 and check valve 29 and thence into the auxiliary vane chamber of the pump housing, substantially as described above in connection with Fig. 1. The suction inlet pipe 3 may be connected to a tank, such as tank 3 of Fig. 1, but as shown in Fig. 2 is connected to the discharge from another centrifugal pump 1a. If necessary this second pump may likewise be supplied with gas under pressure through a conduit 31 which includes check valve 32 and which may be controlled after the manner shown in Fig. 1 or by means of the apparatus described above and shown in Fig. 2. Valves V (Fig. 1) may be used to control the air or other gas flow through conduits 28 and 31 if the device shown in Fig. 1 is used. In Fig. 2 the flow of gas is controlled automatically by ratio relay 26.

The pumps of Figs. 1 and 2 may be of any conventional construction but preferably are of the construction shown in Fig. 3. In that figure the pump housing 40 is supported by a base 41 which also rotatably supports shaft 42 which extends through the back wall of the housing and has the impeller 43 fixed to its inner end. A stuffing box 44 surrounds the shaft where it extends into the pump housing and packing 45 fills the stuffing box.

The impeller 43, as shown in Fig. 3, comprises a shroud 46, main vanes 47 on one side thereof, and auxiliary vanes 48 on the other, or shaft, side of the shroud. As will be noted, auxiliary vanes 48 have a close running fit with the opposed inner surface housing lining and extend outwardly beyond the outer end of main vanes 47. The suction side of the housing, that is, the one opposite the side through which the shaft extends, is provided

with a suction inlet 2 in substantially axial alignment with the shaft.

The housing on the shaft side of the impeller is provided with a passage 50 with which the conduit carrying gas under pressure, that is, conduit 13 of Fig. 1 or conduit 25 of Fig. 2, may be connected. When the impeller is rotating, the auxiliary vanes 48 will create a liquid pressure in the auxiliary vane chamber which will limit the extent of penetration of liquid into that chamber for certain conditions of pressure at the suction inlet. The extent of such penetration is indicated at 49 on Fig. 3. As the pressure at the suction inlet varies from those certain conditions, the air pressure in the auxiliary chamber is varied automatically to maintain substantially constant the extent of liquid penetration indicated at 49 or to prevent penetration to the stuffing box.

The construction of the air ratio valve 26 and the gauge protector 27 is shown in Fig. 4. The valve 26 comprises a lower hollow body 51, a middle body 52, and a top body 53. Diaphragm 54 is positioned between bodies 51 and 52 and diaphragm 55 is positioned between bodies 52 and 53. These five parts are clamped together by any suitable means, for example, by screws 56.

The top body 53 is connected to conduits 25 and 28 and is provided with a passage 57 connecting these two conduits. A valve 60 is positioned in an enlarged part of the passage 57 and serves to vary the volume of air flow from conduit 25 to conduit 28. This valve 60 comprises a fitting 61 which is threaded into the cylindrical enlargement of passage 57 and is provided with a central opening 62 in which a plug 63 is mounted for axial sliding movement. Plug 63 has an extension 64 of reduced diameter to extend through a hole in fitting 61 of somewhat greater diameter and is provided with an enlarged head 65 which may seat in and close the outer end of said hole. This hole through fitting 61 constitutes part of the passage from conduit 25 to conduit 28. A collar 70 surrounds the lower end of plug 63 and abuts against a shoulder on the latter and a spring 71 seated in a recess in fitting 61 surrounding plug 63 presses the collar against the shoulder. The function of the spring 71 is to urge the plug axially endwise in the fitting and thus to vary the position of the head 65 relative to the hole through fitting 61 and thereby to vary the volume of air or gas flowing through the top part 53.

Between diaphragms 54 and 55 is positioned an interiorly threaded cylinder 75. A plug 76 has a head 77 at one end and a screw-threaded shank which extends through diaphragms 54 and is screwed into cylinder 75 thereby clamping diaphragm 57 between its shoulder and cylinder. A similar plug 78 has a head at one end and a screw-threaded shank which extends through the other diaphragm 55 and is threaded into cylinder 75, thereby clamping diaphragm 55 between its shoulder and cylinder. Cylinder 75 has a transversely extending passage which communicates with an axially extending passage in plug 78. This passage is aligned with plug 63 and its adjacent end is closed by that plug under certain operating conditions. The space 80 between diaphragm 55 and top part 53 is in communication through passage 81 with the part of passage 57 which extends from fitting 61 to outlet conduit 28.

The middle part 52 is provided with passages 82 which connect the chamber in part 52 between diaphragms 54 and 55 with the atmosphere.

Bottom part 51 is provided with a chamber 83 which is in communication with the gauge protector 27 through a connecting nipple 84.

The gauge protector 27 consists of a three-part body and a diaphragm. The upper part 90 has a chamber 91 defined on its lower side by diaphragm 92 and communicating through nipple 84 with the fluid chamber 83 in body 51 of the valve 26. The mid-part of protector 27 is ring 93 which bears against the lower side of diaphragm 92. The bottom part 94 fits against the ring 93 and is

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provided with a chamber 95 and a threaded opening 96 by which the assembly of valve and protector may be attached to a pipe leading to the suction inlet of the pump and by which diaphragm 92 may be subjected to the variations in pressures existing in the suction inlet of the pump. Bolts and nuts 97 and 98 hold parts 90, 92, 93 and 94 in assembled position.

The flexible parts of diaphragms 54, 55 and 92 may be made of any suitable material, for example, sheet metal or synthetic rubber such as neoprene which may be reinforced with nylon or Teflon, and the central, relatively rigid discs are preferably made of metal.

The operation of the air ratio valve 26 and the gauge protector 27 may be briefly described as follows:

As assembled and ready for operation the chamber 83 in the valve is filled with a non-compressible, low-expansion fluid, for example, hydraulic brake fluid. When the suction inlet pressure is high, diaphragm 92 will be moved upwardly with resultant exertion of pressure by the liquid on the lower side of diaphragm 54. As that diaphragm moves upwardly under such pressure, cylinder 75 moves the upper diaphragm 55 upwardly and plug 78 moves plug 63 endwise in fitting 61 and lifts head 65 of plug 63 off its seat. Thereupon air under pressure may flow from conduit 25 through the air ratio valve and out through conduit 28. Since this air pressure is also applied to the upper side of diaphragm 55 by reason of passage 81 which conduits the air into chamber 80, the suction inlet pressure in chamber 95 will be offset by the air pressure in chamber 80. As the suction inlet pressure increases, more air pressure is admitted into chamber 80 to offset the increase in suction inlet pressure. As the suction inlet pressure decreases, the diaphragms 92, 54 and 55 are moved downwardly by air pressure entering chamber 80 and this movement of diaphragm 54 and its plug 78 permits spring 71 to move the head 65 of plug 63 closer to its seat, thereby decreasing the volume of air flowing through fitting 61. When head 65 seats on the fitting and the suction inlet pressure continues to drop, the passage through plug 78 will be opened whereupon air under pressure in chamber 80 may escape through the passages in plug 68, and cylinder 75 and passages 82.

Since the effective areas of diaphragms 54 and 55, i.e., the flexible areas outside of the central rigid reinforcing discs, are approximately equal, a 1 to 1 ratio may be maintained between the pressures in chambers 80 and 95. Hence the air pressure admitted into the auxiliary vane chamber of the pump may vary directly with the variations of the suction inlet pressure from a predetermined pressure.

In this manner the pressure of air admitted through conduit 28 into the auxiliary vane chamber of the pump housing may be varied with variations in the suction inlet pressure and, as a result, the penetration of liquid into the auxiliary vane chamber may be maintained at a point out of contact with the stuffing box and the packing therein, for example, at a position indicated at 49 on Fig. 3.

Having thus described the present invention so that those skilled in the art may be able to understand and practice the same, we state that what we desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. A centrifugal pump comprising a housing having a shaft side and a suction inlet side, a shaft extending through said shaft side, packing around the shaft in said shaft side of the housing, an impeller in the housing on said shaft and having a shroud with main and auxiliary vanes on the inlet and shaft sides thereof, respectively, said impeller and housing partly defining an annular space around the shaft adjacent to the packing, a conduit opening into said space for delivering gas under pressure thereinto to protect said packing, a valve in said conduit, and means for actuating said valve, said means includ-

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ing fluid pressure means in the conduit and connected to the suction inlet and being effective to increase and decrease the gas pressure delivered to the housing in proportion to the increase and decrease, respectively, of the pressure at the intake.

2. A centrifugal pump comprising a housing having a shaft side and a suction inlet side, a shaft extending through said shaft side, packing around the shaft in said shaft side of the housing, an impeller in the housing on said shaft and having a shroud with main and auxiliary vanes on the inlet and shaft sides thereof, respectively, the auxiliary vanes extending beyond the outer ends of the main vanes and having a close-running fit with the opposed part of the housing, said impeller and housing partly defining an annular space around the shaft adjacent to the packing, a conduit opening into said space for delivering gas under pressure thereinto to protect said packing, a valve in said conduit, and means for actuating said valve, said means including fluid pressure means in the conduit and connected to the suction inlet and being effective to increase and decrease the gas pressure delivered to the housing in proportion to the increase and decrease, respectively, of the pressure at the intake.

3. A centrifugal pump comprising a housing having a shaft side and a suction inlet side, a shaft extending through said shaft side, packing around the shaft in said shaft side of the housing, an impeller in the housing on said shaft and having a shroud with main and auxiliary vanes on the inlet and shaft sides thereof, respectively, the auxiliary vanes extending inwardly from beyond the outer ends of the main vanes and having a greater inside diameter than the outer diameter of the said packing and having a close-running fit with the opposed part of the housing, said impeller and housing partly defining an annular space around the shaft adjacent to the packing, a conduit opening into said space for delivering gas under pressure thereinto to protect said packing, a valve in said conduit, and means for actuating said valve, said means including fluid pressure means in the conduit and connected to the suction inlet and being effective to increase and decrease the gas pressure delivered to the housing in proportion to the increase and decrease, respectively, of the pressure at the intake.

4. A centrifugal pump comprising a housing having a shaft side and a suction inlet side, a shaft extending through said shaft side, packing around the shaft in said shaft side of the housing, an impeller in the housing on said shaft and having a shroud with main and auxiliary vanes on the inlet and shaft sides thereof, respectively, said impeller and housing partly defining an annular space around the shaft adjacent to the packing, a main conduit to be connected to a source of gas under pressure, a first branch conduit connected to the main conduit and opening into said space for delivering gas under pressure thereinto to protect said packing, a second branch conduit extending from said main conduit and opening into the liquid to be pumped near said suction inlet, a valve in said first conduit, and means for actuating said valve, said means including fluid pressure means in the main conduit and connected to the suction inlet and being effective to increase and decrease the gas pressure delivered to the housing in proportion to the increase and decrease, respectively, of the pressure at the intake.

5. A centrifugal pump comprising a housing having a shaft side and a suction inlet side, a shaft extending through said shaft side, packing around the shaft in said shaft side of the housing, an impeller in the housing on said shaft and having a shroud with main and auxiliary vanes on the inlet and shaft sides thereof, respectively, said impeller and housing partly defining an annular space around the shaft adjacent to the packing, a conduit opening into said space for delivering gas under pressure to protect said packing, a valve in said conduit, and means for actuating said valve, said means including flexible walls connected together and partly defining a closed

chamber confining a non-compressible, low expansion fluid, one of said walls being exposed to varying pressures in the suction inlet, and the other wall being exposed to gas under pressure in said valve, said means being effective to increase and decrease the gas pressure delivered to the housing in proportion to the increase and decreases, respectively, of the pressure at the intake.

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