

- [54] **TURBO-COMPRESSOR HAVING MEANS FOR DRAWING IN WORKING MEDIUM AT LOW TEMPERATURE**
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- [73] Assignee: **Sulzer Brothers Ltd.**, Winterthur, Switzerland
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- [52] U.S. Cl. **415/104, 415/110, 415/175**
- [51] Int. Cl. **F01d 3/00**
- [58] Field of Search **415/104, 110, 111, 415/175**

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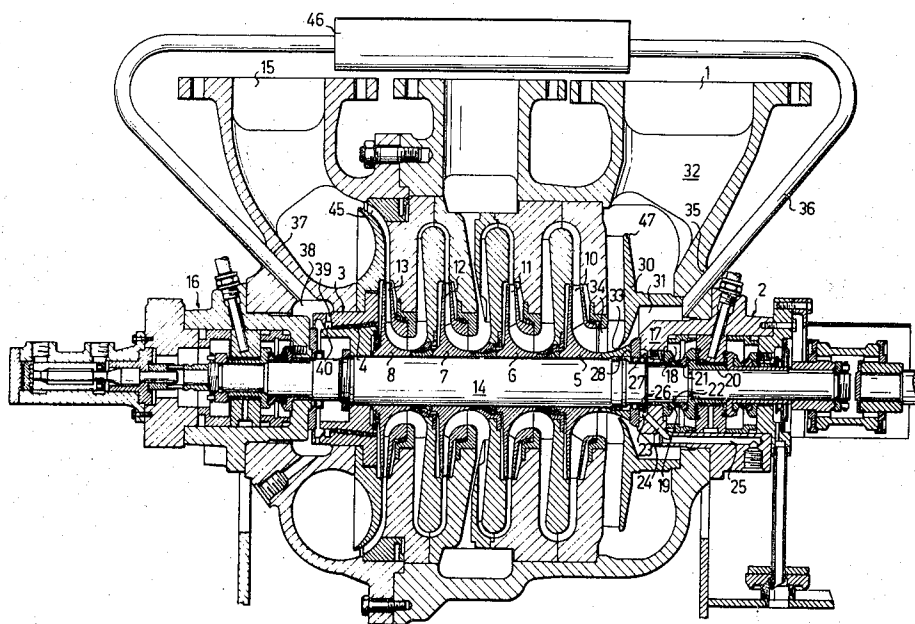
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[57] **ABSTRACT**

The bearing housing on the delivery side of the turbo-compressor is surrounded in spaced relation by a bulk-head to define a chamber which communicates at one end with the suction branch. The opposite end of the chamber is connected to a source of working medium of high temperature so that heated working medium can flow over the bearing housing to maintain the lubricant therein in a fluid state and thereby prevent clogging in the drain-off ducts.

9 Claims, 4 Drawing Figures



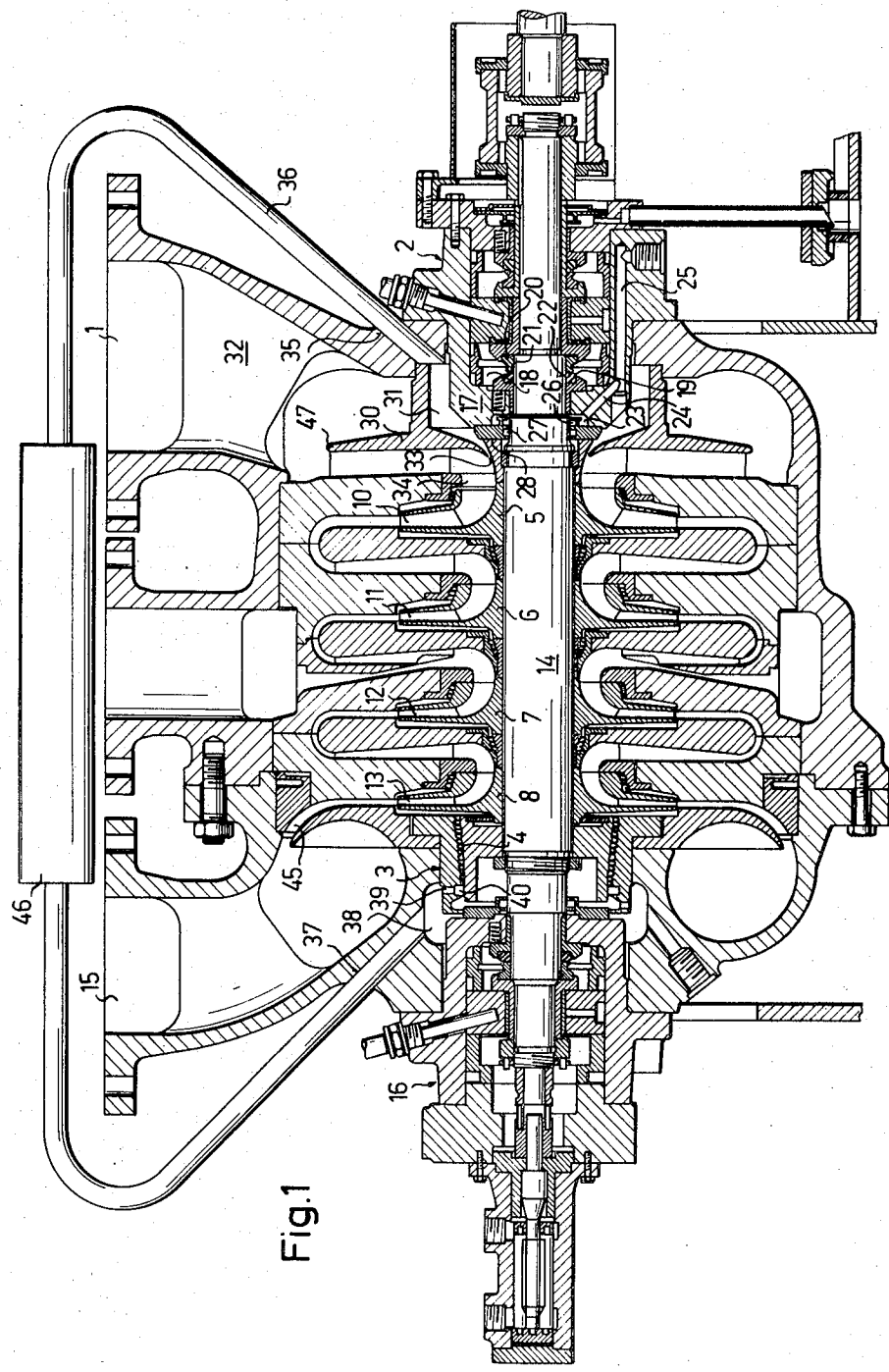


Fig. 2

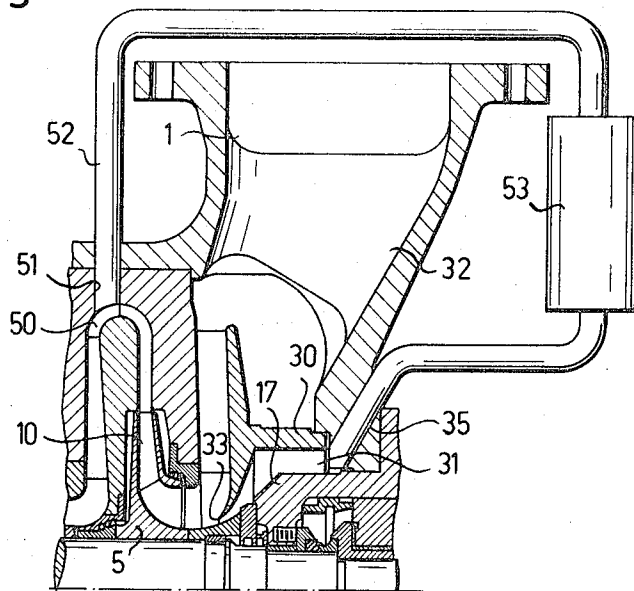


Fig. 3

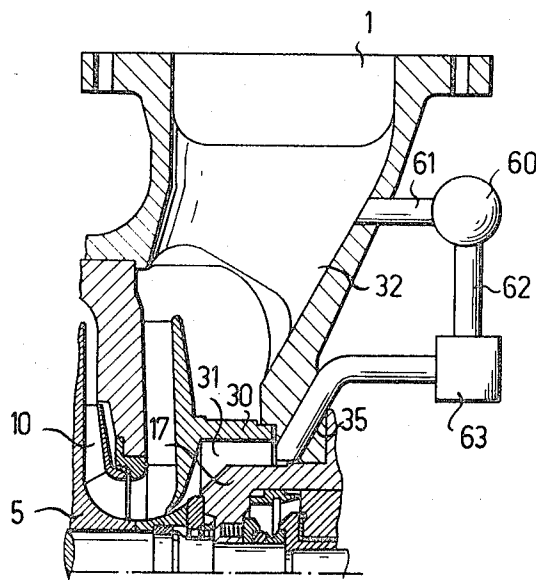
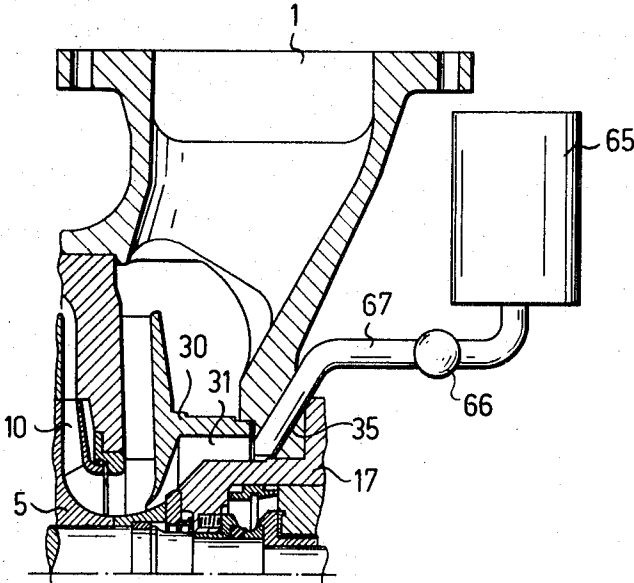


Fig.4



TURBO-COMPRESSOR HAVING MEANS FOR DRAWING IN WORKING MEDIUM AT LOW PRESSURE

This invention relates to a turbo-compressor having means for drawing in working medium at low pressure.

Heretofore, turbo-compressors have been known to have a suction branch at one end which delivers a low-pressure low-temperature working medium to one or more compressor stages and a bearing housing mounted at the suction end for journalling a shaft of the turbo-compressor within a bearing system. In many instances, the bearing housing has projected into the suction branch such that at least a portion of the housing has been excessively cooled by the working medium drawn into the suction branch. As a result, any lubricating oil which has leaked from the bearing system has become at least partially viscous or has become solidified. Regular discharge of the leakage oil to a collecting vessel disposed outside the turbo-compressor has thus been blocked. This, in turn, has created a condition in which the leakage oil may enter the working medium circuit.

Accordingly, it is an object of the invention to prevent blockage of the flow of leakage oil from a bearing system of a turbo-compressor to a collecting vessel.

It is another object of the invention to prevent leakage oil from clogging in a bearing system of a turbo-compressor.

It is another object of the invention to protect the bearing housing for a turbo-compressor bearing system from excessive cooling.

It is another object of the invention to protect the bearing housing for a turbo-compressor bearing system from excessive cooling by utilizing a heated portion of the working medium.

Briefly, the invention provides a turbo-compressor having a suction branch in which a bearing housing projects with a means to introduce working medium into a chamber surrounding a bearing housing at a temperature higher than the temperature of the working medium in the branch duct in order to heat the bearing housing.

In order to form the chamber about the bearing housing, a bulkhead is located in the suction branch in spaced concentric relation about the bearing housing. The bulkhead also defines a second chamber with the remainder of the suction branch and is spaced from the bearing housing to define at least one aperture communicating the two chambers with each other.

In one embodiment, the means for introducing the heated working medium into the chamber about the bearing housing communicates the chamber with an exterior chamber located outside a labyrinth seal on the opposite side of the compressor stages in the turbo-compressor. This exterior chamber is positioned to receive a leakage of the high-pressure high-temperature working medium from the compressor stages at a low pressure for subsequent delivery to the chamber about the bearing housing. A piston may also be positioned between the labyrinth seal and the compressor stage to compensate for axial thrust of the compressor stage.

In another embodiment, the means for introducing the heated working medium into the chamber about the bearing housing communicates the chamber with an exit side of a compressor stage in the turbo-

compressor to deliver a part of the heated working medium back to the chamber.

In still another embodiment, the means for introducing the heated working medium into the chamber shunts a part of the working medium passing through the suction branch into a heating means to heat the shunted part and then passes the heated working medium into the chamber about the bearing housing.

In still another embodiment, an independent source of working medium is connected to the chamber about the bearing housing via a heating means which serves to heat the working medium prior to introduction into the chamber.

The aperture in the bulkhead by means of which the chamber about the bearing housing and the chamber remaining in the suction branch communicate with each other, preferably has the shape of an annular gap which extends upstream of the inlet of the suction side impeller of the turbo-compressor and concentrically thereto. The bulkhead may also have diffusing means for the working medium which flows to the suction-side impeller. If the temperature of the working medium delivered to the chamber about the bearing housing is not sufficiently high in order to ensure adequate thermal insulation of the bearing system relative to the suction branch, the heating means is disposed downstream of the source of the heated working medium.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a longitudinal sectional view of a turbo-compressor according to the invention;

FIG. 2 illustrates a partial cross-sectional view of a turbo-compressor having a means to deliver heated working medium from an exit end of a compressor stage to the bearing housing in the suction branch according to the invention;

FIG. 3 illustrates a partial cross-sectional view of a turbo-compressor having a means to shunt a portion of the drawn-in working medium through a heating means for introduction to a bearing housing according to the invention; and

FIG. 4 illustrates a partial cross-sectional view of a turbo-compressor connected with an independent source of heated working medium according to the invention.

Referring to FIG. 1, the multi-stage turbo compressor of generally known construction has a suction branch 1 and a suction side bearing housing 2 on one side and a piston 3 for compensating axial thrust and a labyrinth seal 4 on the delivery side. A delivery branch 15 and a suitable bearing housing 16 are also mounted on the delivery side with the bearing housing 16 cooperating with the bearing housing 2 to rotatably mount a main shaft 14 within suitable bearing systems as shown. The turbo compressor has four compressor stages 5, 6, 7, 8 each having an impeller 10, 11, 12, 13 disposed on the main shaft 14 between the suction side and the delivery side. During operation, a working medium is drawn in through the suction branch 1, compressed in the compressor stages 5, 6, 7, 8 until achieving a final pressure in the last stage 8 and delivered through the delivery branch 15 at high temperature and high pressure.

As shown, one part 17 of the bearing housing 2 extends into the turbo-compressor as far as the suction branch 1. The bearing housing 2 also houses an oil

chamber 18 for the lubricating oil of the bearing system. This oil chamber 18 is sealed relative to the main shaft 14 by means of a ring seal 19 which co-rotates with the main shaft 14 and bears on a stationary mating member 20 under a spring biasing force. The ring seal 19 together with the mating member 20 forms a seal surface 21. During operation, and in the course of time, part of the lubricating oil will leak through the seal surface 21 from the oil chamber 18 and, following along the circumference 22 of the main shaft 14, will enter a collecting chamber 23 at the forward end of the housing part 17. From there, the lubricating oil will flow through ducts 24 and 25 in the housing 2 into a collecting vessel (not shown) disposed outside the turbo-compressor. Part of the leakage oil which is not discharged through the ducts 24 and 25 is subsequently removed by centrifuging in oil collecting chambers 26 and 27 located at the end of the bearing part 17. If the bearing part 17 of the bearing housing 2 disposed in the suction branch 1 is excessively cooled by the drawn-in working medium of low temperature, the leakage oil reaching the collecting chamber 23 will become so viscous that discharge through the ducts 24, 25 is obstructed. Accordingly, there will be a risk that the amount of leakage oil remaining in the collecting chamber 23 would become so large as to not be accommodated in the oil collecting chambers 26 and 27 with the result that the oil would then pass through a gap 28 between the bearing housing 2 and the shaft 14 of the turbo compressor into the suction branch 1. The oil would then be entrained at that position by the stream of working medium and introduced into the circuit of the turbo-compressor where it may have detrimental effects.

In order to avoid the above, the suction branch 1 is provided with a bulkhead 30 which surrounds the bearing housing part 17 in the suction branch 1 in concentric relation to define a first chamber 31 therebetween while forming a second chamber in the remainder of the suction branch 1. These two chambers 31, 32 communicate with each other through an annular gap 33 which extends upstream of an inlet 34 of the impeller 10 and concentrically thereto. The first chamber 31 also communicates with a chamber 38 in the turbo-compressor at the delivery end through a bore 35 in the casing wall of the turbo-compressor, a duct 36 and a further bore 37. The aforementioned chamber 38 communicates through a bore 39 with the low pressure side 40 of the labyrinth seal 4 of the shaft 14.

During operation of the turbo-compressor, the working medium, compressed to the final pressure and therefore having a higher temperature, leaves the turbo-compressor through a guide duct 45 and the delivery branch 15. The proportion of working medium which leaks through the labyrinth seal 4 and has a higher pressure than that which prevails in the suction branch 1 will flow from the low pressure side 40 through the bore 39, the space 38, the bore 37, the duct 36 and the bore 35 into the chamber 31 and from there into the impeller 10 of the shaft 14. The working medium of elevated temperature which flows through the chamber 31 thermally insulates the bearing housing part 17 from the low temperature medium which flows through the suction branch 1. This prevents the housing part 17 from being cooled to the extent that leakage oil which reaches the collecting chamber 23 becomes excessively viscous. The oil thus retains its original vis-

cosity so as to be readily discharged through the ducts 24 and 25. An ejector effect also occurs in the chamber 31 near the annular gap 33 to assist the transfer of working medium into the impeller 10.

In the event that the temperature of the working medium leaving the final stage 8 is insufficient to adequately and thermally insulate the chamber 31 relative to the working medium which flows through the suction socket 2, a heating means 46 is provided in the duct 36 so that the temperature of the working medium can be raised to the desired magnitude in a suitable manner.

As shown, the bulkhead 30 has a diffuser in the form of a flange 47 which assists the flow of working medium into the impeller 10 of the first stage 5.

It is not necessary for the previously mentioned labyrinth seal 4 to be part of a piston for compensating axial thrust as described earlier for this embodiment. Instead, the seal 4 may be a simple labyrinth seal.

Referring to FIG. 2, wherein like reference characters indicate like parts as above, the source of working medium with a temperature higher than that of the draw-in working medium can, alternatively, be formed by the exit side of the first compressor stage 5 of the turbo-compressor. In this case, a diffuser duct 50 of the first compressor stage 5 communicates with a bore 51 into which a duct 52 is mounted. The duct 52 extends via a heating means 53 to the bore 35 of the chamber 31 defined by the bulkhead 30 about the bearing housing part 17 to deliver a part of the heated working medium flowing from the compressor stage 5 to the chamber 31.

The heating means 53 is switched on when the temperature of the working medium in the first compressor stage 5 is not sufficiently high to ensure adequate heating of the chamber 31. The exit side of another compressor stage may, of course, also be selected as the source of working medium.

Referring to FIG. 3, wherein like reference characters indicate like parts as above, the heated working medium can also be obtained from the working medium drawn-in through the suction branch 1. To this end, a conveying means 60 is connected via a duct 61 directly to the suction branch and is constructed in a known manner to draw off and transfer a portion of the working medium through a duct 62 and bore 35 to the chamber 31. A heating means 63 is also interposed in the duct 62 to heat the flow of working medium to the required temperature.

Referring to FIG. 4, wherein like reference characters indicate like parts as above, while the various embodiments of FIGS. 1 to 3 supply the chamber 31 about the bearing housing 2 with working medium supplied from the turbo-compressor, the working medium can also be supplied independently of the turbo-compressor. To this end, a source 65 independent of the turbo-compressor and containing working medium identical to that processed by the turbo-compressor of suitable pressure and suitable temperature is connected to the chamber 31 through a duct 65 having a control valve 66 therein. The source 65 may form part of a condenser of the plant in which the compressor operates.

What is claimed is:

1. A turbo-compressor comprising a suction branch for delivery of a low temperature working medium thereto; a bearing housing projecting into said suction branch;

a bulkhead surrounding said bearing housing within said suction branch to define a first chamber concentrically between said bearing housing and said bulkhead and a second chamber between said bulkhead and the remainder of said suction branch, said bulkhead being spaced from said bearing housing to define at least one aperture communicating said first chamber with said second chamber; and means communicating with said first chamber for introducing a working medium of higher temperature than the temperature of the working medium in said suction branch into said first chamber to thermally shield said bearing housing from said working medium in said suction branch.

2. A turbo-compressor as set forth in claim 1 which further comprises at least one compressor stage communicating with said second chamber in said suction branch and a labyrinth seal on a side of said compressor stage opposite said suction branch for sealing the interior of said compressor from an exterior chamber, and wherein said means communicates said exterior chamber with said first chamber to introduce heated high pressure working medium leaking from said compressor stage into said exterior chamber at a low pressure to said first chamber.

3. A turbo-compressor as set forth in claim 2 further comprising a piston between said compressor stage and said labyrinth seal for compensating axial thrust of said compressor stage.

4. A turbo-compressor as set forth in claim 1 which

further comprises at least one compressor stage communicating with said second chamber in said suction branch and wherein said means communicates an exit side of said compressor stage opposite said suction branch with said first chamber.

5. A turbo-compressor as set forth in claim 1 which further comprises a suction-side impeller having an inlet adjacent said second chamber to receive working medium therefrom and wherein said aperture is an annular gap extending upstream of said impeller inlet and concentrically thereof.

6. A turbo-compressor as set forth in claim 1 wherein said bulkhead includes a diffuser extending from said gap into said second chamber.

7. A turbo-compressor as set forth in claim 1 wherein said means includes a heating means for heating the working medium introduced into said first chamber.

8. A turbo-compressor as set forth in claim 1 wherein said means is connected to said suction branch upstream of said aperture to draw off a part of the working medium passing through said suction branch, said means including a heating means for heating the drawn off portion of the working medium prior to introduction into said first chamber.

9. A turbo-compressor as set forth in claim 1 wherein said means communicates with a source of working medium mounted independently outside said turbo-compressor.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,758,226 Dated September 11, 1973

Inventor(s) GABOR GYURECH

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 3, change "Pressure" to --Temperature--.

Signed and sealed this 30th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents