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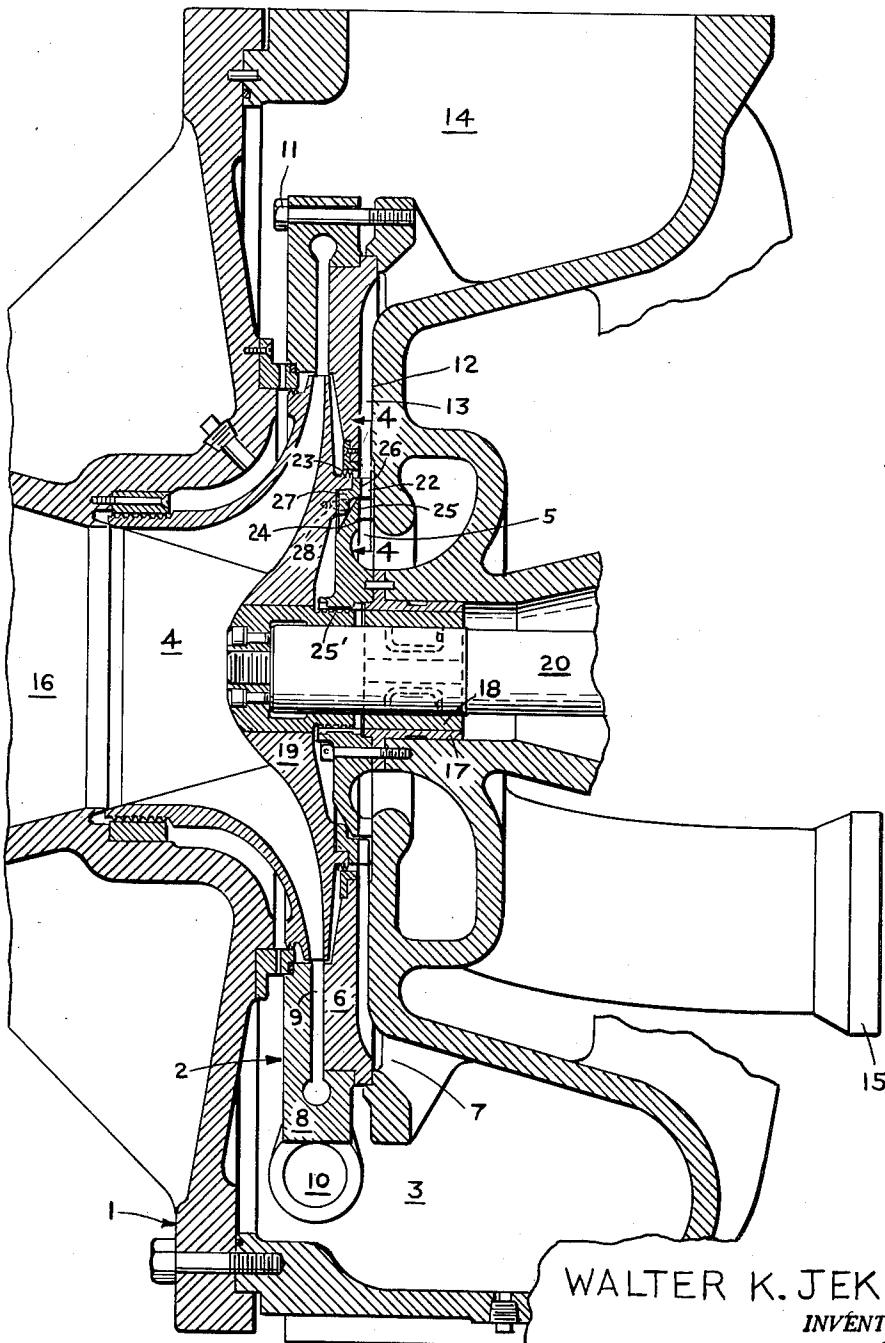


FIG. 2

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ROTARY MACHINE

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This invention relates to rotary machines and more particularly to a turbine-compressor unit designed for use in an installation requiring that mechanical vibrations be maintained at low levels.

While turbine-compressor units for the specific function in installations as indicated above are in industrial use today, the vibrations caused by adverse critical speeds have been overcome through the use of damping devices, and/or the design of such units to include oversize components.

From a commercial standpoint these units, which as for example may serve as a motive force for the refrigerant in a mechanical type of refrigeration installation, must provide substantially vibrationless service at a cost that is comparable with the cost of process type and the like systems which may also be applied for such services.

Because of the advances realized in these competing fields, the above prior type methods of reducing vibrations and noises are no longer justifiable as they add appreciably to the manufacturing costs of the rotary machines.

The present invention meets this problem by providing a rotary machine which may comprise a turbine-compressor adapted to operate with an impeller having the rotor of the turbine formed on a portion thereof.

Such a concept permits direct torque transmittal from the turbine to the compressor without the usual detour of the transmitted torque over the shaft.

The inclusion of the turbine rotor as a part of the impeller means of the unit permits location of the shaft bearing sufficiently close to the center of gravity of the impeller like means to thusly increase the critical speed thereof. Furthermore usual turbine wheel friction is eliminated by forming same on the impeller means.

Accordingly it is evident that with the foregoing concept it is now possible to reduce the size of the components of a unit useful in operations requiring a low level of mechanical vibration and thusly provide a machine of lower cost.

Furthermore in the installations wherein a rotary machine of the type generally described above is useful, it is the customary practice to provide a separate pumping means to accomplish system circulation.

It is now feasible and this pumping means may be provided as a part of the turbine-compressor unit and thusly reduce many of the sealing problems presented in an installation wherein the pump is a separate and distinct appurtenance.

In addition as will be pointed out in detail hereinafter, the pumping means may be combined with a thrust bearing means to thusly reduce shaft and impeller means movement to a prescribed amount.

Accordingly, it is an object of this invention to provide an improved rotary machine having the above mentioned advantages.

Other objects and advantages of the invention including the basic design and the nature of the improvements thereon will appear from the following description taken in conjunction with the following drawings, in which:

FIGURE 1 is a side elevation of the rotary machine contemplated herein.

FIGURE 2 is a fragmentary longitudinal section showing the turbine-compressor portion.

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FIGURE 3 is a fragmentary longitudinal section showing the pumping portion which may be made a part of the unit.

FIGURE 4 is a fragmentary transverse section in reduced size taken on line 4-4 of FIGURE 2.

Referring more particularly to the drawings, the improved rotary machine adapted for use in installations requiring a low level of mechanical vibrations may include either the turbine-compressor unit or the turbine-compressor unit with pumping means formed thereon and comprises a casing generally designated 1.

A partition means taking the form of a diffuser 2 is disposed in chamber 3 of the casing 1 and divides the chamber into a compression compartment 4 and a driving compartment 5. More particularly the diffuser 2 comprising a plate-like annular member 6 disposed about an ear-like extension 7 in chamber 3 and a second annular plate-like means referred to as the diffuser main casing and designated 8 which is disposed about the plate 6 to form an inlet 9 and outlet 10 for the diffuser. The entire unit being held in operative position by bolts 11 which are connected to the ears 7.

Disposition of the diffuser 2 as indicated above not only provides means for forming the necessary compression and driving compartments 4 and 5 but the inward side of the plate 6 and wall 12 of the casing coact to form a portion of passage means 13 which communicates the driving compartment 5 with the sole outlet 14 formed in the portion of the casing, including the chamber 3. Inlet 15 also formed in portion of casing including chamber 3 is provided for supplying working fluid to the driving portion and communicates through passage means 13 with the outlet 14.

With the above diffuser arrangement, inlet 16, formed on casing portion including chamber 3, communicates with outlet 14 as follows: System fluid passed to inlet 16 flows to compression compartment 4 into the inlet 9 of the diffuser and discharges from outlet 10 thereof into the outlet 14 on the casing for use as contemplated.

In order to provide a machine adaptable for use in an installation requiring a low level of mechanical vibration, bearing housing 17 and bearing means 18 disposed therein are located as close as practicable to the center of gravity of the impeller used in such a unit to propel the system fluid. This is accomplished in the present instant by the disposition of an impeller means 19, on a shaft 20, which is journaled in above bearing means 18 and bearing means 21 disposed at the other end of the casing, which includes blade means 22 formed thereon as is hereinafter described to serve as the driving means of the unit. Inclusion of the blade means 22 on the impeller permits closer location of the bearing means 18 than was heretofore possible to the center of gravity of the impeller 19.

With the arrangement of the diffuser as above described impeller means 19 is now arranged in the compression compartment 4 and coacts with seal member 23 formed on the impeller near the blade means 22, the plate 6 and nozzle 24 disposed between the impeller and bearing housing 17 and including seal means 25' to provide for a substantially fluid tight arrangement between the compression and driving compartments.

The nozzle 24 which is arranged relative blades 22 to direct motive fluid passed to the inlet 15 of the unit is referred to at times herein as being adjacent to or in the passage means 13. While it is indicated above that the major portion of passage means 13 is formed between the plate 6 and wall of the chamber 3, for purposes of clarity it is intended that the passage means 13 extend to the entry tip of nozzle 24 and thusly comprise the portion between the face 25 of nozzle 24, face 26 of

blade means 22 and plate means 6 running along the wall 12 of chamber 3.

Referring to FIGURE 4 while blade means 22 is shown as including a ring 27 connected to the back shroud of the impeller means 19 by threaded means 28 and as being disposed in the passage means 13 downstream from nozzle member 24 it is not intended to limit this invention to the form outlined herein. As it will be evident to one skilled in this art that the blades could be conveniently formed on the front shroud of the impeller and furthermore it will be evident that the impeller means comprising the means moving the system fluid from inlet 16 to outlet 14 and the rotor of the turbine can be cast as a unitary element if desired.

In the embodiment of this disclosure comprising solely a turbine-compressor any suitable closure can be disposed about the end of the unit. However, in the preferred form shown means taking the form of a pump casing 30 having the usual inlet 31 and outlet (not shown) is connected to the casing 1 or formed thereon as an integral portion therewith.

A double suction pump 33 of the rotating type is disposed in pump housing 34 which also includes means as is described hereinafter forming a thrust bearing 35. It will be understood that a single suction pump may be used as well.

Coaction between the pump 33 and thrust bearing 35 limits the movement of the blade means 22 to prescribed limits in the driving compartment 5 or passage means as follows: Pump 33 comprises a double suction impeller 36 including inner and outer shrouds 38 and 39 with annular inner and outer labyrinth members 40 and 41 formed as a portion thereof. The impeller 36 as described above is connected to the shaft 20 by any well known method and disposed in housing 34 to flow fluid from inlet 31 to the outlet.

Inner and outer thrust end plates 42 and 43 are disposed on the opposite end faces of the housing 34 and include inwardly extending rings 44 and 45 which abut the inner portion of the pump housing as is clearly shown in the drawings.

Inner and outer thrust shoes 46 and 47 having inwardly disposed lands 48 and 48' are mounted about the shrouds of the impeller and between end plates 42 and 43.

With the provision of the labyrinth rings and shoes 46 and 47 fixed orifices 49 are formed along the portion of the labyrinth ring abutting the inner portion of housing 34; whereas the lands 48 and 48' form variable orifices 50 and 50' with the opposite end faces of the labyrinth rings.

In operation and on rotation of shaft 20 by the driving means of the unit and assuming that thrust moves the shaft towards the pump, fluid being discharged by pump 33 leaks through orifices 49 and 49' and due to the thrust being encountered at the prescribed moment, ring 41 is in closer proximity to land 48' than ring 40 to land 48. Due to the fact that orifices 49 and 49' are fixed and orifice 50 is now larger than orifice 50', a greater pressure results on the face of thrust shoe 47' than on thrust shoe 46 which tends to move pump impeller 39 in opposite direction to the thrust encountered and thus stabilizes the movement of blade means 22 in the driving compartment.

Although this invention has been described with reference to specific apparatus it will be appreciated that a wide variety of changes may be made within the ability of one skilled in the art without departing from the scope of this invention. For example, some of the components of the apparatus may be reversed, certain features of the invention may be used independently of others, and equivalents may be substituted for the apparatus, all within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A rotary machine for use in installations requiring a low level of mechanical vibration, said rotary machine comprising a casing including a chamber formed therein, a first and second inlet and an outlet formed on the casing, a diffuser means mounted in said chamber to divide same into a compression and driving compartment, inlet and outlet means on said diffuser to communicate the outlet on said casing with the first inlet and through said compression compartment, and said diffuser and casing forming a passage means intercommunicating the second inlet and outlet on the casing through said driving compartment, a bearing housing formed in the casing and including bracing means disposed therein, a shaft journaled in said bearing means and extending into the compression compartment, an impeller means disposed on the portion of said shaft extending into said compression compartment and said impeller means having a portion thereof disposed in proximate relation with said driving compartment, blade means formed on the last mentioned portion of said impeller means to act as a driving means for the rotary machine, said blade means disposed in the driving compartment and spaced relative to the passage means to receive motive fluid passed to said second inlet, and nozzle means disposed adjacent said passage means to direct fluid received by said second inlet against said blade means to produce mechanical power whereby said blade means causes said impeller means to flow fluid from the inlet through the diffuser means to said outlet on the casing.

2. A rotary machine for use in installations requiring a low level of mechanical vibration, said rotary machine comprising a casing including a chamber formed therein, a first and second inlet and an outlet formed on the casing, a diffuser means mounted in said chamber to divide same into a compression and driving compartment, inlet and outlet means on said diffuser to communicate the outlet on said casing with the first inlet and through said compression compartment, and said diffuser and casing forming a passage means intercommunicating the second inlet and outlet on the casing through said driving compartment, a bearing housing formed in the casing and including bearing means disposed therein, a shaft journaled in said bearing means and extending into the compression compartment, an impeller means disposed on the portion of said shaft extending into said compression compartment, said bearing housing disposed as close as practicable to the center of gravity of said impeller means, said impeller means having a portion thereof disposed in proximate relation with said driving compartment, blade means formed on the last mentioned portion of said impeller means to act as a driving means for the rotary machine, said blade means disposed in the driving compartment and spaced relative to the passage means to receive motive fluid passed to said second inlet, and nozzle means disposed adjacent said passage means to direct fluid received by said second inlet against said blade means to produce mechanical power whereby said blade means causes said impeller means to flow fluid from the inlet through the diffuser means to said outlet on the casing.

3. The rotary machine claimed in claim 2 wherein the chamber includes flange means formed therein, and the diffuser means comprises a plate means disposed in abutment with the flange means, a diffuser main casing mounted about the plate and connected to the flange means to dispose the inlet of the diffuser means in proximate relation with the impeller means.

4. The rotary machine claimed in claim 3 wherein the plate means of the diffuser means coacts with the wall of the chamber to form the passage means providing communication between the second inlet and the outlet on the casing.

5. A rotary machine for use in installations requiring a low level of mechanical vibration, said rotary machine comprising a casing having a partition means disposed

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therein to form compression and driving compartments in one portion thereof and means in the casing forming a pumping compartment in another portion thereof, first and second inlet means on the portion of the casing including the partition means and communicating respectively with the compression and driving compartments, an outlet on the portion of the casing including the partition and communicating with both the compression and driving compartments, inlet and outlet means on the portion of the casing including the pumping compartment and communicating therewith, a bearing housing formed in the casing and including bearing means disposed therein; a shaft journaled in said bearing means and extending into said compression, driving and pumping compartments, an impeller means disposed on the portion of said shaft extending into said compression compartment and said impeller means having a portion thereof disposed in proximate relation with said driving compartment, blade means formed on the last mentioned portion of said impeller means to act as a driving means for the rotary machine, nozzle means disposed in said casing to direct fluid received by said second inlet against said blade means, a pumping means disposed in said pumping compartment and connected to said shaft and being driven by said blade means, and thrust means formed in said pumping chamber and coacting with said pumping means to maintain said blade means between a predetermined limit in said driving compartment.

6. The rotary machine claimed in claim 5 wherein the bearing housing is disposed between the portion of the casing including said partition and the pumping chamber.

7. A rotary machine for use in installations requiring a low level of mechanical vibration, said rotary machine comprising a casing including a first chamber in a portion thereof, a second chamber in another portion of said casing forming a pumping compartment, a first and second inlet and outlet on the portion of said casing including said first chamber, inlet and outlet means on the portion of the casing including said second chamber and in communication therewith, a diffuser means mounted in said first chamber to divide same into a compression and driving compartment, inlet and outlet means on said diffuser to communicate the outlet on the portion of the casing including the first chamber with the first inlet and through said compression compartment, said diffuser and casing forming a passage means intercommunicating the second inlet and outlet formed on the portion of the casing including said first chamber and through said driving compartment, a bearing housing formed in the casing and including bearing means disposed therein; a shaft journaled in said bearing means and extending into said compression, driving and pumping compartments, an impeller means disposed on the portion of said shaft extend-

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ing into said compression compartment and said impeller means having a portion thereof disposed in proximate relation with said driving compartment, blade means formed on the last mentioned portion of said impeller means to act as a driving means for the rotary machine, said blade means disposed in the driving compartment and spaced relative the passage means to receive motive fluid passed to said second inlet, nozzle means disposed adjacent said passage means to direct fluid received by said second inlet against said blade means, a pumping means disposed in said pumping chamber and connected to said shaft and being driven by said blade means, and thrust means formed in said pumping chamber and coacting with said pumping means to maintain said blade means between predetermined limits in the driving compartment.

8. The rotary machine claimed in claim 7 wherein the chamber includes flange means formed therein, and the diffuser means comprises a plate means disposed in abutment with the flange means, a diffuser main casing mounted about the plate and connected to the flange means to dispose the inlet of the diffuser means in proximate relation with the impeller means.

9. The rotary machine claimed in claim 8 wherein the plate means of the diffuser means coacts with the wall of the chamber to form the passage means providing communication between the second inlet and the outlet on the casing.

10. The rotary machine claimed in claim 9 wherein the bearing housing is disposed between the first and second chambers.

11. The rotary machine claimed in claim 10 wherein the thrust bearing includes means for counterbalancing the axial movement of the shaft to therefor maintain said blade means between predetermined limits in said driving compartment.

12. The rotary machine claimed in claim 10 wherein the pumping chamber includes an inner and outer thrust bearing, each having inwardly disposed annular extensions, inner and outer seal means forming fixed orifices with the walls of said second chamber, inner and outer shoes disposed about the shaft and in abutment with the annular extensions and said shoes including lands being movable relative said seal means to form a variable orifice therewith whereby fluid from said pump acts on said shoes to maintain said blade means between predetermined limits in said driving compartment.

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