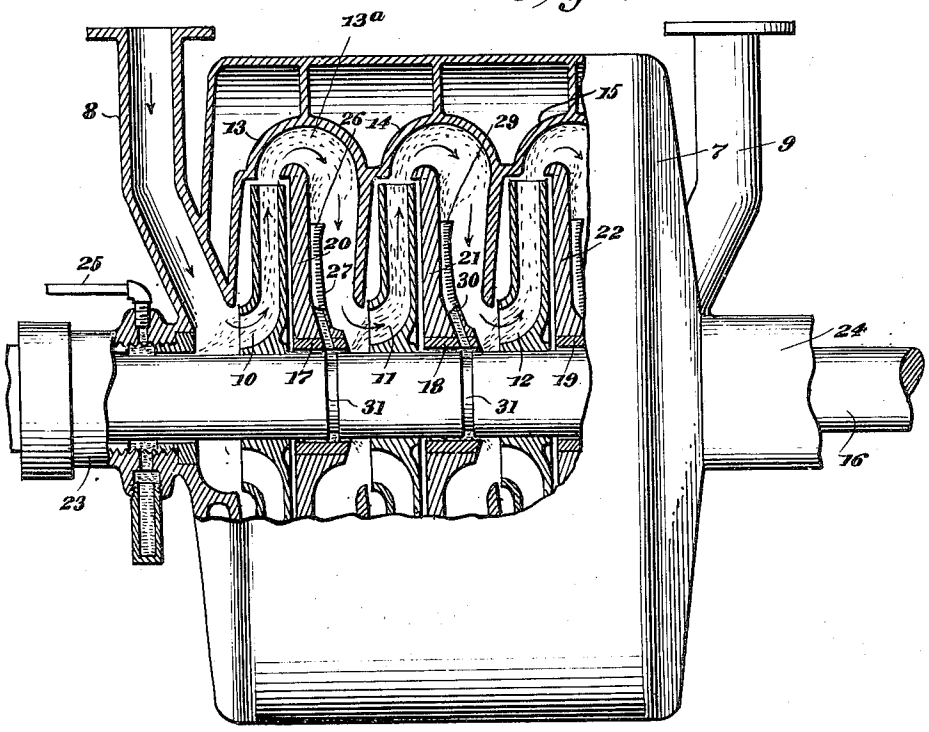
Oct. 26, 1943. J. S. SWEARINGEN 2,332,614

MEANS FOR LUBRICATING INTERNAL BEARINGS IN CENTRIFUGAL GAS PUMPS

Filed Jan. 30, 1939 2 Sheets-Sheet 1

Fig. 1.



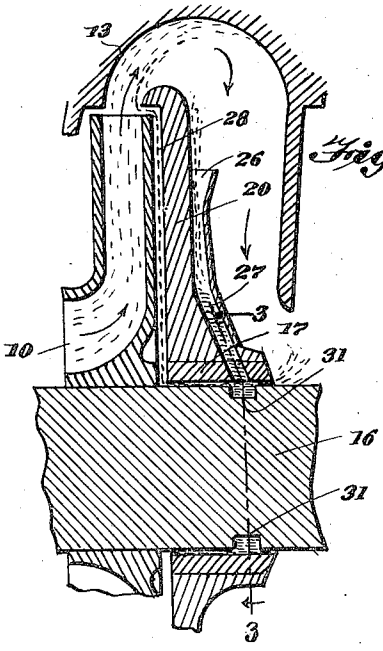


Fig. 2.

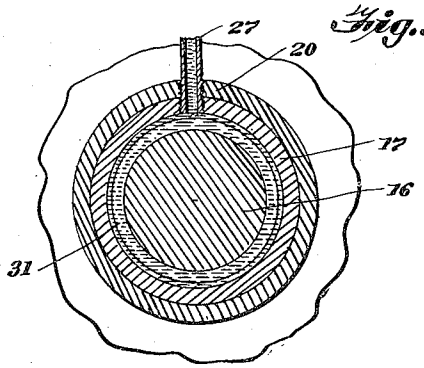


Fig. 3.

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By E. F. Salter

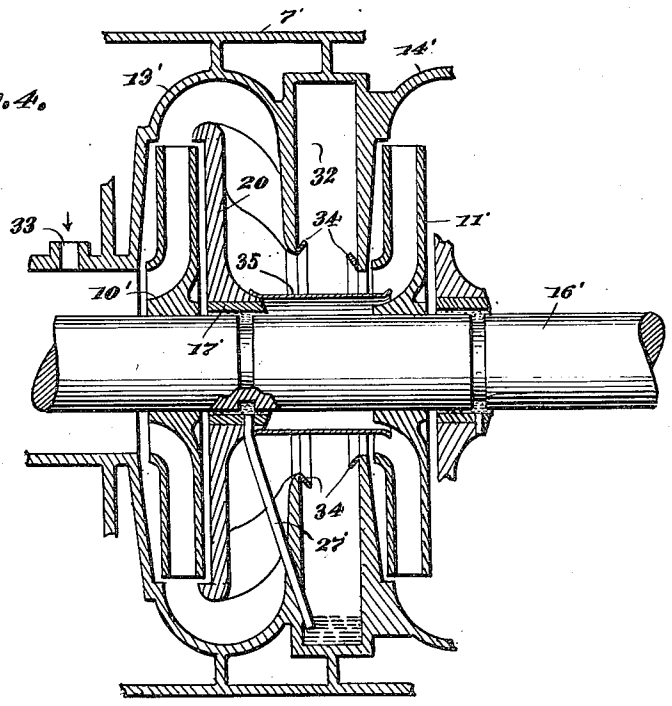
Attorney

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MEANS FOR LUBRICATING INTERNAL BEARINGS IN CENTRIFUGAL GAS PUMPS

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Fig. 4.



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2,332,614

MEANS FOR LUBRICATING INTERNAL BEARINGS IN CENTRIFUGAL GAS PUMPS

Judson S. Swearingen, San Antonio, Tex.

Application January 30, 1939, Serial No. 253,694

7 Claims. (Cl. 230—207)

This invention relates to the art of fluid compressors of the high speed, multi-stage centrifugal type, and deals particularly with a means for supplying adequate lubrication to the impeller shaft bearings disposed internally of the compressor casing.

The present disclosure pertains to that class of such devices known as multi-stage centrifugal gas pumps or blowers. As is well known to those versed in the art, the problem of lubricating the impeller shaft bearings between the successive stages is a serious one for the pressure within the pump increases by increments of from about 30 to about 125 pounds per square inch at the various stages in succession from inlet to outlet. Prior art practice has sought to solve the problem by employing either an individual lubricant pump supplying direct to each bearing or a lubricant pump common to all, in which latter case additional means must be utilized to throttle the pressure on the lubricant supply to all bearings but the one disposed at the zone of highest gas pressure within the pump. In either case the necessary accessories and system arrangements are troublesome and expensive, and the pump efficiency suffers considerably from the inevitable excessive entrainment of lubricant in the gas stream.

The present invention is designed to eliminate these difficulties attendant upon the prior practice, and to that end has as a primary object the provision of means self-contained within the pump stages for automatically distributing an adequate supply of lubricant to the various bearings.

Another object is to provide a novel means for lubricating the internal bearings of multi-stage centrifugal gas pumps and the like by making use of pressure differences at various points within the pump as a means of feeding lubricant or a sealing or cooling medium to the bearings.

A further object is to provide in pumps of the character described and in like apparatus, means for mechanically separating oil from the pump gas stream in which it is entrained and delivering such oil in adequate quantity to the various bearings.

Other objects will become apparent to those skilled in the art. While the instant disclosure constitutes an embodiment of the best means I have thus far devised for reducing the invention to practice, it is to be understood that within the scope of the invention as claimed any desired variations and substitutions may be made in structural detail and arrangement of parts.

In the accompanying drawings, wherein like characters of reference designate like parts throughout the several views—

Figure 1 is an axial section, partly in elevation, of a multi-stage centrifugal gas pump equipped with my invention.

Figure 2 is an enlarged fragmentary section through the mechanism at one of the pump stages.

Figure 3 is a section taken on the line 3—3 of Figure 2.

Figure 4 is a fragmentary axial section, partly in elevation, of the mechanism at one of the stages in an alternative embodiment of pump structure.

The pump illustrated in Figures 1 and 2 is of the general form and construction of the pump shown in my copending application Serial No. 253,693, filed January 30, 1939, entitled Lubricating seal. That is, it embodies a casing 7 provided at its low pressure end with a gas inlet 8 and at its high pressure end with an outlet 9. The successive stages are defined by the respective impellers 10, 11 and 12 which discharge radially into their respective volutes or diffusors 13, 14 and 15. The impellers are fixed to the axially extending impeller shaft 16 for rotation therewith, which shaft passes entirely through the pump in bearing bushings 17, 18 and 19 mounted axially in the fixed partition walls 20, 21 and 22 respectively. These walls divide the stages in the conventional manner of such pumps. The inner end of the inlet conduit 8 opens in communication with the eye of the first stage impeller 10 and the discharge from the return passage from the first volute 13 opens to the eye of the second stage impeller 11, and so on throughout the longitudinal extent of the pump, the final stage discharge being to the outlet conduit 9. At each end of the pump casing the shaft 16 projects through the end wall, being journalled in end bearings 23 and 24.

A supply of lubricant, preferably a light lubricating oil, is continuously fed into the incoming gas stream and is entrained therein. The lubricant may be introduced at any point in the inlet conduit 8 or prior thereto but in the embodiment herein disclosed it is introduced axially along the shaft 16 through the inner end of the bearing 23 and mingles with the gas stream just in advance of the eye of the first stage impeller 10. The lubricant is fed to the bearing through a supply line 25 under a pressure slightly greater than the pressure within the pump in the inlet conduit. As more particularly described in my

aforesaid copending application, the shaft 16 has an appreciable radial clearance in all bearings, the clearance being sufficient to insure full film lubrication. By virtue of such clearance and its higher pressure the lubricant is forced from the bearing into the incoming gas stream in the pump.

As the gas and entrained lubricant emerge from the impeller the droplets of lubricant due to their greater density are thrown radially outward by centrifugal force and collect as a film on the outer wall of the first stage volute 13, or on the outer walls of the curved return passage acting as the nozzle or diffusor. Due to the high velocity of the gas in the volute the film of oil is caused to travel along the walls of the volute in the direction of gas flow, but of course at a much slower rate. The diffusor nozzle and return passage are represented as a continuous passage by 13a, the diffusor nozzle being continuous with the volute and the return passage being continuous with the diffusor nozzle. This whole continuous passage follows an essentially circumferential path. Due to the curvature of the path of the gas subsequent to emerging from the first stage impeller, an approximate free vortex exists in the body of the gas. This creates a higher pressure near the outer wall and lower pressure near the inner wall of the passage. Because of its viscosity the oil film is moved relatively slowly along the surface of this curved passage and its own centrifugal force is usually not great enough to keep its path along the outer wall. Accordingly it is forced by the above explained pressure difference due to the free vortex to flow around to the inner surface.

One or more walls of the return passage from the volute is provided with lubricant collector means, here shown as a trough 26 interposed in the path of travel of the lubricant as indicated by the dotted lines in Figures 1 and 2. A portion of the lubricant is caught in the collector 26 and from there is fed through a conduit 27 into the first stage bearing 17 adjacent the inner end of the bearing. In its travel through the conduit 27, of which there may be more than one, movement of the lubricant is rendered positive by virtue of the difference in pressure in the passage between the bends and that portion of the return passage immediately in advance of the eye of the second impeller 11, at which latter point the exposed end of the bearing 17 is located. Actually the difference amounts to two pounds or more per square inch as the increase in velocity of the pump gas when sucked into the eye of the impeller lowers its pressure at that point. This pressure differential between the trough 26 and the delivery end of the conduit 27 insures that the oil collected in the conduit will be moved under a positive force to the point of lowest pressure, which is, of course, the bearing. Due to this two pound pressure difference a small amount of oil will leak out of the aforementioned exposed end of the bearing near the second stage impeller instead of gas leaking into the bearing at that point.

Movement of the oil is enhanced by a further reduction in pressure between the ends of the bearing. Since the pressure prevailing in the space 28 between the back of the impeller 10 and the wall 20 is much lower than any other that directly communicates with the bearing, the greater part of the oil required by the bearing flows into this space whence it is picked up by the rotating impeller and under the action of centrifugal force is again thrown into the gas stream as it emerges from the impeller from which point it is again passed through the volute 13 and subsequent passages as entrained lubricant.

The entrained lubricant not picked up in the collector 26 together with lubricant that leaks back into the gas stream from the right end of the bearing passes with the gas into the second stage impeller 11 whose volute 14 is equipped with a collector 29 identical to the first stage collector 26, and which delivers lubricant through its conduit 30 to the second stage bearing 18. All pressures existing in the second stage are uniformly increased over those of the first stage and the lubricant distribution therefore is the same as in the first stage except that it is at an increased pressure.

The same arrangement of wall carried lubricant collector means and delivery conduit to the associated bearing holds for every subsequent stage of the pump, the operation of distribution being the same in each except that, as above stated, it is accomplished at higher pressures in the successive stages.

The impeller shaft 16 is provided with an annular lubricant reservoir groove 31 in registry with the delivery end of each lubricant conduit, which insures that a sufficient body of lubricant shall be retained at all times within the bearing to effect a liquid seal which prevents leakage of the gas axially back along the shaft from the higher pressure stages to the lower. This is in contrast to the alternative of cutting the groove in the bushing. In this latter case centrifugal force due to the rotating shaft would tend to carry the oil away from the bearing.

In the alternative embodiment illustrated in Figure 4 the pump casing 7' between successive stages, as between volutes 13' and 14' is formed with an annular lubricant collector chamber 32 in lieu of collector means on the walls as in the preceding embodiment. Lubricant is supplied through an inlet 33 to mingle with the incoming pump gas delivered at the eye of the impeller 10'. The gas with its entrained lubricant issues from the impeller, collects on the walls of the volute, diffusor nozzles and return passages as explained in the foregoing embodiments and by virtue of the free vortices existing in the curved passages is carried along the shortest path unless obstructions are encountered. To eliminate the obstructions the passages are twisted in a manner necessary to keep the same wall on the continuous shortest path for the oil and to have it terminate so that the stream of oil does not have to traverse the swift gas current. The gas with some remaining entrained lubricant issues from the discharge end of the return passage from the volute 13' and passes in a swirling mass across the mouth of the chamber 32 into which droplets of the entrained lubricant are expelled by centrifugal force. Troughs or lips 34 are provided on the walls of the chamber 32 at its mouth to trap lubricant and prevent its being returned into the gas stream. The lubricant collects at the low points of the chamber and as the pressure within the chamber is higher than the pressure existing at the clearance in the bearing 17' the liquid lubricant will be forced up through the delivery conduit 27' which leads from the bottom of the chamber 32 to the bearing 17'. The reduction in pressure existing at the bearing 17' may be enhanced by providing a sleeve 35 secured at one end to the hub of the wall 20'

over the inner end of the bearing and extending concentric with the impeller shaft 16' into the eye of the next succeeding impeller 11', the sleeve being open at this end. As the pressure in the eye 11' is at least two pounds lower than the pressure in the return passage from the volute 13' and chamber 32 this reduction will be evidenced within the confines of the sleeve and will be effective at the bearing.

In the herein contained illustrations the supply of lubricant has been introduced into the incoming stream of gas. If the gas already contains a usable lubricant such as oil or water, obviously this introduction of lubricant will not be necessary.

The term "lubricant" as used herein is intended to cover any liquid lubricating, cooling or sealing medium, and the term "gas pump" to cover any equivalent apparatus.

I claim:

1. An internal bearing lubricating system for centrifugal gas pumps and the like, comprising in combination with a pump having an inlet, an outlet, a rotatable impeller, a bearing therefor, and a volute or diffusor and a gas passage with which the impeller is associated; means entraining a supply of lubricant with the pump gas in the inlet, means on a wall of the passage for collecting lubricant deposited by action of centrifugal force, and a lubricant conduit between said collecting means and the bearing, the pump gas pressure being higher adjacent the collecting means than at the bearing whereby the collected lubricant is forced through the conduit to the bearing.

2. In a centrifugal gas pump or the like having an inlet, an outlet, a driven impeller shaft, impeller means on the shaft and rotatable therewith, an internal bearing for the shaft, and volute and return passage means associated with the impeller means between the inlet and outlet; means for introducing in the inlet a supply of liquid to be transmitted to the bearing whereby the liquid is entrained in the pump gas, said entrained liquid being deposited on the passage walls by the action of centrifugal force as the pump is operated, at least one wall having thereon means for collecting the deposited liquid, and a conduit connecting said collecting means and the bearing and establishing open communication therebetween to convey collected liquid to the bearing.

3. In a centrifugal gas pump or the like having an inlet, an outlet, a driven impeller shaft, impeller means on the shaft and rotatable therewith, volute and return passage means associated with the impeller means between said inlet and outlet, and bearings for the shaft internally of the pump; means for introducing into the inlet a supply of liquid for entrainment in the pump gas, said entrained liquid being in part separated from the gas stream by centrifugal force as the pump is operated, means internally of the pump for collecting the separated liquid, and means also internally of the pump for conveying the collected liquid to the bearings.

4. In a centrifugal gas pump or the like having an inlet, an outlet, a driven impeller shaft, bearings therefor internally of the pump, a plurality of impellers spaced axially on said shaft and rotatable therewith, and volutes or diffusers and return passages associated with the impellers between the inlet and outlet; means for introducing into the inlet a supply of liquid for entrainment in the pump gas, the walls of said passages receiving liquid deposited thereon by centrifugal force as the pump is operated, and means internally of the pump for conveying the deposited liquid to the bearings without further entrainment in the pump gas.

5. In a centrifugal gas pump or the like having an inlet, an outlet, a driven impeller shaft, bearings therefor internally of the pump, impeller means on the shaft and rotatable therewith, and volute and return passage means associated with the impeller means between the inlet and outlet; means for introducing into the pump gas stream a supply of liquid for entrainment therewith, means internally of the pump for collecting liquid separated from the gas stream by centrifugal force as the pump is operated, and means also internally of the pump for conveying the separated liquid to the bearings without further entrainment in the pump gas.

6. In a multi-stage centrifugal gas pump or the like having an inlet, an outlet, a driven impeller shaft, a plurality of impellers spaced axially on the shaft and rotatable therewith, a shaft bearing closely adjacent each impeller, and a volute and return passage associated with each impeller between the inlet and outlet; means for introducing into the pump gas stream a supply of liquid to be transmitted to the bearings, the pump gas pressure being, in each stage, lower in the circumferential zone of its associated bearing than at any other point therein, means between the stages for collecting liquid separated from the gas stream by action of centrifugal force, a conduit between each collecting means and the bearing immediately preceding, the difference in gas pressure between the point of liquid collection and the bearing effecting delivery of liquid through the conduit to the bearing, and low pressure maintaining means in the zone of said bearings between each bearing and the immediately succeeding impeller.

7. In a centrifugal gas pump or the like having an inlet, an outlet, a driven impeller shaft, a bearing therefor internally of the pump, impeller means on the shaft and rotatable therewith, and volute and return passage means associated with the impeller means between the inlet and outlet; means for introducing into the pump gas stream a supply of liquid for entrainment therewith, means internally of the pump for collecting liquid separated from the gas stream by the force produced by deflection of the gas stream as the pump is operated, and means also internally of the pump for conveying the separated liquid to said bearing.

JUDSON S. SWEARINGEN.