

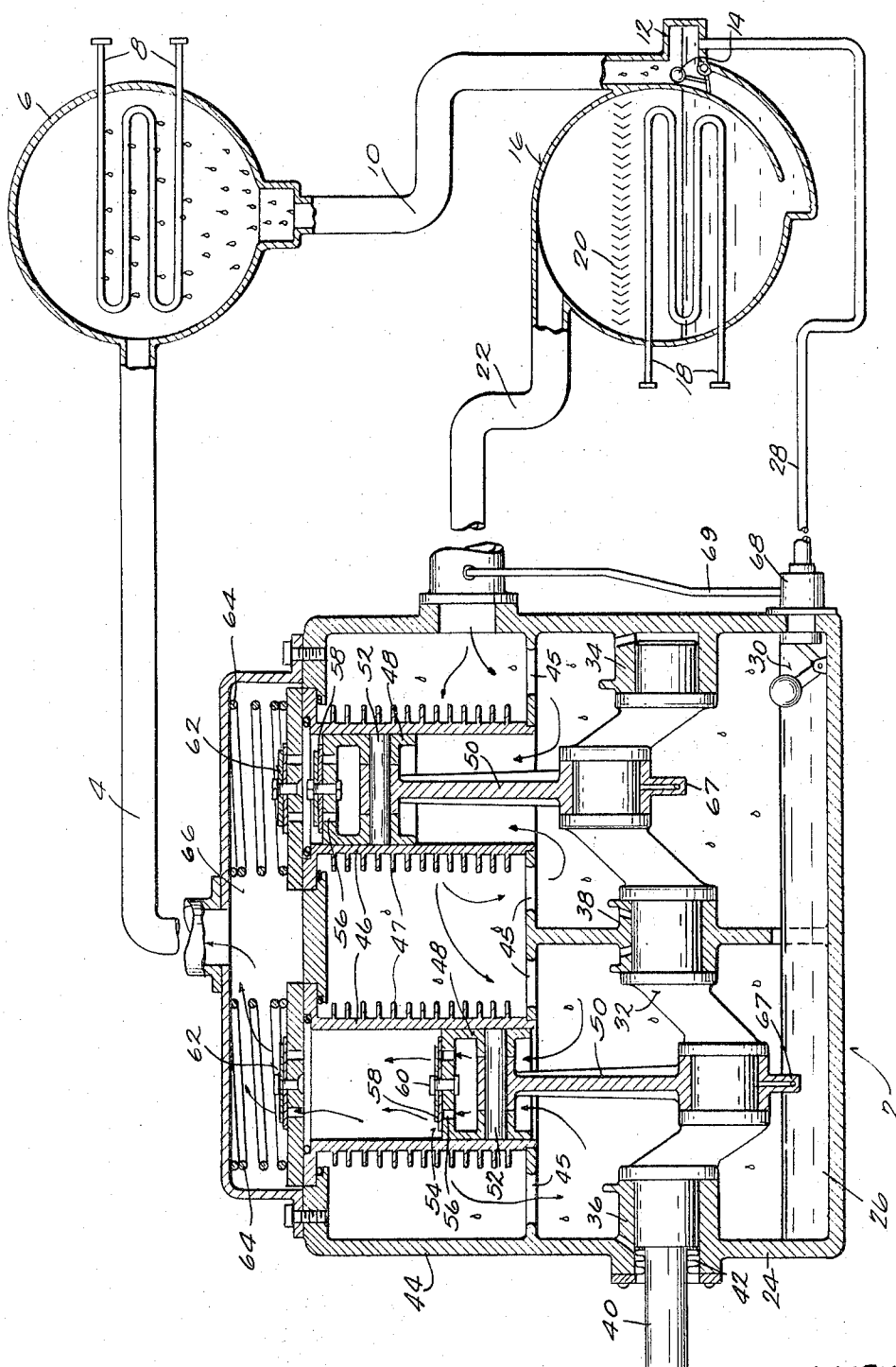
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OIL FREE REFRIGERANT COMPRESSOR

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OIL FREE REFRIGERANT COMPRESSOR

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This invention relates to refrigerant compressors especially suitable for use in a closed, gas-liquid system employing a recirculating refrigerant medium.

More specifically, this invention relates to an oil free compressor having an improved refrigerant cooling means. Such a compressor may find particular utility in a refrigeration system employing, by way of example, a medium such as freon as a refrigerant, and the present invention proposes to eliminate, or at least minimize, the need for lubricating the working parts of such compressors by utilizing the refrigerant to cool such parts during operation.

The invention is illustrated herein as applied to a compressor of the reciprocating type operating in a typical refrigerating system. As is well known, such reciprocating gas compressors commonly employ one or more cylinders having pistons therein for compressing purposes. The gas is drawn into cylinders on the suction stroke and compressed and discharged on the compression stroke. The pistons are generally reciprocated by a rotary crank shaft driven in a suitable manner by an electric motor or the like.

As is well explained by the principles of thermodynamics, heat is generated in the compressor by the compression of a gas. The friction produced by the crank shaft and pistons during the reciprocal operation of the compressor produces additional heat. For efficient operation of the compressor, heat from both of the above sources must be removed from the compressor, and it is customary practice to lubricate the working parts by supplying an abundance of lubricant to the crankcase and operating the crankshaft and attendant parts in such lubricant bath.

In addition, the heat generated by the compression of the gas has sometimes been removed by circulating a coolant around the outside of the cylinders. This may, for example, be ambient air, cooling water, or in the case of a closed system, the recirculating medium. However, the use of air or water to cool the compressor requires pumps or blowers to circulate the coolant and seals to prevent the coolant from leaking out or contaminating the gas being compressed. Such apparatus adds to the expense and complexity of the compressor.

Also, the use of the circulating medium or refrigerant in prior compressors has generally been confined to cooling of the cylinders or other parts of such machines as by conducting a portion of the refrigerant through jackets or similar enclosures surrounding or adjacent to the exterior of the part or parts to be cooled. Due to the fact that all such cooling by use of the refrigerant or a portion thereof has, in fact, been externally applied, the results have left much to be desired, and lubrication of working parts has still been necessary. In other words, these prior attempts to cool the working parts failed to bring the cooling medium into sufficiently close heat exchange relation with the parts to be cooled to be effective.

When the heat generated by the friction of the moving parts of the compressor is eliminated or reduced by employing a lubricant, generally oil, to reduce friction and cool the parts, the lubricant and the recirculating medium become intermixed to a considerable extent and are accordingly both present in the compressor. The lubricant thus entrained in and carried by the refrigerant also

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reduces the efficiency of the system, clogs its other mechanisms, and requires expensive traps in efforts to remove the oil.

The present invention, therefore, provides an improved gas compressor particularly adapted for use in a closed, gas-liquid system in which the working parts of the compressor are effectively cooled by the recirculating medium of the system to thereby eliminate the heat normally attendant compressor operation and the need for employing a lubricant which would normally become entrained in the medium. The apparatus necessary to circulate and seal a separate coolant are thereby eliminated at substantial cost savings, and the use of an oil lubricant which would become entrained in the circulating medium is likewise eliminated along with the need for oil separation or the like.

Furthermore, the present invention provides for such cooling by the circulating medium in a manner which does not substantially lessen the efficiency of the closed system.

Briefly, the invention provides a gas compressor for a closed, gas-liquid, recirculating medium system connected to a source of refrigerant medium within the system. The compressor has a crankcase including a sump for receiving liquid refrigerant. A crankshaft is journaled in bearings in the crankcase and is cooled directly by refrigerant as will be hereafter more fully described.

The compressor housing has an inlet for receiving gaseous refrigerant in the closed system. The compressor housing includes the compressing cylinders which preferably have a finned outer surface and are cooled by the gaseous refrigerant entering the housing. A piston is mounted in each of the cylinders and these pistons are connected to the crankshaft for reciprocation in the cylinders as the crankshaft is rotated. The pistons have check valves thereon which open on the suction stroke of the pistons.

In operation, gaseous refrigerant is drawn into the compressor housing via the inlet in the housing, then across the finned outer surface of the cylinders to cool the cylinders externally. The crankcase is ported to communicate with the housing, and the refrigerant gas thus passes into and through the crankcase to the suction side of the pistons. From the sump, liquid refrigerant is splashed about the working parts of the compressor, including the crankshaft and its attendant parts as well as the cylinders and pistons. Since the operating parts generate heat, the splashing refrigerant is caused to boil and extract such heat as it vaporizes, thereby cooling the parts. This augments the cooling accomplished by the vapor passing through the interior of the compressor.

The invention, both as to its construction, features, and method of operation, may be better understood by reference to the following specification and drawing, forming a part thereof, in which:

The figure is a sectional view of a reciprocating gas compressor of the present invention including the associated closed system shown more-or-less diagrammatically.

While the drawings and the subsequent description illustratively describe the present invention in the environment of a typical simplified refrigeration system, it is to be understood that its application is not limited exclusively thereto.

Referring now to the figure, there is shown therein a typical closed refrigerant system containing a reciprocating compressor 2 embodying the present invention. The discharge outlet of the compressor is connected to pipe line or conduit 4 which conducts compressed gaseous refrigerant to a condenser 6. Condenser 6 is shown as being of the shell-and-tube type in which water or the like flows through tubes 8 and the gaseous refrigerant is confined to the shell outside of and in heat exchange relation

to the tubes. The refrigerant condensed in condenser 6 flows by gravity through pipe line or conduit 10 to a receiver or chamber 12. A float 14 in the receiver or chamber 12 controls the flow of liquid refrigerant to an evaporator 16 wherein the cooling takes place in a well known manner with water or brine circulating through tubing 18 between the evaporator 16 and the cooling load served by the refrigeration apparatus to thereby transfer heat from the load to evaporator 16. In removing heat from the water or brine, the liquid medium in the evaporator 16 boils, forming a gas which passes through liquid eliminator 20 and then to suction pipe 22 connected to compressor 2.

Compressor 2 includes a crankcase 24 which has a sump 26 in the lower portion thereof for liquid refrigerant. Sump 26 may be conveniently connected to a source of the liquid refrigerant in the refrigeration system as by means of pipe or conduit 28 connected to the float chamber 12 as shown. The level of the refrigerant in sump 26 is controlled as by a float valve 30.

The crankshaft 32 is journaled in bearings 34, 36 and 38 of crankcase 24. These bearings may be of any suitable type and are typically shown as sleeve bearings in the figure. Bearings 34, 36 and 38 are preferably lined with a material having a low co-efficient of friction to thereby permit dry operation of the crankshaft 32. By way of example, Teflon (tetrafluoro-ethylene), nylon or other synthetic polyamides may provide suitable coatings for bearings 34, 36 and 38. Crankshaft 32 is rotated by an electric motor or other suitable power source (not shown) connected to shaft 40. A rotary seal, such as labyrinth seal 42, prevents the leakage into or out of compressor 2 along rotating shaft 40.

The compressor housing 44 is in open communication the crankcase 24 as by way of a number of ports 45, and the housing 44 is furthermore connected to pipe line or conduit 22 which provides the inlet to the compressor 2. The cylinders 46 are mounted in compressor housing 44, and the outer surfaces of the cylinders 46 preferably contain fins 47 for more effective heat exchange. While two such cylinders are shown in this figure, it will be appreciated that any desired number of cylinders may be employed. Additionally, the cylinders may be arranged in line, or in a V, or in horizontally opposed relation without departing from the scope or applicability of the present invention. Each cylinder has a piston 48 mounted therein and each piston is connected to the crankshaft 32 by connecting rods 50 and piston pins 52. These parts may also be coated with Teflon or the like, as mentioned above, to reduce friction between them.

Each of the pistons 48 has a check valve 54 mounted thereon which opens during the suction or downward stroke of piston 48 and closes during the upward or compression stroke. As shown in the figure, each check valve 54 may consist of ports 56 in the piston and flap 58 mounted on the face of piston 48. Flap 58 may be anchored to the face by pin 60 in any suitable manner to prevent complete displacement thereof. It will be appreciated that check valves 54 permit gas to flow upwardly through the ports in the pistons 48 during the downward stroke of the piston and is sealed by the gas above the pistons during the upward stroke thereof so that the space above the cylinders and pistons constitutes the compression chamber 66 communicating with the discharge line 4.

A check valve 62, similar in construction to check valve 54 may also be mounted on the upper end of each cylinder 46, each such check valve 62 being spring loaded as by a coil spring 64 to protect the compressor 2 from damage due to excessive gas pressure. The discharge chamber or manifold 66 collects the compressed gas from valves 62 and supplies it to pipe 4 for delivery to the condenser 20.

As indicated, the sump 26 of crankcase 24 is supplied with liquid refrigerant, and the level of liquid refrigerant

in the crankcase is maintained at the proper level by a float valve 30. Connecting the float chamber 68 with the suction inlet 22 is a pipe or conduit 69 to intermix liquid refrigerant with the incoming vapors. The level in the sump is such that splash cups or scoops 67 mounted on the connecting rods 50 will dip into the liquid refrigerant during rotation of the crank shaft 40, thus causing the splash cups 67 to scoop up liquid refrigerant and splash it around in the crankcase to thereby cause such liquid refrigerant to contact the warm operating parts and cause boiling or vaporizing of the refrigerant to aid in cooling the compressor parts internally and by direct heat exchange contact.

Cooling is accordingly provided to the working parts of the compressor 2 by the gaseous refrigerant entering via line 22 from evaporator 16 and containing liquid refrigerant intermixed therewith by way of conduit 69, such cooling being augmented by the splashing refrigerant. The gas enters compressor housing 44 and flows across the fins 47 and the outer surface of cylinders 46, thus serving to cool the cylinders exteriorly. The gas then flows through the ports 45 between the upper compressor housing 44 and the lower crankcase 24 and across the main bearings 34, 36 and 38, seal 42, and the bearings between connecting rods 50 and crankshaft 32 cooling these parts in its passage. The liquid refrigerant being splashed within the crankcase also serves to cool the various parts and the vapor created then passes from the crankcase into the lower ends of cylinders 46 and through check valve 54 on the suction stroke of pistons 48. The upward flow of refrigerant into cylinders 46 cools the interior of the cylinders, the connecting rods 50, piston pins 52, and pistons 48. On the compression stroke of piston 48, the gas in the cylinders 46 is compressed, sealing check valve 54. The compressed gas passes through valve 62 to pipe 4 and is then recycled in the refrigeration system.

It will be appreciated that the improved refrigeration compressor described above is cooled solely by the recirculating medium of the closed system to which the compressor is connected, thereby eliminating the various pumps and blowers, as well as the seals, required by compressors that are cooled by a separate cooling medium. In addition, the cooling of the compressor by the refrigerant in the manner described, together with the use of a material having a low co-efficient of friction for the bearing surfaces, enables the compressor to be run "dry" or without lubricant. This eliminates the need for oil separation and helps to maintain maximum efficiency in the system.

It should be understood that it is not desired to limit this invention to the exact details of construction or the precise mode of use herein shown and described, since various modifications within the scope of the appended claims may occur to persons skilled in the art.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. The method of cooling the compression cylinders and pistons extending into the housing and toward the crankcase of a refrigerant compressor operating in a gas-liquid system, which comprises, drawing gaseous refrigerant employed in the system into the compressor housing in direct heat exchange relation with the compression cylinders and toward the crankcase, introducing liquid refrigerant from the system into direct heat exchange relation with the gaseous refrigerant within the compressor housing, admitting the gaseous refrigerant to the compression cylinders past the pistons therein, and compressing the gaseous refrigerant within the compression cylinders for return thereof to the system.

2. The method of claim 1, wherein liquid refrigerant

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is also introduced directly into the gaseous refrigerant prior to its entry into the compressor housing.

3. The method of claim 1, wherein the liquid refrigerant is also brought into direct heat exchange relation with the compression cylinders.

4. A refrigeration compressor comprising, a housing providing a compression section and a crankcase section in open communication with each other, a compression cylinder extending into said compression section with its inner end open to said crankcase section, drive means extending into said crankcase, a compression piston in said compression cylinder operably connected to said drive means to reciprocate said piston, means for supplying gaseous refrigerant to said compression section in proximity to said cylinder, valve means on said piston and cylinder operable upon reciprocation of said piston to draw gaseous refrigerant from said compression section about the exterior of said cylinder and into the open end thereof past the piston and into the upper end of said cylinder wherein it is compressed, means for discharging the compressed gaseous refrigerant from the compressor, means for supplying liquid refrigerant to said crankcase section, and means for splashing liquid refrigerant from said crankcase section about the interior of said compressor housing during reciprocation of said piston.

5. A refrigeration compressor according to claim 4, wherein means is also provided for supplying liquid refrigerant directly to the gaseous refrigerant prior to its entry into the compression section.

6. In a refrigeration system, a compressor having a compression section and a crankcase section in open communication with each other, said compression section having at least one compression cylinder extending therein with one end thereof open to said crankcase section, said compression cylinder having a piston operable therein, a condenser communicating with the other

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end of said compression cylinder through a high pressure discharge line to receive gaseous refrigerant therefrom, an evaporator communicating with said condenser to receive liquid refrigerant therefrom, said evaporator also communicating with the compression section of said compressor in proximity to said compression cylinder to supply gaseous refrigerant thereto, means for supplying liquid refrigerant from said condenser to said crankcase section, means for reciprocating said piston to draw gaseous refrigerant from said compression section about the exterior of said compression cylinder and into the open end thereof and to discharge compressed gaseous refrigerant through said high pressure discharge line, and means for simultaneously splashing liquid refrigerant from said crankcase section about the interior of said compressor and into heat exchange relation with the gaseous refrigerant.

7. A refrigeration system according to claim 6, wherein liquid refrigerant is also mixed directly with the gaseous refrigerant as it is supplied to the compression section from the evaporator.

8. A refrigeration system according to claim 6, wherein the liquid refrigerant is also splashed into direct heat exchange relation with the compression cylinder.

References Cited by the Examiner

UNITED STATES PATENTS

2,492,611	12/1949	Zearfoss	62—505 X
2,963,216	12/1960	Heitchne	62—505
3,088,042	4/1963	Robinson	62—505
3,155,312	11/1964	Douglas	62—505
3,226,949	1/1966	Gamache	62—505 X
3,239,132	3/1966	Frank et al.	230—208 X
3,241,331	3/1966	Endress et al.	62—117

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