

Dec. 9, 1941.

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2,265,834

PUMP LUBRICATION

Filed Dec. 21, 1939

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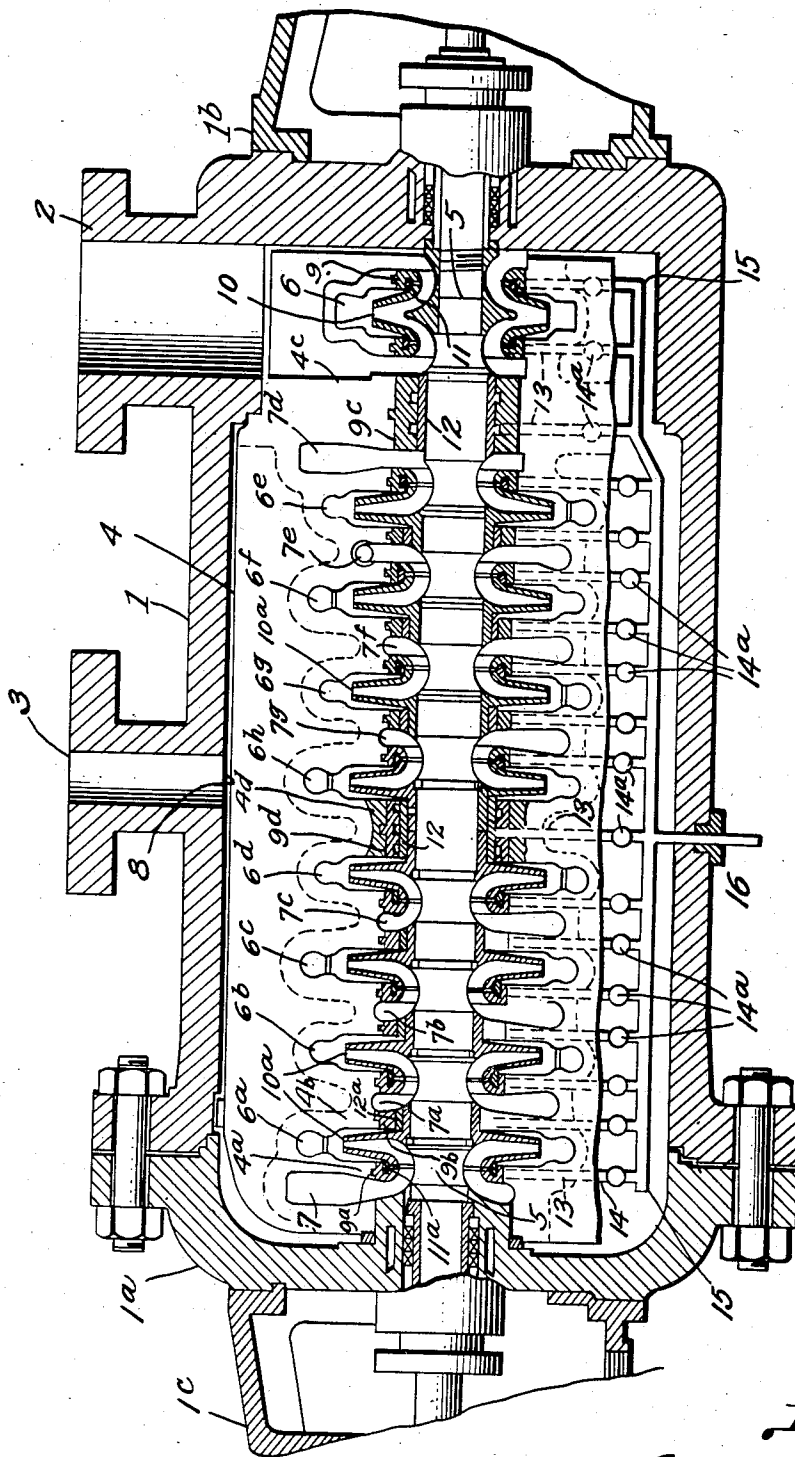


Fig. 1.

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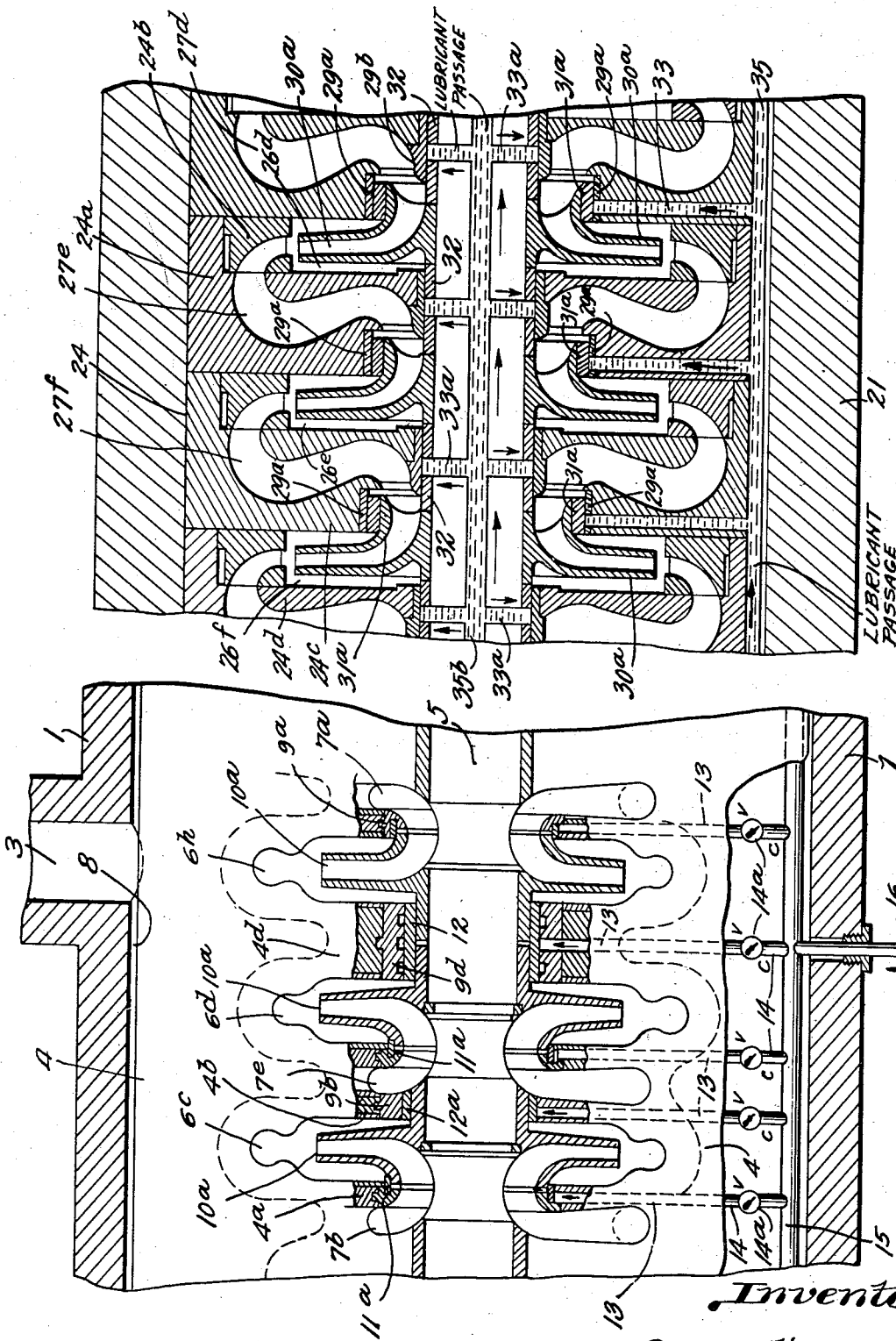


Fig. 2.

Fig. 4.

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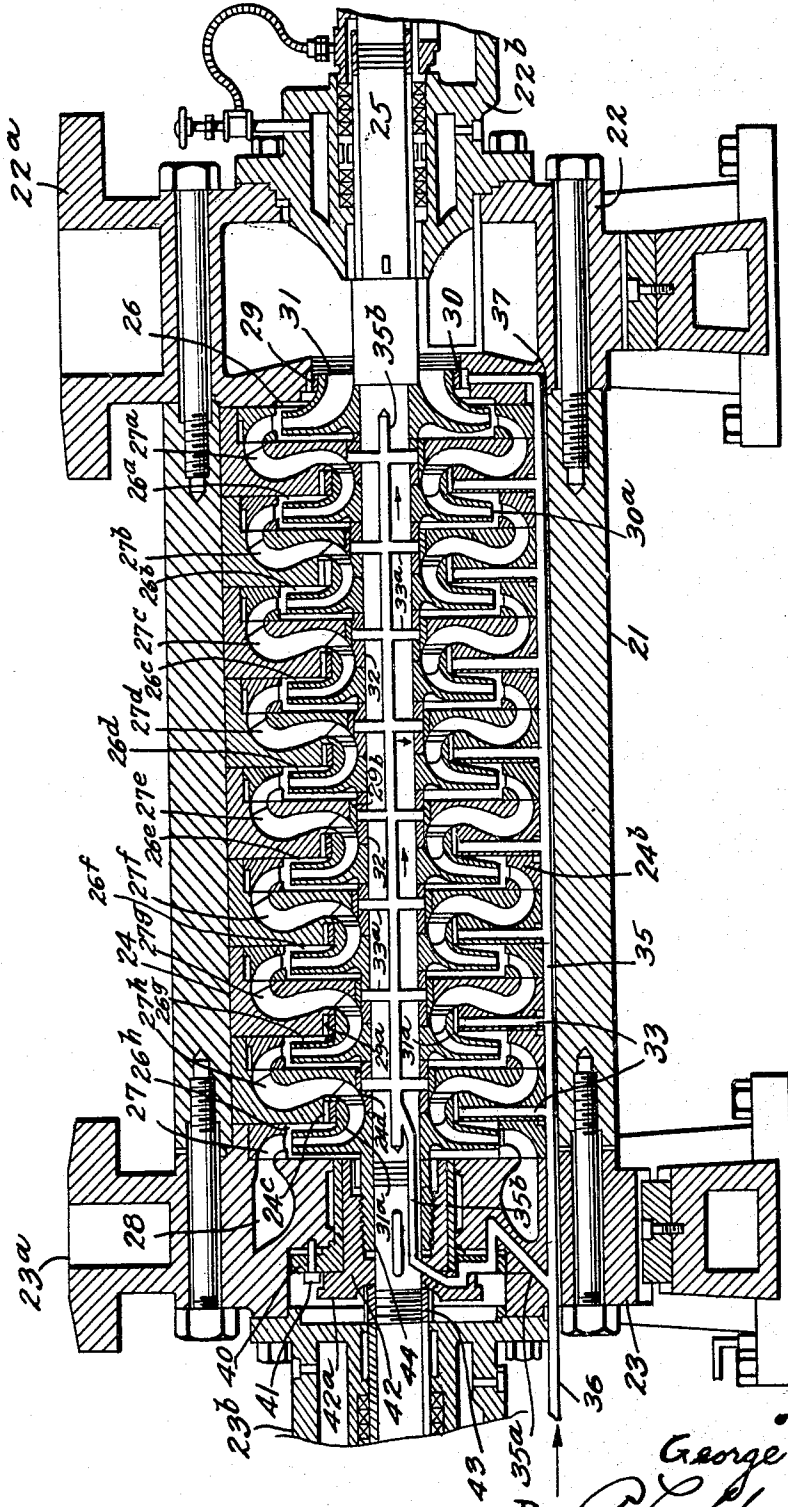


Fig. 3.

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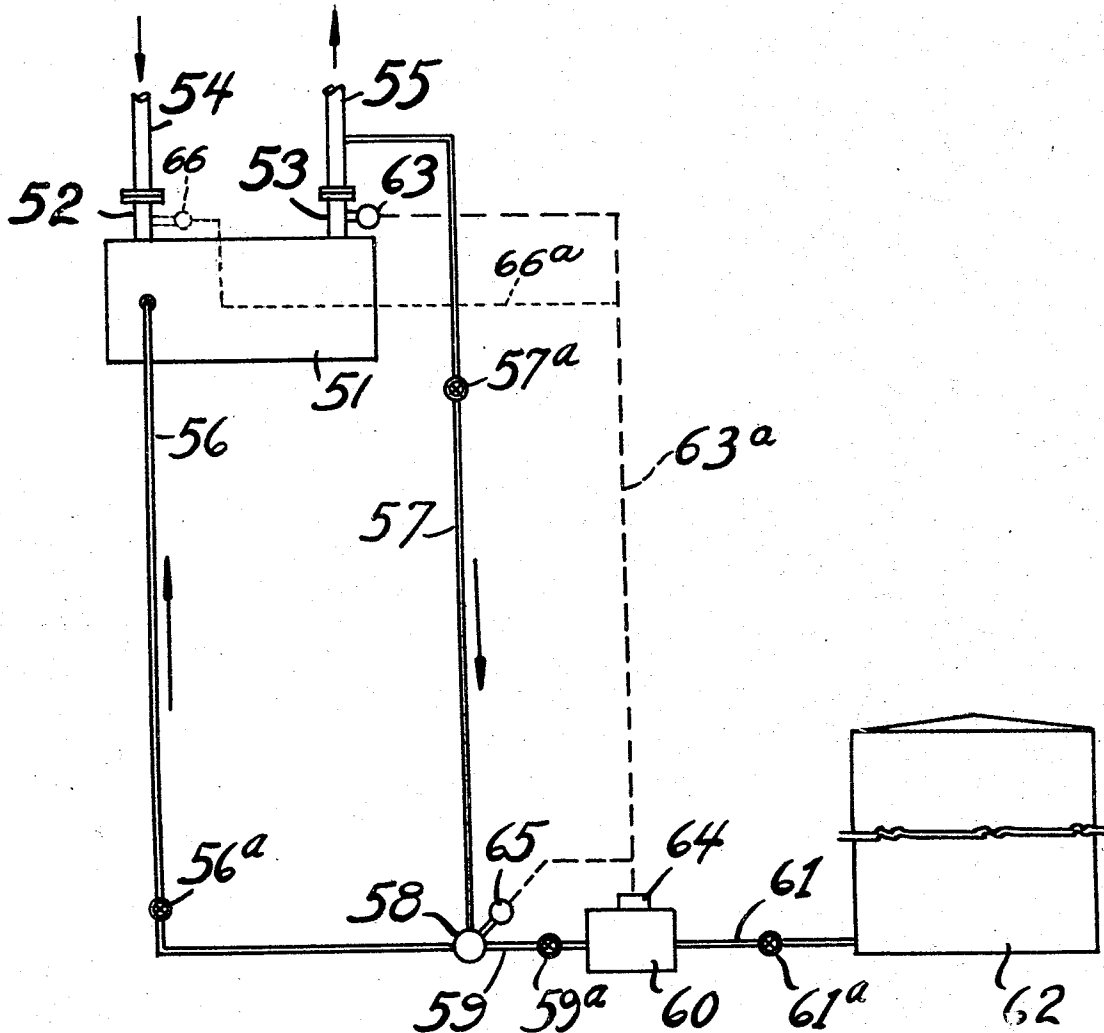


FIG. -5

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UNITED STATES PATENT OFFICE

2,265,834

PUMP LUBRICATION

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Application December 21, 1939, Serial No. 310,269

6 Claims. (Cl. 103-111)

The present invention relates to a method and means for lubricating multi-stage centrifugal pumps. More particularly, it relates to such a method and means adapted to provide positive lubrication for pumps having no internal bearings, or which may be used for the handling of hot or normally gaseous fluids. A specific embodiment of the invention contemplates structure and a mode of operation in which the fluid being pumped may be used to supply the positive lubrication required, or in which lubricant from a separate source alone or in cooperation with the pumped fluid may be utilized.

The conventional multi-stage centrifugal pump is ordinarily designed to utilize the lubrication effect of inter-stage leakage to protect internal wearing surfaces from dangerous frictional contact. This effect, when pumping light fluids, is of the nature of a "floating" or cooling action rather than true lubrication, and while it may be effective so long as suction is maintained in all stages, if suction is lost, there is no residual lubricant film between the wearing surfaces to provide the protection required. With the loss of the floating action of intra-stage and inter-stage leakage, the wearing surfaces rapidly deteriorate and seize under the heat of frictional contact at the high speeds of pump operation. By means of the present invention, a positive floating or lubrication effect is maintained at all times between the principal wearing surfaces, whether or not the pump maintains its suction in the manner intended. The floating effect of intra-stage and inter-stage leakage is complemented or supplemented by a positive supply of fluid forced between the wearing surfaces.

The invention and its objects may be fully understood from the following specification when it is read in conjunction with the accompanying drawings, in which

Fig. 1 is a longitudinal section through one form of multi-stage centrifugal pump;

Fig. 2 is an enlarged sectional view showing two stages of compression in the pump illustrated in Fig. 1 and the elements involved therein;

Fig. 3 is a longitudinal section through another form of multi-stage centrifugal pump of the diffuser type;

Fig. 4 is an enlarged sectional view showing two stages of compression in the pump illustrated in Fig. 3 and the elements involved therein; and

Fig. 5 is a diagrammatic showing of a lubrication system according to the present invention.

Referring to the drawings and particularly to

Figs. 1 and 2, there is shown a multi-stage centrifugal pump in which the principal parts designated are the pump barrel 1, having a suction nozzle 2 and a discharge nozzle 3; a two-part volute impeller casing 4, of which one-half is shown, and an impeller shaft 5. The entire assembly is of generally conventional form and requires only such description as may be necessary to set forth the nature of the present invention as applied thereto.

The pump barrel 1 is of cylindrical shape, having a closed end, and an open end closed by a head portion 1a. The closed end carries a bracket 1b supporting a bearing, not shown, for one end of the shaft 5, while the head portion 1a carries a bracket 1c supporting a bearing, not shown, for the other end of the shaft.

The volute impeller casing 4 is cast or formed with a plurality of chambers 6, 6a, 6b, 6c, 6d, 6e, 6f, 6g, and 6h, connected by the passages 7, 7a, 7b, 7c, 7d, 7e, 7f and 7g. Fluid flow through the respective chambers and passages is accomplished, in operation, from chamber 6 through a connecting line, not shown, and passage 7 to chamber 6a. Thence flow continues through passage 7a to chamber 6b, and so on to chamber 6d. From chamber 6d flow continues through a connecting line, not shown, and passage 7d to chamber 6e. Thence flow continues through passage 7e to chamber 6f and so on to chamber 6h. In each chamber the pressure upon the fluid, which enters originally by way of the suction nozzle 2 and chamber 6, is raised above that of the preceding chamber, and the fluid under its maximum pump pressure is discharged from chamber 6h into the substantially annular space 8 between the volute impeller casing and the pump barrel, whence it discharges through the nozzle 3.

As arranged, the chambers and passages are disposed in series, the chambers 6a to 6d inclusive, comprising the first series providing the second to fifth stages of compression. The chambers 6e to 6h inclusive, comprise the second series providing the sixth to ninth stages of compression. Each chamber and passage, within a series group, is spaced from another by means of the rib portions 4a between a passage and a chamber, and the rib portions 4b between a chamber and a passage. The chamber 6 is spaced from the passage 7d by an enlarged rib portion 4c, while the two series groups are spaced by a rib portion 4d between the chambers 6d and 6h. Provision is made in each of the rib portions 4a for receiving a case wear-ring 8a,

and in each of the rib portions 4b, provision is made to receive a stage piece 9b. Likewise, the rib portions 4c and 4d are provided to receive stage pieces 9c and 9d respectively. In addition, the chamber 6 is formed with shouldered portions adapted to receive case wear-rings 9. These case wear-rings and stage pieces mentioned, along with other shaft elements, are suitably assembled on the shaft before enclosure in the volute casing halves.

The other elements, assembled on the shaft with case wear-rings 9 and 9a, and stage pieces 9b to 9d inclusive, include an impeller 10 for the first stage chamber 6, and impellers 10a for the second to ninth stage chambers inclusive. Impeller wear-rings 11 are disposed between the impeller 10 and case wear-rings 9, and impeller wear-rings 11a between the impellers 10a and case wear-rings 9a. Series stage wear-rings 12 are disposed between the shaft 5 and series stage pieces 9c and 9d, while stage wear-rings 12a are disposed between stage pieces 9b and the impellers 10a.

In the conventional structure thus far set forth, frictional contact may be made between case wear-rings 9 and 9a and impeller wear-rings 11 and 11a, between stage pieces 9b and stage wear-rings 12a, and also between series stage pieces 9c and 9d, and series stage wear-rings 12. These points of possible friction in the conventional structure are intended to be lubricated by intra-stage and inter-stage circulation or leakage. Such lubrication, however, is only effective when suction is maintained throughout the system. When suction is lost in any stage, the lubrication or floating and cooling effects of the pumped fluid often fail to prevent over-heating and seizure of the parts in frictional contact. Also, when working with certain types of materials it may be desirable to supplement the lubrication effect of the pumped fluid by a lubricant supplied under positive pressure from outside the pump.

To the structure illustrated in Figs. 1 and 2, it is now proposed to add a positive lubrication system. The system specifically shown is composed of a series of passages 13 drilled in the volute case 4 through rib portions 4a to 4d inclusive, communicating by way of extensions thereof through the respective case wear-rings, and stage pieces. At the inner end of the impeller casing, the passages extend through the walls of the chamber 6 and case wear-rings 9. In each passage 13 or the connecting feed pipes 14, it is desirable to have a check valve 14a to prevent inter-stage pressure loss. These passages are extended by means of the feed pipes 14 to an inter-connecting distributing line 15 which in turn is supplied by means of the feed line 16. The lubricant material supplied through these lines may be drawn from the discharge line of the pump under pump pressure, or may be derived from a separate source as required.

Another conventional form of multi-stage centrifugal pump is illustrated in Figs. 3 and 4, in which the principal parts are designated as pump barrel 21, supporting heads 22 and 23, in which are included the suction nozzle 22a and discharge nozzle 23a respectively; and impeller casing 24 made up of channel rings 24a and diffuser rings 24b, and an impeller shaft 25.

The head 22 carries a bracket 22b supporting a bearing, not shown, for one end of the shaft 25, while the head 23 carries a bracket 22b supporting a bearing for the other end of the shaft.

The impeller casing 24, as formed by the channel rings 24a and diffuser rings 24b, fits in the pump barrel in substantially fluid-tight relation to the barrel and to each other, and forms a plurality of chambers 26a, 26b, 26c, 26d, 26e, 26f, 26g, and 26h, and a plurality of passages 27a, 27b, 27c, 27d, 27e, 27f, 27g, and 27h. A chamber 26 is formed at the suction end of the pump between the innermost channel and diffuser rings and the head 22, while the outermost diffuser ring provides a passage 27 communicating with an annular space 28 in the head 23, opening through the discharge nozzle 23a. Fluid flow progresses in stages through the series of chambers and passages from one end of the pump to the other, the fluid pressure being raised from one stage to another.

The conformation of the channel rings 24a is such as to provide a plurality of stepwise rib portions 24c and 24d. The rib portions 24c are adapted to receive case wear-rings 29a, while the rib portions 24d receive stage pieces or channel ring bushings 29b. A head wear-ring 29 is provided in inner shaft opening in head 22.

The shaft 25 carries on that portion disposed within the barrel a series of impellers 30 and 30a. The impeller 30 providing for the first stage of compression, communicates with the interior of head 22 and discharges into chamber 26. The remaining impellers provide for the successive stage of compression, with the ninth or outermost impeller discharging into chamber 26h and outward therefrom through the passage 27. The impellers 30 and 30a may be in frictional contact with the head wear-ring 29 and case wear-rings 29a respectively, through impeller wear-rings 31 and 31a. The proper spacing of the impellers 30 and 30a on shaft 25 is accomplished by means of the sleeve members 32 with which the stage pieces or channel ring bushings 29b may be in frictional contact.

As in the form of multi-stage pump illustrated by Figs. 1 and 2, the effect of friction between rotating and fixed parts in contact is intended to be alleviated in the pump illustrated by Figs. 3 and 4, by means of intra-stage circulation or inter-stage leakage. In this form of apparatus, the lubricating or floating effect is no more efficient on loss of suction and it is proposed to add a positive lubrication system thereto.

In the structure shown by Figs. 3 and 4, excess pressure on the packing at the discharge end of the pump and excessive axial hydraulic thrust is prevented by a generally conventional arrangement. Bushing 40 is secured in substantially fluid-tight relation to the head 23 by means of bolts 41. The balancing drum 42 having a flanged head portion 42 is held in substantially fluid-tight relation to the shaft 25 by means of lock nut 43 and the tapered sleeve 44. The balancing drum 42 rotates in the sleeve 40 with extremely close clearance, leakage therebetween being returned to the suction end of the pump by means not shown.

In order to provide positive lubrication of the inner pump parts which are in frictional contact as set forth above, a system, similar in concept to that shown in Figs. 1 and 2, is applied. The system specifically shown, is composed of a series of passages 33 drilled through the rib portions 24c communicating, by way of extensions thereof, through the respective case wear-rings 29a and with a distributing line or drilled passage 35, which in turn is supplied by the feed line 36. Due to the construction of the pump

shown, however, it is not possible to lubricate the points of contact between channel ring bushings 29b and the sleeve members 32 by means of similar passages through the rib portions 24d. Therefore, a supplemental or branch distributing passage 35a is provided, which is extended in any convenient fashion to the shaft 25. As shown, it extends through the head 23 and balancing drum bushing to an opening and channeled way in the bushing, and balancing drum flange 42a. Thence through the flange as shown, to a channeled passage 35b extending along the shaft 25. As shown, this passage 35b, for the greater portion of its length, is formed by undercutting the longitudinal shaft keyway by which the impellers and sleeves are keyed to the shaft for rotation therewith. From the distributing passage 35b, passages 33a are drilled in the shaft 25 and through sleeves 32 whereby the contact between sleeves 32 and channel ring bushings 29b may be lubricated. Contact between the head wear-ring 29 and impeller wear-ring 31 is lubricated by means of an angular passage 37 drilled in the inner portion of head 22, and communicating with the distributing passage 33 extending through the impeller casing 24.

Fig. 5 provides diagrammatic illustration of a lubrication system according to the invention. As shown, the system is composed of a multi-stage centrifugal pump 51 having suction and discharge nozzles 52 and 53, connected respectively to a feed line 54 and a discharge line 55, the pump 51 being provided with internal lubrication distributing lines and passages in the manner shown in Figs. 1 to 4 inclusive. Connected to the internal lines and passages a feed line 56 extends outwardly from the pump 51 toward a source of supply, such as bleed-off line 57 from the discharge line 55. Preferably the lines 56 and 57 are connected through a multi-pass valve 58 which is also connected by line 59 through pump 60 and line 61, with a separate supply source for lubricant material, such as tank 62. Valves 56a, 57a, 59a and 61a may be provided in the respective lines.

In the preferred form, with valves 56a, 57a, 59a and 61a open, and the multi-pass valve 58 affording communication between lines 56 and 57, a small amount of the fluid being handled by pump 51 will be circulated by way of lines 57 and 56, through the inner lubricant lines and passages to prevent seizure of the bearings. By any desired means, the loss of suction within the pump may be indicated, and by resetting the valve 58 so that lines 56 and 59 are in communication, to the exclusion of line 57, a lubricant from the supply tank 62 may be pumped to the various frictional contact surfaces within the pump, and which may require lubrication. When normal operation of the pump has been restored, the setting of the valve 58 may be changed so that the flow of the material being handled may be again circulated and will flush from the lines and bearings surfaces all traces of the auxiliary lubricant. In hot oil service, this action prevents coking and plugging of the internal lubrication lines and passages.

It is also preferable that operation of the system be subject to automatic control, and for that purpose, controls as shown may be provided. A flow meter 63 or another suitable device may be disposed in the discharge line 55, and by electric connection, as indicated at 63a, with a pump control mechanism 64 on pump 60 and a valve

control mechanism 65 on valve 58, the meter may be made to actuate the pump and valve so as to maintain lubrication of the pump in the manner set forth above.

It is contemplated that automatic operation of the lubrication system may be accomplished also by means of a flow meter or similar device disposed in the suction or feed line 54. Such an arrangement is indicated, the flow meter device being designated by the numeral 66, electrically connected to the line 63a by a line 66a. Furthermore, in certain services, such as in the pumping of light or normally gaseous materials, it may be found desirable to use the external source of lubricant to the exclusion of the recirculation of a portion of the pump discharge.

Obviously, these and other changes may be made in the system as set forth without departing from the inventive concept. Therefore, it is not intended that the invention shall be considered as limited by any disclosure of the specification or drawings which have been made for the express purpose of illustration. It is intended that the scope of this invention shall be limited only by the appended claims.

I claim:

1. In combination with a multi-stage centrifugal pump, a lubrication system comprising a plurality of conduits in said pump opening to the inter-stage and intra-stage wearing surfaces between rotating and non-rotating elements of said pump, a conduit system for a liquid lubricating material, communicating with said inner conduits, means for delivering said material to the system under positive pressure, and a means for controlling the supply of said material to the system, according to the flow of fluid through said pump.

2. A system according to claim 1 in which the means for controlling the supply of said material to the system is a fluid meter in the discharge line of the pump adapted to activate the means for delivering said material to the system.

3. A system according to claim 1 in which the means for controlling the supply of said material to the system is a fluid meter in the suction line of the pump, adapted to actuate the means for delivering said material to the system.

4. In combination with a multi-stage centrifugal pump, a lubrication system comprising a plurality of conduits in said pump opening to the inter-stage and intra-stage wearing surfaces between rotating and non-rotating elements of said pump, a reservoir for a liquid lubricant disposed externally of said pump, connecting conduit means communicating with said inner conduits and the reservoir, means for supplying said liquid material to the inner conduits under positive pressure, and an activator for said means actuated by the flow of liquid through said pump.

5. In combination with a multi-stage centrifugal pump, a lubrication system comprising a plurality of conduits in said pump, opening to the inter-stage and intra-stage wearing surfaces between rotating and non-rotating elements of said pump, a reservoir for a liquid lubricant disposed externally of said pump, connecting conduit means communicating with said inner conduits and the reservoir, means for supplying said liquid material to the connecting means under positive pressure, a connection between the discharge of said pump and said connecting conduit means for flushing said inner conduits, and a control for said pressure and flushing means

individually activated by the flow of liquid through said pump.

6. In combination with a multi-stage centrifugal pump, a lubrication system comprising a plurality of conduits within the pump opening to the inter-stage and intra-stage wearing surfaces between rotating and non-rotating elements of said pump, connecting conduit means communicating with said inner conduits and the discharge

line of the pump, a conduit system communicating with said connecting conduit means and a reservoir for a liquid lubricant, pressure means in said system, a multi-pass valve between said system and the conduit means, meter means measuring the flow of fluid through said pump, and valve actuating means activated through said meter.

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