Dec. 29, 1942. A. A. McCORMACK 2,306,632

REFRIGERATING APPARATUS

Filed Sept. 28, 1940 2 Sheets-Sheet 1

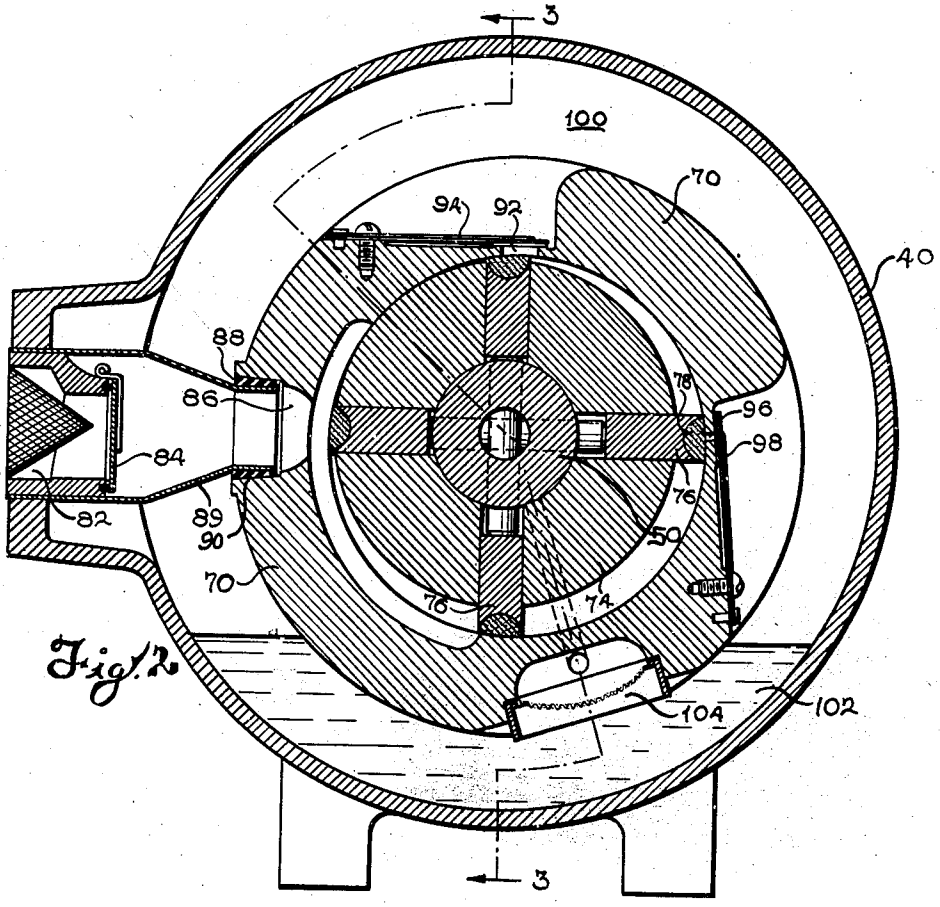


Fig. 2

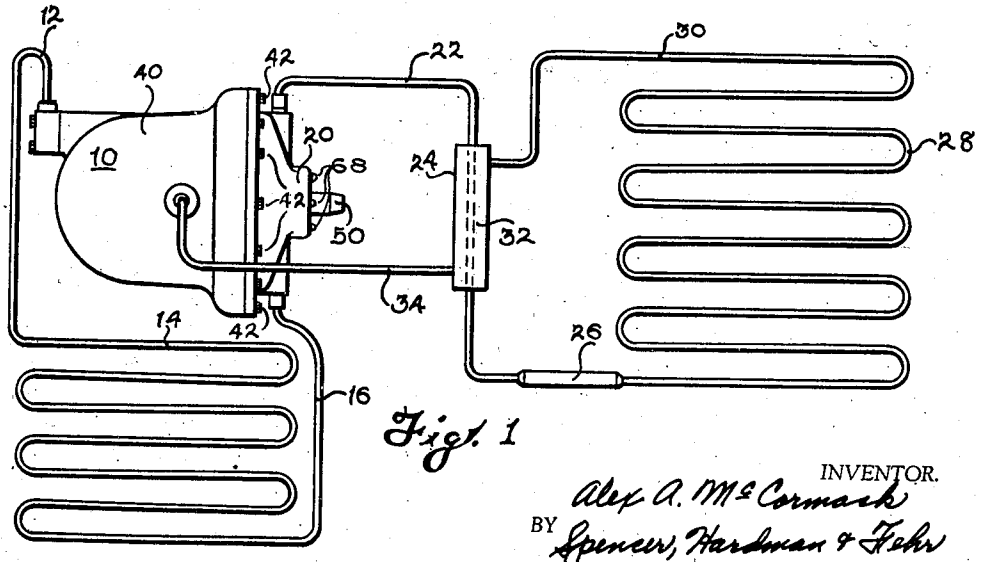


Fig. 1

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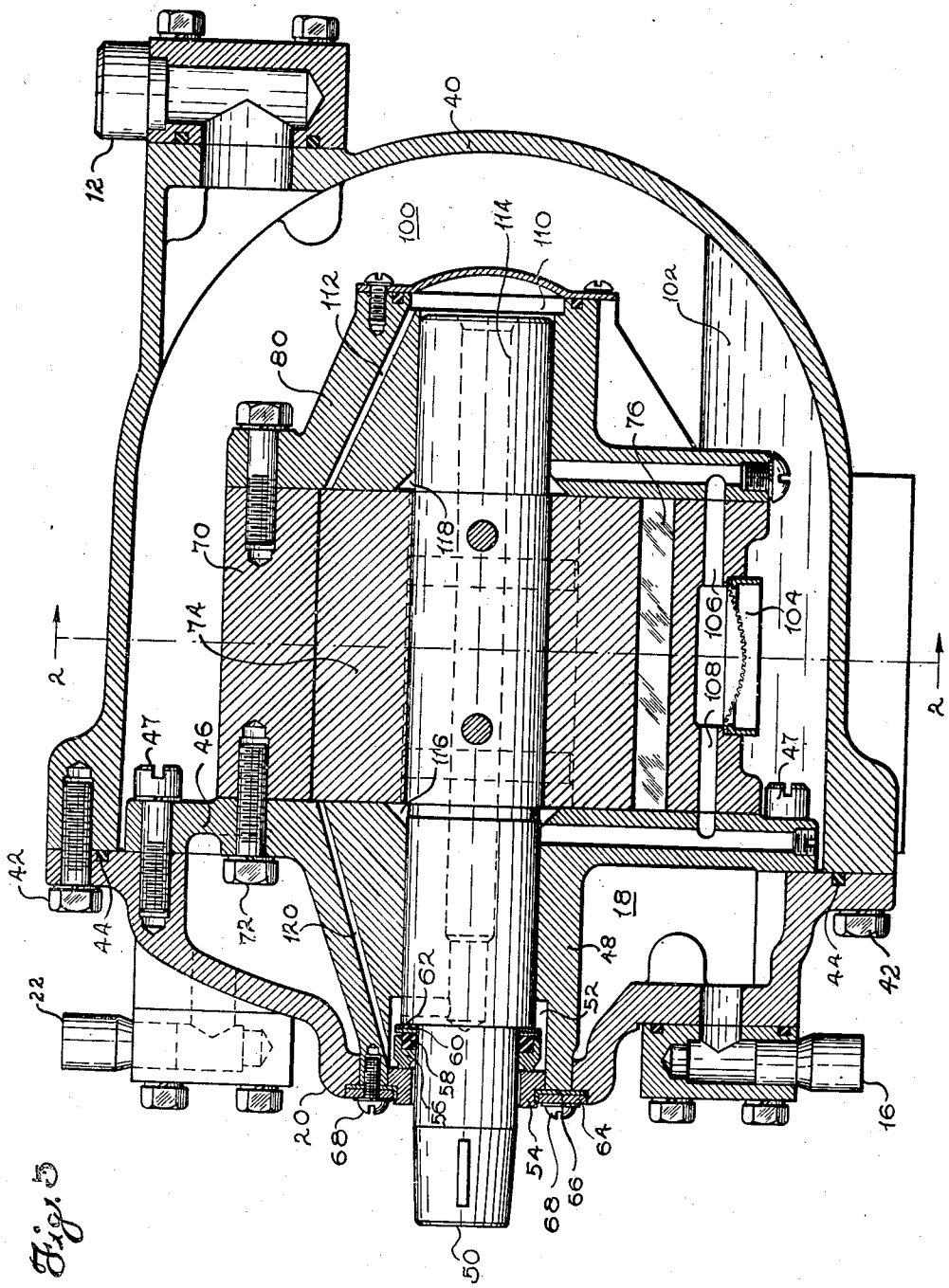


Fig. 5

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2,306,632

REFRIGERATING APPARATUS

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10 Claims. (Cl. 62—115)

This invention relates to refrigerating apparatus and more particularly to an improved refrigerant system employing a high speed rotary compressor.

Numerous attempts have been made from time to time to make certain parts of a rotary compressor unit from cast iron and other parts, such as the outer casing, from lighter weight metals such as aluminum. However, inasmuch as the coefficient of expansion of the desired lighter weight metals, such as aluminum, is not the same as the coefficient of expansion of iron, it has not been considered possible to make use of the lighter weight materials in any unit in which a refrigerant tight joint must be provided at the juncture of the two different types of metal.

Attempts have also been made to reduce the weight of a rotary compressor by increasing the capacity of a given weight compressor by increasing the speed of the compressor. However, these attempts have also proven unsuccessful prior to my invention, due to certain difficulties encountered in lubricating and cooling the various parts of the compressor mechanism. It is an object of this invention, therefore, to provide a compressor construction which overcomes these problems which have heretofore prevented the use of light weight, high speed, large capacity, rotary compressors.

A further object of this invention is to provide an improved arrangement for lubricating the compressor parts.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view, partly diagrammatic, showing a refrigerant system embodying my invention;

Fig. 2 is a cross sectional view of the compressor shown in Figs. 1 and 3, and taken on the line 2—2 of Fig. 3; and

Fig. 3 is a cross sectional view of the compressor shown in Figs. 1 and 2, and is taken on the line 3—3 of Fig. 2.

Referring now to Fig. 1, the reference numeral 10 designates a compressor which may be driven by means of an internal combustion engine (not shown) or any other suitable prime mover. The compressed gas leaves the compressor via the line 12 leading to the condenser 14 wherein the compressed refrigerant gas is converted into liquid refrigerant. Liquid refrigerant leaves the condenser 14 through the line 16 which conveys the liquid refrigerant into a shaft seal cooling chamber 18 formed in part by the aluminum casting 20. The refrigerant leaves the chamber 18 through line 22 which leads to the heat interchanger 24. After leaving the heat interchanger 24, the refrigerant is required to flow through a fixed restrictor 26 which may be of the capillary tube type or of the type disclosed in the Kucher patent, No. 2,063,745. After leaving the fixed restrictor, the refrigerant enters the evaporator 28 wherein the refrigerant is converted into vapor. The refrigerant vapor leaves the evaporator through the line 30 which is connected to the outer passage 32 of the heat interchanger 24. Inasmuch as the refrigerant vapor leaving the evaporator 30 is at a relatively low temperature, it will serve to re-liquefy any high pressure refrigerant which may have been vaporized in the chamber 18. After leaving the interchanger 24, the low pressure vapor is conveyed to the intake of the compressor 10 through the line 34.

Referring now to Fig. 3, in which a cross section of the compressor is shown, the reference numeral 40 designates an aluminum casting which is secured to the aluminum casting 20 by means of cap screws 42. A gasket 44, of any suitable material, such as neoprene, is provided between the aluminum casting 40 and the aluminum casting 20, so as to make the joint between the two castings gas tight. Inasmuch as the castings 20 and 40 are both made from aluminum, both will expand and contract at substantially the same rate in response to temperature changes.

The compressor mechanism proper is supported within the chamber formed by the aluminum castings 20 and 40 and includes an iron casting 46 bolted to the aluminum casting 20 by means of the cap screws 47. The iron casting 46 is provided with a bearing extension 48 in which the main compressor shaft 50 is journaled. The bearing extension 48 is recessed at 52 so as to provide a recess for the shaft seal which comprises a stationary sealing ring 54 carried by the bearing extension 48 and a movable sealing ring 56 which rotates along with the shaft 50. The stationary ring 54 is held in place by means of a metal washer 64 which in turn is held in place by means of the cap screws 68. The movable ring 56 is sealed to the shaft 50 by means of the neoprene ring 58 which is compressed into sealing engagement with the shaft 50 and the ring 56 by means of the spring washer 60. The washer 60 abuts against the shoulder 62 provided on the shaft 50. The shaft 50 may be driven by any suitable means (not shown) such as an electric motor or an

internal combustion engine which may be direct-connected or connected to the shaft by means of a belt or some similar power transmitting means.

The compressor is of the four-vane rotary type and includes the main cylinder 70 which is secured to the iron casting 46 by means of cap screws 72. The rotor element 74 is provided with the usual guideways for the vanes 76. Vanes 76 may be of cast iron construction or the equivalent, but the shoes 78 are preferably made of sintered iron. There are several advantages in using sintered iron shoes. One advantage is that the sintered iron shoes may be made very cheaply without a great deal of machining since it is possible to size a sintered iron shoe of this type merely by pushing it through a sizing die. Another advantage of using a sintered iron shoe is that a shoe of this type is substantially self-lubricating in that a certain amount of lubricant is absorbed by the sintered iron, and this lubricant is fed to the wearing surfaces directly through the pores of the sintered iron.

The iron casting 46 forms one end of the compression chamber, whereas the iron casting 80 forms the other end of the compression chamber. As best shown in Fig. 2, the low pressure refrigerant vapor enters the compressor through the screened inlet 82. The entering vapor passes through the check valve 84 on its way to the main inlet port 86 of the compressor proper. In order to prevent any of the high pressure refrigerant gas surrounding the compressor cylinder 70 from entering the low pressure inlet of the compressor a neoprene gasket 88 is provided between the main cylinder 70 and the inlet pipe 89. The gasket 88 is mounted within a tapered recess 90 provided in the side wall of the compressor cylinder 70. The gasket 88 is also tapered a small amount whereby as the conduit 89 is forced into the tapered recess of the gasket 88, a fluid tight joint is provided. The low pressure vapor entering the compressor through the inlet port 86 is compressed in the usual well-known manner which needs no further explanation. The compressed gas normally discharges through the outlet port 92 which is provided with the usual form of valve 94. Inasmuch as there may be times when the pressure within the main compression chamber exceeds the discharge pressure before the outlet port 92 is uncovered, I have provided a special relief port 96 which is normally closed by the valve element 98. This relief valve 98 prevents excessive pressures from building up within the main compression chamber. The compressed gas leaving the outlet port 92 discharges directly into the chamber 100 formed between the aluminum casting 40 and the iron casting 46. Inasmuch as the chamber 18 is normally filled with high pressure liquid refrigerant and the chamber 100 is filled with refrigerant gas at the same pressure, the tendency for leakage between the chamber 18 and the chamber 100 is very little. This is especially true in view of the fact that the chamber 18 is filled with liquid which helps to seal the joint between the aluminum casting 20 and the iron casting 46. By virtue of this particular arrangement it is possible to use aluminum for the outer casing and cast iron for the main dividing wall 46. This is possible notwithstanding the fact that the coefficient of expansion for aluminum is almost twice as great as the coefficient of expansion of iron. Furthermore, the presence of a single body of liquid refrigerant in direct thermal exchange with both the iron casting 46 and the aluminum casting 20 prevents large fluctuations in the temperature of the castings whereby the relative movement between the iron casting 46 and the aluminum casting 20 resulting from the great difference in the coefficient of expansion of these two elements is largely eliminated.

As best shown in Fig. 3, lubricant is supplied to the moving parts of the compressor from the main lubricant supply 102 in the chamber 100. Lubricant from the supply 102 enters the lubricant supply passages adjacent the bottom of the cylinder at 104. Lubricant entering at 104 is conveyed to the bearings through the passages 106 and 108. Inasmuch as the main body of lubricant 102 is under high pressure, this lubricant is automatically fed to the bearings through the oil feed passages 106 and 108. Oil flowing through the passage 106 tends to lubricate the right end of the four-vane rotor 74 as viewed in Fig. 3 and also serves to lubricate the right bearing of the shaft 50. An appreciable amount of lubricant will find its way along the bearing 50 into the end chamber 110 from whence a portion of the lubricant is supplied to the lubricant passage 112, from whence the lubricant finds its way into the low pressure side of the compressor. Another portion of the lubricant entering the end chamber 110 is supplied to the lubricant passage 114 formed by boring out the center of the shaft 50 as shown in Fig. 3. The lubricant flowing through the passage 114 enters the shaft seal cavity 52 provided at the left end of the shaft 50. Lubricant flowing through the passage 108 serves to lubricate the main bearing formed by the iron casting 46 and also serves to lubricate the left end of the four-vane rotor 74.

As shown in Fig. 3, cone-shaped cavities 116 and 118 are provided in the end walls of the castings 46 and 80 respectively, so as to facilitate lubrication of the moving parts. A certain amount of the lubricant entering the passage 108 will flow along the shaft into the shaft seal cavity 52 from whence the lubricant returns to the low pressure portion of the compression chamber through the lubricant passage 120. The inlet to the passage 120 is provided at a point in proximity to the main sealing surfaces of the shaft seal whereby the lubricant is required to pass directly in contact with the shaft seal before returning to the compressor through the passage 120.

As pointed out hereinabove, the main body of lubricant 102 is subjected to high side pressure, whereas the pressure within the compression chamber adjacent the discharge ends of the lubricant passages 112 and 120, is substantially equal to the low side pressure with the result that the difference in pressures causes an appreciable amount of lubricant to be fed to all of the surfaces which require lubrication. The sintered iron shoes 78 help to distribute the lubricant to the surfaces contacting the shoes and are capable of retaining a small reserve supply of lubricant during periods of shut down. This reserve supply of lubricant serves to lubricate the shoe surfaces when the compressor first starts up after a period of shut-down.

By virtue of the above described lubricating arrangement, it will be noted that the left end of the shaft 50 is subjected to atmospheric pressure and is also subjected to pressure by the shaft seal spring 60. The combined pressures of the atmosphere and the shaft steel spring 60 substantially equal the pressure exerted against the right end of the shaft by the lubricant in the chamber 110 when the compressor is in opera-

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tion. This balance between the pressures at the two ends of the shaft very materially reduces the wear on the compressor parts which would otherwise be required to absorb the end thrust of the shaft. It will also be noted that the pressure within the shaft seal cavity is relatively low whereby the danger of leakage at the shaft seal is greatly reduced.

While I have disclosed the use of aluminum castings for the main casing elements, it is to be understood that in referring to the use of aluminum that other light weight materials such as the magnesium alloys, duralumin and the like could be used.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A cast iron frame member, compressor mechanism secured to said frame member and having a shaft journaled in said frame member, a first aluminum casting enclosing a first portion of said frame member and forming with said frame member a first refrigerant chamber, a second aluminum casting secured to said first aluminum casting enclosing another portion of said frame member and forming a second refrigerant chamber, an inlet port for said compressor, an outlet port for said compressor discharging into one of said chambers and means for supplying high pressure liquid refrigerant to the other of said chambers whereby said liquid refrigerant is in thermal exchange with said frame member and one of said aluminum castings.

2. In combination a frame member, compressor mechanism carried by said frame member and including a tapered inlet port, housing means secured to said frame member and including an opening spaced from said tapered inlet port, means for conveying refrigerant from said opening to said inlet port comprising a refrigerant conduit secured to said housing means and removably projecting into said tapered inlet port, and gasket means within said tapered port surrounding said conduit means.

3. In combination a frame member, compressor mechanism carried by said frame member and including a tapered inlet port, housing means secured to said frame member and including an opening spaced from said tapered inlet port, means for conveying refrigerant from said opening to said inlet port comprising a refrigerant conduit secured to said outer casting and removably projecting into said tapered inlet port, and gasket means within said tapered port surrounding said conduit means, and a check valve supported within said conduit for preventing fluid from flowing from said inlet port through said opening.

4. In a refrigerant compressor, casing means, compressor mechanism within said casing, a drive shaft for said compressor mechanism having one end projecting through one wall of said casing and subjected to atmospheric pressure, shaft seal means preventing escape of refrigerant between said shaft and said casing, said shaft seal means including spring means tending to move said shaft inwardly of said casing, a fluid chamber adjacent the inner end of said shaft, and means for maintaining the pressure of the fluid in said chamber at a value whereby the pressure exerted by said fluid against the inner end of said shaft substantially equals the inward pressure exerted against said shaft by said spring means and the atmosphere.

5. Refrigerating apparatus comprising in combination, an evaporator, a compressor for withdrawing refrigerant vapor from said evaporator comprising a main frame having one coefficient of expansion and an outer casing secured to said frame and having a different coefficient of expansion, a condenser for condensing refrigerant discharged from said compressor, and means for conveying liquid refrigerant condensed by said condenser into thermal exchange relationship with said frame and said casing at the juncture of said frame and said casing, said compressor including a driving shaft projecting through said outer casing, and a shaft seal between said shaft and said casing having the stationary portion thereof carried by said main frame.

6. A compressor mechanism comprising in combination, a cast iron frame member, a compressor shaft journaled in said frame member, shaft seal means carried by said frame member, cast aluminum means secured to said frame member forming with said frame member a cooling chamber, compressor mechanism operated by said shaft and secured to said frame member, and cast aluminum means enclosing said compressor mechanism and forming with said frame member a lubricant and refrigerant chamber enclosing said mechanism.

7. A cast iron frame member, compressor mechanism secured to said frame member and having a shaft journaled in said frame member, a first aluminum casting enclosing a first portion of said frame member and forming with said frame member a first refrigerant chamber, a second aluminum casting secured to said first aluminum casting enclosing another portion of said frame member and forming a second refrigerant chamber, and means for supplying high pressure liquid refrigerant to one of said chambers whereby said liquid refrigerant is in thermal exchange with said frame member and one of said alumium castings.

8. In combination a frame member having one coefficient of expansion, compressor mechanism carried by said frame member and including a tapered inlet port, housing means having a different coefficient of expansion secured to said frame member and including an opening spaced from said tapered inlet port, means for conveying refrigerant from said opening to said inlet port comprising a refrigerant conduit secured to said outer housing and removably projecting into said tapered inlet port, and gasket means within said tapered port surrounding said conduit means.

9. In combination, pump mechanism including a frame member having one coefficient of expansion and provided with an inlet port, a housing member having a different coefficient of expansion than said frame member and enclosing said pump mechanism, means for conveying a fluid to be pumped from outside said housing to said inlet port comprising a conduit having a rigid connection to said housing member and a yieldable connection to said frame member.

10. A refrigerant compressor comprising in combination, a cast iron frame member, a cast iron compressor cylinder secured to said frame member, a compressor shaft journaled in said frame member, a multiple vane rotary compressing means rotated by said shaft and operating within said compressor cylinder, each of said vanes comprising a cast iron body portion and a sintered iron shoe portion, shaft seal means for

preventing the escape of lubricant along said shaft, an aluminum casing surrounding said shaft seal means and forming with said frame member a cooling chamber, a second aluminum casing secured to said first casing and forming with said frame member a lubricant and high pressure refrigerant reservoir into which the compressed gas is discharged, means for feeding lubricant from said high pressure reservoir to said shaft seal means, and means for supplying lubricant from said reservoir to said multiple vane compressing means including said sintered iron shoes, said cooling chamber being arranged to cool said shaft seal and to cool the juncture of said frame member with said first named aluminum casing.

ALEX A. McCORMACK.