April 6, 1954 T. R. WIESEMAN 2,674,404

TURBOCOMPRESSOR FOR REFRIGERATING APPARATUS

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Fig. 1.

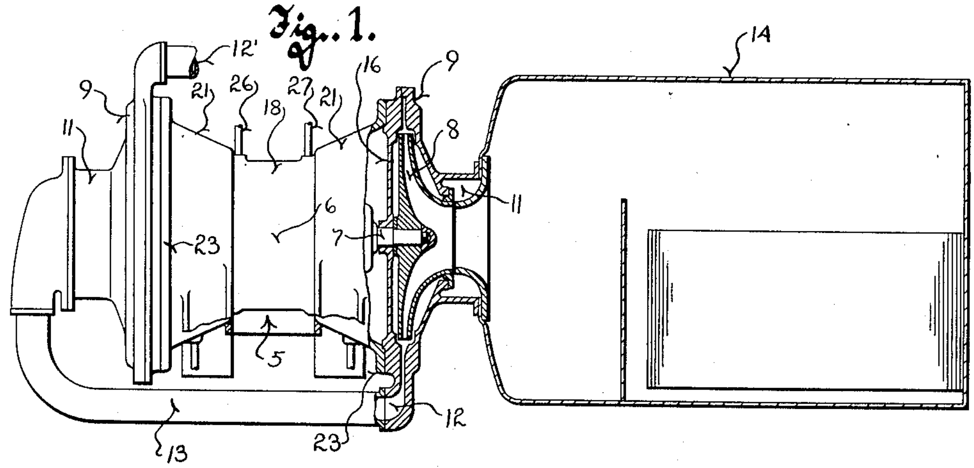

Fig. 2.

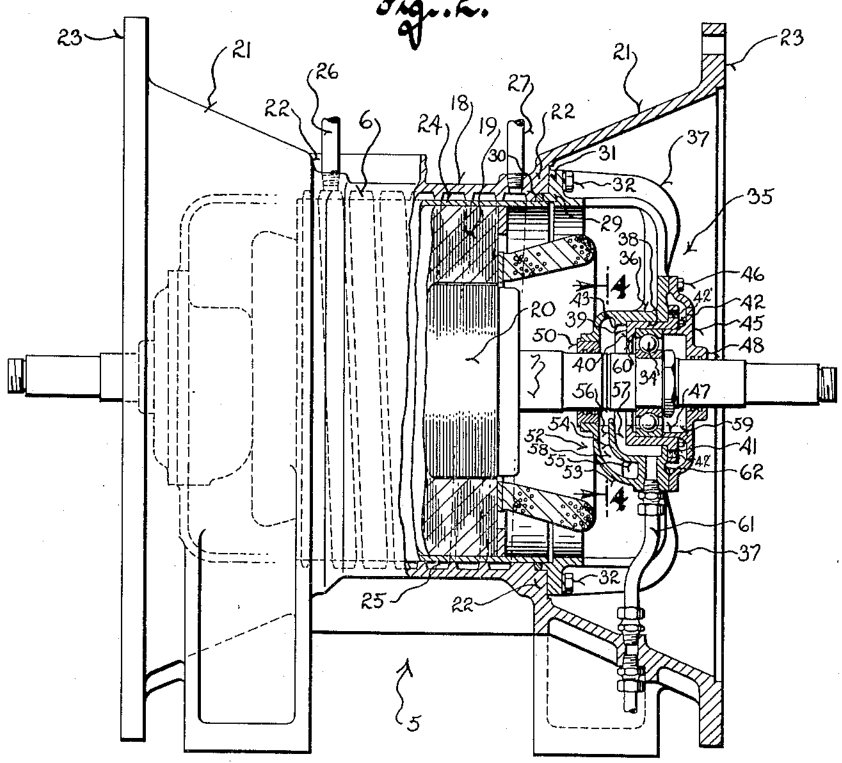

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Fig. 3.

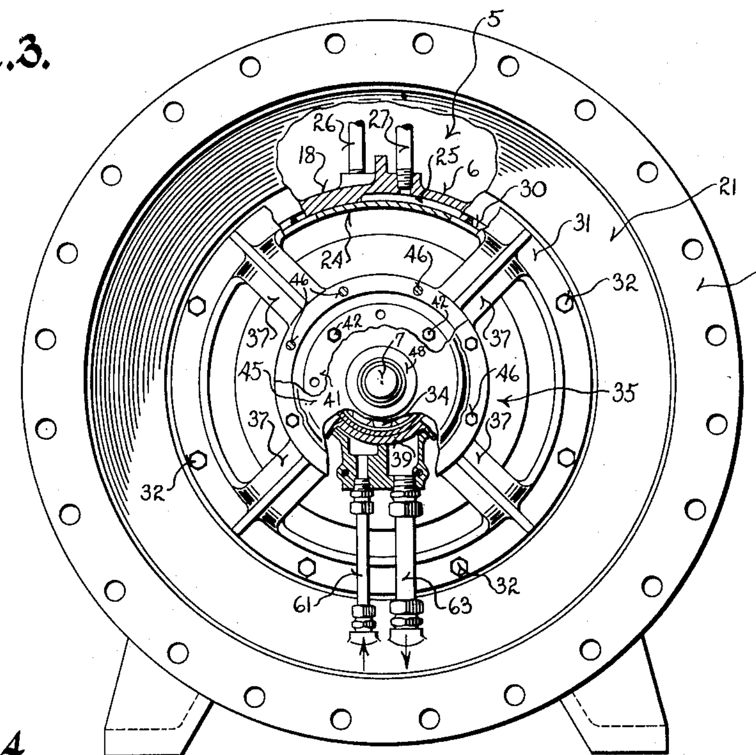


Fig. 4.

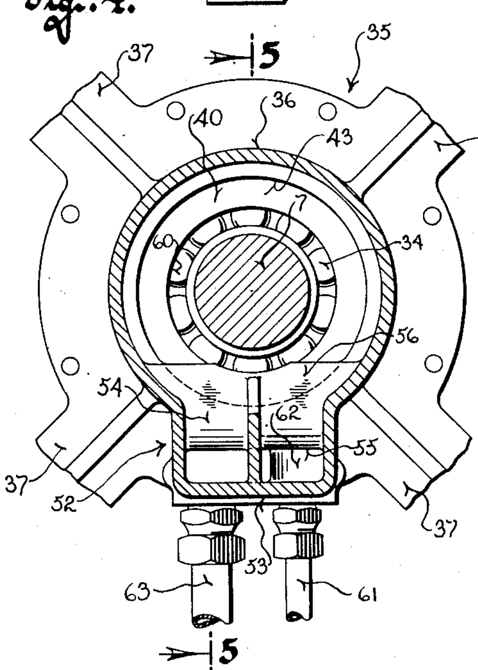
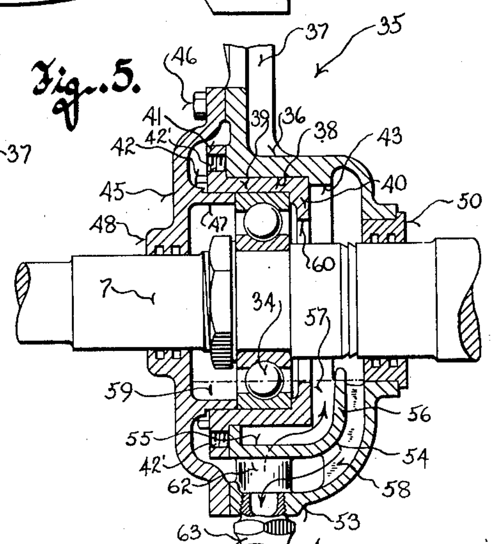


Fig. 5.



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Patented Apr. 6, 1954 2,674,404

UNITED STATES PATENT OFFICE

2,674,404

TURBOCOMPRESSOR FOR REFRIGERATING APPARATUS

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Application December 26, 1950, Serial No. 202,716

1 Claim. (Cl. 230—117)

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This invention relates to refrigerating apparatus and has more particular reference to improvements in turbo compressors used with such apparatus.

Turbo compressors of the type herein concerned comprise an electric motor having a shaft projecting from each end to drive the impeller of a compressor. These impellers are mounted directly upon the ends of the motor shaft, and each operates in a housing provided with an inlet opening coaxial with the motor shaft and an outlet opening remote from the axis of the motor shaft.

The two impellers thus provide first and second stage compressors, the inlet of one compressor being connectable with an evaporator tank containing a supply of cold refrigerant at subatmospheric pressure, and its outlet being communicated with the inlet of the second compressor at the opposite end of the motor.

Heretofore the cooling of the electric motor and the provision of a satisfactory lubricating system for the motor shaft bearings has presented a difficult problem in a turbo compressor of this type. One expedient resorted to in the past for cooling the motor involved circulation of the cold refrigerant gas over the motor parts by the first stage compressor during transfer of the gas to the second stage compressor at the opposite end of the motor. This, of course, necessitated mounting the motor and both compressors in a duct-like shell or casing to constrain the refrigerant gas issuing from the first stage compressor to flow over the motor parts in order to reach the inlet of the second stage compressor.

With such a cooling system for the electric motor, the entire interior of the casing containing the turbo compressor was maintained at subatmospheric pressure, that of the refrigerant gas being transferred from the first to the second stage compressors; and it was extremely difficult to effectively seal the bearings for the motor shaft to prevent the loss of lubricant from these bearings.

Schemes such as that disclosed in the Waterfill Patent No. 2,266,107 which deal with this problem upon the basis of maintaining a zone of compressed refrigerant vapor around the shaft at the mouth of the bearing are subject to objectionable admixture of oil and refrigerant which leads to foaming and frothing within the system and the need for subsequently disassociating the oil and refrigerant. This is not always easy of accomplishment.

The present invention overcomes the objec-

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tions of such schemes as that of the Waterfill patent through the provision of a closed lubricating system for each bearing connected with an external source of lubricant under pressure and an externally located reservoir, and incorporates a novel arrangement of oil passages at the bearing by which an adequate supply of lubricant is at all times assured for the bearing and at the same time the total quantity of lubricant within the system is held to a negligible minimum.

Another object of this invention is to provide an improved turbo compressor wherein the interiors of the motor and compressor housing are isolated from one another so that the motor parts are not in anywise influenced or affected by the compressors and the refrigerant handled thereby.

More specifically it is an object of this invention to provide a turbo compressor wherein the motor has a substantially tubular housing and wherein the compressor housings have walls extending across the open ends of the motor housing to serve as closures therefor and by which the interior of the motor housing is isolated from the compressors with the bearings located within the motor housing.

Another feature of this invention involves the specific manner in which the bearings are constructed with a view toward facilitating pulling the bearings and obviating the need for a bearing puller which is not always readily available in the field.

Another object of this invention resides in the provision of simple but highly effective means for cooling the motor without subjecting it to the cooling effects of the refrigerant gas.

With the above objects in view, together with others that will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claim; it being understood that such changes in the precise embodiment of the herein disclosed invention may be made as come within the scope of the claim.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a view partly in elevation and partly in section illustrating the turbo compressor of this invention and showing the same connected with the evaporating tank of a refrigerating system;

Figure 2 is an enlarged view of the motor unit per se, parts thereof being broken away and shown in section to illustrate interior construction;

Figure 3 is an elevational view looking at the right hand end of the motor shown in Figure 2, with parts of the motor housing broken away and shown in section;

Figure 4 is a detail cross-sectional view on an enlarged scale taken through Figure 2 along the plane of the line 4—4; and

Figure 5 is a sectional view taken through Figure 4 along the line 5—5.

Referring now more particularly to the accompanying drawings in which like numerals designate like parts throughout the several views, the numeral 5 generally designates an electric motor contained within a substantially tubular housing 6, and having a shaft 7 projecting from the opposite open ends of the housing to drive centrifugal impellers 8. Each of the impellers is contained within a compressor housing 9, and these housings are secured to the opposite ends of the motor housing 6. Each compressor housing is entirely enclosed except for an inlet 11 coaxial with the motor shaft and an outlet 12 remote from the axis of the motor shaft; the housings having their inlets facing in opposite directions, that is at their sides remote from the electric motor.

By way of illustration, Figure 1 shows the inlet 11 of the first stage compressor housing, at the right hand end of the electric motor, communicated with the interior of an evaporating tank 14, forming part of a refrigerating apparatus, to receive cold gas at subatmospheric pressure therefrom. The pressure of the gaseous refrigerant is raised slightly in the first stage compressor and issues from its outlet 12 to be conducted into the inlet of the second stage compressor, at the opposite end of the electric motor, through a duct 13 connected therebetween.

From the outlet 12′ of the second stage compressor the gaseous refrigerant may be conducted into the third and fourth stage compressors of a second turbo compressor (not shown) before it is discharged into the condensing tank of the apparatus.

With the arrangement described, it will be noted that each compressor housing has a wall 16 which extends entirely across the adjacent open end of the motor housing to provide an end closure therefor. These closure walls, however, are provided with suitable axial apertures to snugly but rotatably receive the motor shaft 7. The inner end walls 16 of the compressor housing thus prevent the entrance of the gaseous refrigerant into the motor housing and consequently isolate it from the refrigerating system. Thus all of the gas acted upon by the first and second stage compressors is by-passed around the motor housing, which leaves the interior of the motor housing uninfluenced by the subatmospheric pressure of the gas except to the extent that leakage through the axial apertures in the walls 16 through which the shaft passes may diminish the pressure within the motor housing.

The motor 5 is of novel construction particularly by reason of the means incorporated therein for cooling the same and for lubrication of its bearings. Referring to Figure 2 it will be noted that the tubular motor housing comprises a substantially cylindrical intermediate section 18 in which the stator 19 and rotor 20 are located, and end sections 21 larger than the intermediate section and joined thereto by outwardly directed circumferential flanges 22 on the ends of the intermediate section. The end sections connect with the peripheral portions of the flanges 22 and their walls diverge outwardly therefrom to terminate in circumferential flanges 23 extending entirely around the open ends of the housing.

Provision for cooling the motor and particularly the stator 19 thereof is made possible by the provision of a thin metallic sleeve or shell 24 telescoped over the stator core, in heat transfer relationship therewith, and into the interior of the intermediate section 18 of the motor housing to have its exterior surface engaged thereby. On its interior, the intermediate housing section 18 of the motor has a helical groove 25 of several convolutions opening to the exterior of the shell 24, with the ends of the groove terminating adjacent to the ends of the rotor.

Inlet and outlet pipes 26 and 27 threading into ports communicating with the terminal ends of this groove provide for forced circulation of a heat absorbing medium such as water through the passageway afforded by the convolutions of the groove, to absorb heat from the shell 24 transferred thereto from the stator. Effective control of the temperature of the stator core can thus be obtained.

It is essential, of course, to prevent the cooling water or other medium circulated through the passageway afforded by the groove 25 from escaping beyond the ends of the shell 24, and for this purpose the motor housing is provided with a packing gland 29 at each end of the shell and encircling the same. Each gland includes a yieldable sealing ring 30 received in a circumferential groove in the outer face of the flange 22 and held compressed against the exterior of the shell by means of a pressure ring 31 attached to the outer face of the flange 22 as by screws 32.

Each end of the motor shaft 7 is rotatably journalled in a ball bearing 34 inside the adjacent end section of the motor housing and carried by a bearing supporting structure 35. The supporting structure, in the present case, comprises an annular hub 36 encircling the ball bearing and joined to the pressure ring 31 by a plurality of substantially radial arms 37. The hub 36, however, has a bore 38 large enough to slidably receive the cylindrical side wall of a bearing cup 39 in which the bearing is received with its outer race engaged against an inwardly directed flange 40 at the bottom of the cup. The outer or opposite end of the cup has an outwardly directed flange or rim 41 thereon which overlies the outer face of the hub. Bolt holes at a number of locations in the rim 41 receive screws 42 which thread into the hub 36 and thus detachably hold the bearing cup and the bearing therein in place in the hub. In the present case, the screws 42, when tightened, draw the bottom of the bearing cup firmly against an abutment 43 in the bore of the hub to define the axial position of the cartridge which the bearing element and its cup provide.

A feature of the bearing construction described is that it may be readily removed without the use of special tools. This may be accomplished by removing the screws 42 and threading them in tapped holes 42′ in the rim 41, to force the ends of the screws against the hub and thereby draw the bearing cartridge axially out of the hub.

The ball bearing is retained within its cup by a cap 45 encircling the motor shaft and detachably secured to the outer face of the hub as by screws 46 in a position overlying the rim of the bearing cup. This cap is provided with a cylindrical neck 47 on its inner side which projects into the bearing cup to have its extremity closely adjacent to or even engaged with the outer race of the ball bearing so that the latter is confined between the neck and the bottom of the cup. The cap 45, of course, has a hub-like part 48 which substantially closely encircles the motor shaft and which may have seals in its bore to prevent oil supplied to the bearing from seeping out along the shaft.

At its inner end, the hub 36 is extended inwardly a short distance beyond the abutment 43 and has an annular auxiliary shaft supporting bushing 50 fixed thereto and capable of supporting the motor shaft during such times as the ball bearing is removed from the shaft for inspection and/or replacement. The bushing 50 may also have sealing means in its bore to prevent seepage of oil supplied to the bearing element inwardly along the motor shaft.

With the bearing construction described it will be apparent that the bearing cap 45, the hub 36, and inner extension thereon with its bushing 50 comprise a housing completely enclosing the ball bearing 34, and into which oil may be conducted and circulated to effect cooling of the bearing. According to this invention, the wall of the hub 36 is offset outwardly or downwardly as at 52 to provide a pocket having a bottom 53 spaced a substantial distance below the side wall of the bearing cup. A baffle 54 extends across the upper portion of this pocket and has a horizontal wall 55 abutting the underside of the rim 41 of the bearing cup and lying intermediate the bottom of the pocket and the side of the bearing cup; and an upstanding portion 56 disposed intermediate the bottom 40 of the cup and the wall at the inner end of the hub.

Hence, it will be seen that the baffle walls 55 and 56 divide the lower portion of the bearing housing into inner and outer chambers 57 and 58 respectively, each opening upwardly toward the motor shaft at the inner end of the bearing housing, adjacent to the shaft supporting bushing 50, between the latter and the ball bearing 34. It will be noted that the bearing cup 39 and the cap 45 which closes its open outer end cooperate to define a reservoir 59 beneath the motor shaft in which the bearing 34 operates. The reservoir, of course, is communicated with the inner chamber 57 adjacent to the underside of the motor shaft by a central hole 60 in the bottom wall or flange 40 on the bearing cup, the hole having a diameter slightly greater than that of the ball circle of the ball bearing.

Oil is forced upwardly into the inner chamber 57 through a pipe line 61 connecting with a port in the bottom wall 53 of the hub pocket, and communicated with the inner chamber 57 through a bored neck 62 extending between the horizontal portion 55 of the baffle and the bottom wall 53 of the pocket. The oil thus introduced into the inner chamber 57 flows upwardly between the upstanding baffle portion 56 and the flange or bottom 40 of the bearing cup 39. Since the upper edge of the upstanding baffle portion 56 is at a level somewhat higher than that of the adjacent edge of the hole 60 in the bottom of the bearing cup, part of the oil overflows through the hole 60 and into the reservoir 59 to maintain the same filled with oil at a depth partially submerging the lowermost balls of the ball bearing. The remainder of the oil flowing upwardly in the outer chamber 57, of course, flows over the weir provided by the upstanding portion 56 of the baffle and into the outer chamber 58, from which it is led out of the bearing housing by means of a drain line 63 communicating with the lower portion of the outer chamber 58 through a suitable port in the bottom wall 53.

With this arrangement a continuous stream of oil may be positively circulated through the interior of the bearing housing to at all times maintain a small though fully adequate supply of oil in the reservoir 59 to insure proper lubrication for the bearing 34 and at the same time effect a degree of cooling of the bearing.

The oil supply and drain lines 61 and 63 respectively lead downwardly inside the end sections of the motor housing and are secured in suitable ports in their walls which provide for connection of outside supply and return lines forming part of a circulatory system including a pump (not shown) outside the motor housing and by which oil is positively fed to the bearing through the line 61.

Again referring to Figure 1, it will be noted that the end wall 16 of each compressor housing closes off the adjacent end of the motor housing so that the bearing housing therein is substantially uninfluenced by the subatmospheric pressure obtaining in the compressor housings.

From the foregoing description, taken together with the accompanying drawings, it will be readily apparent to those skilled in the art that this invention provides an improved motor-compressor assembly wherein the refrigerating gas handled by the compressor is completely by-passed around the motor and its housing; and featuring a unique cooling and lubricating system for the motor and its bearings.

What I claim as my invention is:

In a motor-compressor assembly of the type wherein the compressor comprises a centrifugal impeller and a housing for the impeller having a disc-like end wall which is imperforate except for a hole in its center; a motor housing having a substantially cylindrical medial section comprising inner and outer tubular members having radially spaced portions defining a circumferential fluid passageway in the wall of the medial housing section through which passageway a fluid cooling medium may be circulated, a coaxial annular end section fixed to one end of the medial housing section and larger in diameter than said medial housing section, and a continuous circumferential flange on the housing extending radially between and joining said end of the medial housing section with the end section of the motor housing, said flange having a surface facing away from the medial housing section and lying in a plane normal to the housing axis; an electric motor in the motor housing, including a stator fixed inside said inner tubular member in heat transfer relation therewith, a rotor operable inside the stator, and a motor shaft carrying the rotor and projecting coaxially through and beyond said end housing section; means providing a fluid tight joint between said tubular members adjacent to the junction between said motor housing sections, comprising an annular sealing element encircling the inner tubular member and seated in a substantially shallow annular groove in said end of the medial housing section, said groove opening to said surface of the housing flange and the sealing element being confined between said tubular members in the bottom of said groove, and a ring seated on said surface of the housing flange and secured to the latter, said ring bearing axially against the sealing element to hold the same in the bottom of its groove and tightly engaged between said tubular members; a bearing carried by said ring and in which the adjacent end portion of the motor shaft is journalled, said bearing being located wholly within said end section of the motor housing; and a mounting flange on the outer end of said housing end section providing for attachment of the latter to said imperforate end wall of the compressor housing with the motor shaft closing the hole in said end wall and projecting therethrough for driving engagement with the impeller.

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