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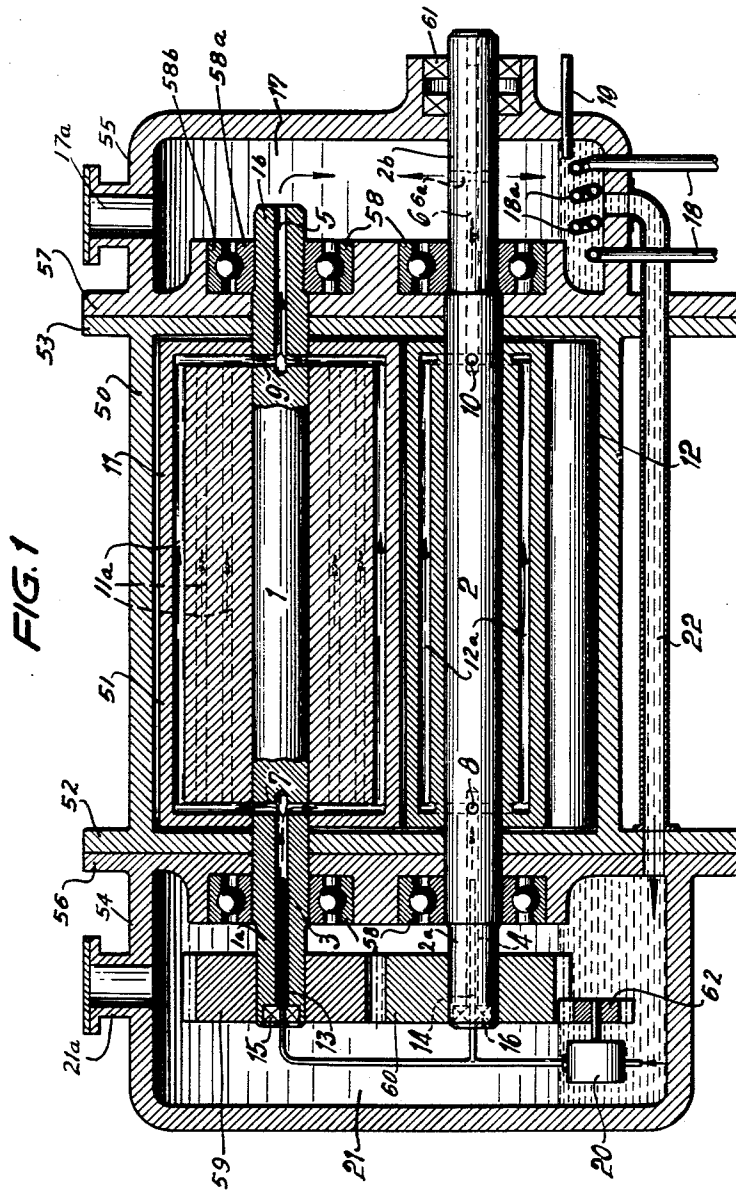
HANS-GEORG NÖLLER

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PUMP

Filed Jan. 17, 1956

2 Sheets-Sheet 1



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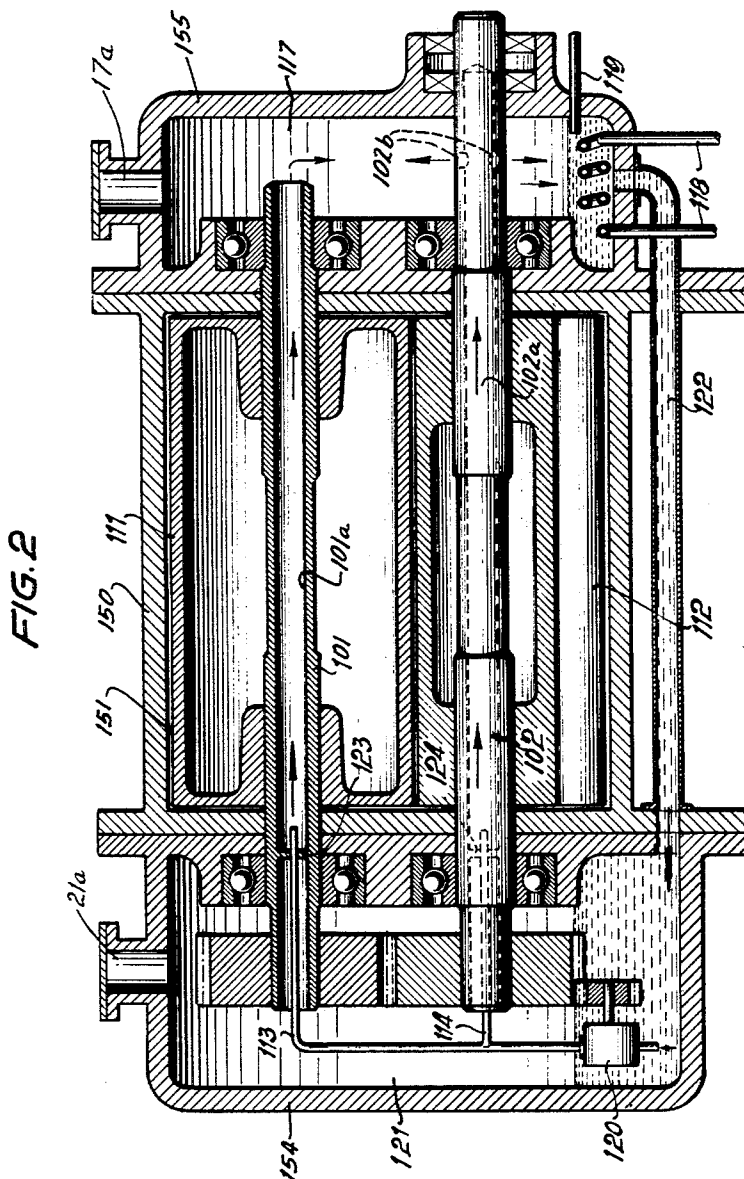
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The present invention relates to a pump.

More particularly, the present invention relates to a cooling arrangement by means of which the pump members of a high vacuum pump are cooled by a cooling medium circulated through the pump members.

There exists pump devices, such as Roots blowers or Lysholm rotary compressors, wherein the individual pump members operate a pumping space in which a pressure of the order of 40 mm. of Hg, or less, prevails. It has been found desirable to provide these pump members with suitable cooling means, such as conduits which pass through the pump members and which have a cooling liquid or the like circulated therethrough. In practice, these conduits extend through the axle portions of the pump members by which axles the pump members are mounted for rotation in the pump housing. This, in turn, makes it necessary to project the axles exteriorly of the pump housing, and more particularly, exteriorly of the pumping chamber within which the pumping members rotate. As a result, the great pressure differential between the pressure prevailing within the pumping chamber and the pressure prevailing exterior thereof causes leakage along the exterior surface of the pump member axles. Known devices, therefore, require very elaborate and expensive sealing or packing between the pump member axles and the pump housing, particularly if the pump is to be used to create a high vacuum. However, even the best of known sealings and packings have been found to be insufficiently fluid-tight to enable the pump to produce extremely high vacuums.

It is therefore an object of the present invention to provide a pump which incorporates a cooling arrangement that overcomes the above disadvantages.

It is another object of the present invention to provide a pump which incorporates a cooling arrangement that is capable of circulating a cooling liquid, such as oil, through the pump members.

The objects of the present invention also include the provision of a pump, such as a Roots blower or Lysholm rotary converter, wherein a cooling liquid or the like that is circulated through the pump members of the pump may be maintained at a pressure substantially equal to the pressure prevailing within the pumping space in which the pump members operate.

It is a still further object of the present invention to provide a pump wherein a cooling liquid that is circulated through the pump members is maintained at the proper temperature so as to produce efficient cooling of the pump members.

It is also an object of the present invention to provide a pump incorporating a cooling arrangement in which the arrangement of the parts is such that the entire pump structure, including its cooling arrangement, is located in a fluid-tight housing.

With the above objects in view, the present invention mainly consists in an apparatus such as a pump or the like which includes a housing having at least two opposite

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walls defining between themselves a work space. At least one work member, which has a work portion in the work space and a pair of opposite axle portions projecting through the opposite walls, respectively, is mounted for rotation relative to the housing. The work member is formed with conduit means therethrough opening in the opposite axle portions. Wall means are connected to each of the opposite walls exteriorly of the work space. The wall means form a pair of fluid-tight chambers respectively containing the projecting opposite axle portions of the work member so that the conduit means therethrough communicate with the fluid-tight chambers, respectively. Connecting conduit means place the fluid-tight chambers in communication with each other. As a result, a temperature-controlling fluid medium may under any desired pressure be circulated through the conduit means of the work member, thereby controlling the temperature thereof, while the same rotates in the work space relative to the housing.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a cross sectional view of a preferred embodiment of the present invention; and

Fig. 2 is a cross sectional view of another preferred embodiment of the present invention.

Referring now to the drawings, and to Fig. 1 thereof in particular, there is shown a pump housing 50 forming a pumping chamber 51. A pair of cooperating pump members 11 and 12 are mounted for rotation within the pump housing and may be multi-lobe impellers of the type commonly used in Roots blowers and Lysholm compressors. The pump members 11 and 12 are supported for rotation within the housing 50 by means of a pair of shafts 1 and 2, respectively. The shafts 1 and 2 have opposite axle portions 1a, 1b and 2a, 2b extending through the opposite side walls 52 and 53 of the pump housing 50.

The axle portion 1a is formed with a conduit 3 extending therethrough, which conduit is formed with a plurality of radial bores 7. The axle portion 1b is formed with a conduit 5 extending therethrough, which conduit is formed with a plurality of radial bores 9. The pump member 11 is formed with passages 11a which communicate with the bores 7 and 9 so that the impeller or pump member which is constituted by the elements 1 and 11 is traversed by continuous conduit means.

Similarly, the axle portion 2a has a conduit 4 which is formed with radial bores 8, and the axle portion 2b has a conduit 6 which is formed with radial bores 10. The pump member 12 is formed with bores or passages 12a which communicate with the bores 8 and 10, so that the impeller constituted by the elements 2 and 12 is traversed by continuous conduit means.

A pair of fluid-tight housing members or shells 54 and 55 are arranged on opposite sides of the pump housing 50. The arrangement of the parts is such that the end walls 56 and 57 of the shells 54 and 55, respectively, are adjacent the side walls 52 and 53 of the pump housing 50 so that the walls 52, 56 and the walls 53, 57 each constitute a composite partition wall through which the axle portions of the shafts 1 and 2 extend. If desired, suitable ball bearing means 58 may be provided for mounting the axle portions of the shafts 1 and 2 for rotation relative to the pump housing 50. In the illustrated embodiment, the bearing means 58 are shown as being ball bear-

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ing, with the inner ball races 58a being secured to the axle portion for rotation therewith and with the outer ball races 58b being secured to the shells 54 and 55. Suitable sealing or packing means (not shown) may be provided for packing the bearing means so as to increase the fluid-tightness of the mounting.

The axle portions 1a and 2a may carry cooperating gears 59 and 60 so that the pump members 11 and 12 are motion transmittingly interconnected with each other. The axle portion 2b may extend through the shell 55 by way of a suitable seal or packing arrangement 61, thereby enabling the shaft 2, and consequently the shaft 1, to be rotated by an external driving means (not shown).

The shells 54 and 55 define a pair of fluid-tight chambers 21 and 17, respectively, which are placed in communication with each other by means of a connecting conduit 22. Thus, the chambers 21 and 17, together with the conduit 22, form a single fluid-tight chamber, hereinafter referred to as a control chamber, which is exterior of the pumping chamber 51, and it will be seen that the composite wall 52, 56 as well as the composite wall 53, 57 each constitute a wall of the pumping chamber 51 as well as a wall of the control chamber.

The lower portion of the control chamber is adapted to contain a temperature-controlling fluid medium such as oil, which may be circulated through the control chamber and through the conduits traversing the pumping members 11 and 12. For this purpose, a pump 20 may be provided which is preferably arranged below the liquid level of the oil while shafts 1 and 2 are located above the liquid level. The pump may be driven by a gear 62 which is in meshing engagement with the gear 60 carried by the axle portion 2a so that the pump 20 is actuated during rotation of the pump members 11 and 12. The pump serves to inject oil into the conduits 3 and 4 by way of tubes 13 and 14. Suitable sealing or packing glands 15 and 16 may be provided for closing the left-hand free ends of the conduits 3 and 4.

When the pump members 11 and 12 are rotated, the oil injected into the conduits 3 and 4 will be centrifuged by way of the radial bores 7 and 8 and flow through the passages 11a and 12a, the radial bores 9 and 10, and the conduits 5 and 6 in the direction shown by the arrows. The cross sectional areas of the conduits 5 and 6 are greater, respectively than the cross sectional areas of the tubes 13 and 14, the cross-sectional areas of the latter constituting the effective cross sectional areas of the conduits formed through the axle portions 1a and 2a.

The circulated oil is free to leave the port at the open end of the conduit 5 and to drop in the direction shown by the arrow. The oil moving rightwardly through the conduit 6 may leave the same by way of radial passages or bores 6a ending in ports located in the upper portion of chamber 17 and thereafter drop toward the bottom of the chamber 17. Thus, the oil leaving the conduits 5 and 6 is recirculated, by way of the connecting conduit 22 into the chamber 21 where the pump 20 may once again inject the oil into the conduits 3 and 4.

In practice, it is desirable to cool the pump members 11 and 12 so as to avoid excessive expansion thereof and consequent mutual blocking during rotation of the pump members 11 and 12. It is therefore desirable to cool the oil leaving the conduits 5 and 6, and suitable heat exchange means 18 may be provided for accomplishing this mission. The heat exchange means 18 is located at the bottom of the chamber 17 and may consist of cooling coils 18a that are traversed by any suitable heat exchange medium, as, for example, air or water. A suitable temperature responsive control means 19 may be provided for maintaining the temperature of the circulating oil constant or for otherwise controlling the action of the heat exchange means 18.

It will be seen from the above that the pumping chamber 51 and the control chamber within which the oil circulates and into which the axle portions of the shafts 1

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and 2 project are two entirely separate chambers which are substantially out of communication with each other. The only way by means of which communication between these two chambers may be established is between the outer surfaces of the axle portions of the shafts 1 and 2 and the inner surfaces of the openings through the composite walls 52, 56 and 53, 57 within which these axle portions rotate.

It has been found, however, that in Roots blowers and Lysholm rotary compressors, particularly in such blowers and compressors which include several stages, the pressure prevailing within the pumping chamber 51 may be of the order of 40 mm. of Hg, or less. Thus, if the axle portions of the shafts 1 and 2 were to project into a chamber maintained at atmospheric pressure, the pressure differential between atmospheric pressure and the very high vacuum prevailing within the pumping chamber 51 would be sufficient to cause leakage into this pumping chamber by way of the space between the outer surfaces of the axle portions of the shafts 1 and 2 and the inner surfaces of the composite walls 52, 56 and 53, 57.

It is therefore desirable that the axle portions of the shafts 1 and 2 be contained in a chamber or chambers in which the pressure is more nearly equal to the pressure prevailing within the pumping chamber. It will be seen that inasmuch as the control chamber into which the axle portions of the shafts 1 and 2 project is a fluid-tight one, the pressure therewithin may be maintained at any desired pressure, particularly at a pressure which is substantially equal to that prevailing within the pumping chamber 51. Accordingly, in a device wherein the pressure within the pumping chamber 51 is extremely low, the pressure within the control chamber should likewise be extremely low. According to the present invention, therefore, the control chamber which includes the chambers 21 and 17 is evacuated so that the oil is circulated under a pressure which is substantially equal to that prevailing in the working chamber 51. This evacuation may be accomplished by providing suitable normally closed evacuating conduit means 21a and 17a communicating with the chambers 21 and 17 and adapted to be connected to any suitable source of vacuum (not shown).

If desired, the oil which is circulated through the control chamber may be brought into heat exchange relationship with the bearings 58 and/or the sealing or packing means therefor, and/or the gears. These elements may thus be cooled and/or lubricated. The arrangement of the parts may be such that the oil is moved serially past the parts to be cooled and/or lubricated as well as through the pump members 11 and 12. Alternatively, one or more separate or parallel paths may be provided for the oil which serves for a purpose other than to cool the pump members 11 and 12. In such alternative arrangement, additional pumping means may be provided for pumping the oil along such parallel paths. The additional pumping means may include one or more additional pumps which are operatively connected to one of the pump members in such a manner as to be actuated thereby during rotation of the pump members.

Pump 20 can supply sufficient pressure to force the oil injected into the tubes 13 and 14 through the passages 11a and 12a.

The embodiment shown in Fig. 2 is similar to that shown in Fig. 1 in that it includes a pump housing 150 forming a pumping chamber 151. The shafts 101 and 102 support the pump members 111 and 112 for rotation relative to the pump housing, the shafts having axle portions extending into the chambers 121 and 117 formed by the shells 154 and 155, respectively. The connecting conduit 122 interconnects the chambers 117 and 121, and a heat exchange means 118, including its temperature-responsive control means 119, is arranged at the bottom of the chamber 117. The embodiment of Fig. 2 differs from that shown in Fig. 1 in that the shafts 101 and 102 are formed with conduits 101a and 102a, respec-

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tively. The right open end of the conduit 101a opens into the chamber 117 and the right end of the conduit 102a is formed with radial bores 102b which place the right end portion of the conduit 102a in communication with the chamber 117. The left end portions of the shafts 101 and 102 are formed with interior collar portions 123 and 124, respectively, which are adapted to receive the free ends of the tubes 113 and 114 through which the pump 120 injects the oil into the conduits 101a and 102a. Once the pump 120 has so injected the oil, the centrifugal force will normally suffice to move the oil rightwardly through these conduits 101a and 102a in the direction of the arrows. The cross sectional areas of the conduits 101a and 102a, particularly the right-hand end portions thereof, are greater than the cross sectional areas of the tubes 113 and 114, respectively. Pump 120 may be relied on to force the oil through the conduits 101a and 102a.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of pumps differing from the types described above.

While the invention has been illustrated and described as embodied in a Roots blower or Lysholm rotary compressor, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an apparatus of the type described, in combination, housing means including first wall means defining a working chamber and including a pair of opposite walls constituting walls of said working chamber, said housing means including second wall means defining with each of said opposite walls a fluid-tight bearing chamber exterior of said working chamber; at least one rotor having a work portion in said working chamber and a pair of opposite axle portions projecting through said opposite walls, respectively, for turnably supporting said rotor on said opposite walls, said rotor being formed with conduit means in said work portion and in said axle portions opening in port means respectively located in said axle portions outside of said opposite walls and in said bearing chambers; a cooling medium located in said bearing chambers; pump means having an inlet means in said cooling medium and an outlet means connected to said port means for circulating said cooling medium through said conduit means in said rotor and through said bearing chambers; and fluid-tight closed evacuating conduit means on said second wall means communicating with said bearing chambers and adapted to serve for the evacuation of said bearing chambers to substantially the same pressure as produced by said rotor in said working chamber so that no leakage takes place between said working chamber and said bearing chambers.

2. In an apparatus of the type described, in combination, housing means including first wall means defining a working chamber and including a pair of opposite walls constituting walls of said working chamber, said housing means including second wall means defining with each of said opposite walls a fluid-tight bearing chamber exterior of said working chamber; at least one rotor having a work portion in said working chamber and a pair of opposite axle portions projecting through said opposite walls, respectively, for turnably supporting said rotor on

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said opposite walls, said rotor being formed with conduit means in said work portion and in said axle portions opening in port means respectively located in said axle portions outside of said opposite walls and in said bearing chambers; a liquid cooling medium located in a first portion of each of said bearing chambers, said bearing chambers having second portions in which said axle portions are located spaced from said liquid cooling medium; pump means having an inlet communicating with said first portions of said bearing chambers and outlet conduit means connected to said port means for circulating said cooling medium through said conduit means in said rotor and through said bearing chambers; and fluid-tight closed evacuating conduit means on said second wall means communicating with said second portions of said bearing chambers and adapted to serve for the evacuation of said second portions of said bearing chambers to substantially the same pressure as produced by said rotor in said working chamber so that no leakage takes place between said working chamber and said bearing chambers.

3. In an apparatus of the type described, in combination, housing means including first wall means defining a working chamber and including a pair of opposite walls constituting walls of said working chamber, said housing means including second wall means defining with each of said opposite walls a fluid-tight bearing chamber exterior of said working chamber; at least one rotor having a work portion in said working chamber and a pair of opposite axle portions projecting through said opposite walls, respectively, for turnably supporting said rotor on said opposite walls, said rotor being formed with conduit means in said work portion and in said axle portions opening in port means respectively located in said axle portions outside of said opposite walls and in said bearing chambers; a liquid cooling medium located in a lower portion of each of said bearing chambers, said bearing chambers having higher portions in which said axle portions are located spaced from said liquid cooling medium; pump means having an inlet communicating with said lower portions of said bearing chambers and outlet conduit means connected to said port means for circulating said cooling medium through said conduit means in said rotor and through said bearing chambers; and fluid-tight closed evacuating conduit means on said second wall means communicating with said higher portions of said bearing chambers and adapted to serve for the evacuation of said higher portions of said bearing chambers to substantially the same pressure as produced by said rotor in said working chamber so that no leakage takes place between said working chamber and said bearing chambers.

4. In an apparatus of the type described, in combination, housing means including first wall means defining a working chamber and including a pair of opposite walls constituting walls of said working chamber, said housing means including second wall means defining with each of said opposite walls a fluid-tight bearing chamber exterior of said working chamber; at least one rotor having a work portion in said working chamber and a pair of opposite axle portions projecting through said opposite walls, respectively, for turnably supporting said rotor on said opposite walls, said rotor being formed with conduit means in said work portion and in said axle portions opening in port means respectively located in said axle portions outside of said opposite walls and in said bearing chambers; a liquid cooling medium located in a lower portion of each of said bearing chambers, said bearing chambers having higher portions in which said axle portions are located spaced from said liquid cooling medium; pump means having an inlet communicating with said lower portions of said bearing chambers and outlet conduit means connected to said port means for circulating said cooling medium through said conduit means in said rotor and through said bearing chambers; heat exchange means in said lower portion of at least one of said bearing cham-

bers for cooling said cooling medium; and fluid-tight closed evacuating conduit means on said second wall means communicating with said higher portions of said bearing chambers and adapted to serve for the evacuation of said higher portions of said bearing chambers to substantially the same pressure as produced by said rotor in said working chamber so that no leakage takes place between said working chamber and said bearing chambers.

5. In an apparatus of the type described, in combination, housing means including first wall means defining a working chamber and including a pair of opposite walls constituting walls of said working chamber, said housing means including second wall means defining with each of said opposite walls a fluid-tight bearing chamber exterior of said working chamber; at least one rotor having a work portion in said working chamber and a pair of opposite axle portions projecting through said opposite walls, respectively, for turnably supporting said rotor on said opposite walls, said rotor being formed with conduit means in said work portion and in said axle portions opening in port means respectively located in said axle portions outside of said opposite walls and in said bearing chambers; a liquid cooling medium located in a first portion of each of said bearing chambers, said bearing chambers having higher portions in which said axle portions are located spaced from said liquid cooling medium; a connecting conduit means connecting said lower portions of said fluid-tight bearing chambers with each other and being filled with said cooling medium; pump means located in one of said bearing chambers and having an inlet opening into said cooling medium in the lower portion of said one bearing chamber and outlet conduit means connected to said port means in said one bearing chamber for circulating said cooling medium through said conduit means in said rotor, through the other bearing chamber, and through said connecting conduit means; heat exchange means in said lower portion of at least one of said bearing chambers for cooling said cooling medium; and fluid-tight closed evacuating conduit means on said second wall means communicating with said higher portions of said bearing chambers and adapted to serve for the evacuation of said higher portions of said bearing chambers to substantially the same pressure as produced by said rotor in said working chamber so that no leakage takes place between said working chamber and said bearing chambers.

6. An apparatus as set forth in claim 5 and including gear means located in said one of said bearing chambers

and connecting the respective axle portion with said pump means for driving the latter; wherein the other of said axle portions extends through the other bearing chamber and has a portion projecting out of said housing means so as to be driven, and wherein said conduit means in said pump rotor terminates in said other axle portion in the region of said other bearing chamber in at least one radial conduit portion ending in said port of said other axle portion.

7. An apparatus as set forth in claim 5 and including heat exchange means located in the lower portion of said other control chamber for cooling said liquid cooling medium.

8. An apparatus as set forth in claim 5 and comprising another pump rotor including a work portion located in said pump chamber cooperating with said work portion of said first-mentioned pump rotor and two axle portions turnably mounted in said opposite walls and respectively projecting into said bearing chambers, said other pump rotor being formed with other conduit means in said work portion and said axle portions opening in port means respectively located in said last-mentioned axle portions outside of said opposite walls and in said bearing chambers; and wherein said outlet conduit means of said pump means includes an outlet conduit portion connected to said port in the axle portion of said other pump rotor located in said one bearing chamber so that said liquid medium is circulated through said conduit means in both said pump rotors and the other bearing chamber.

9. An apparatus as set forth in claim 8 wherein said pump rotors are spaced by a gap from the inner surface of said working chamber; and wherein each of said conduit means in said pump rotors includes radially extending conduit portions and axially extending conduit portions located near the outer surface of the work portion of the respective pump rotor.

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