Jan. 20, 1970 E. J. KOCHER 3,490,683

GAS COMPRESSOR

Filed June 18, 1968 2 Sheets-Sheet 1

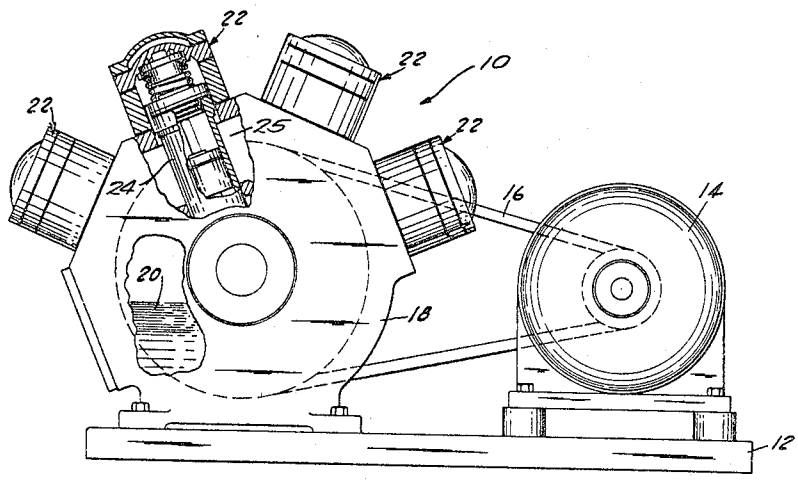


Fig. 1

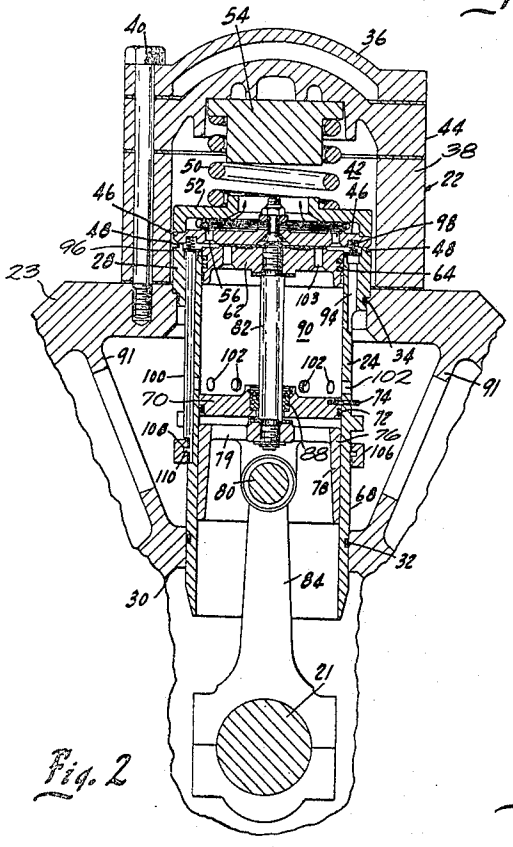


Fig. 2

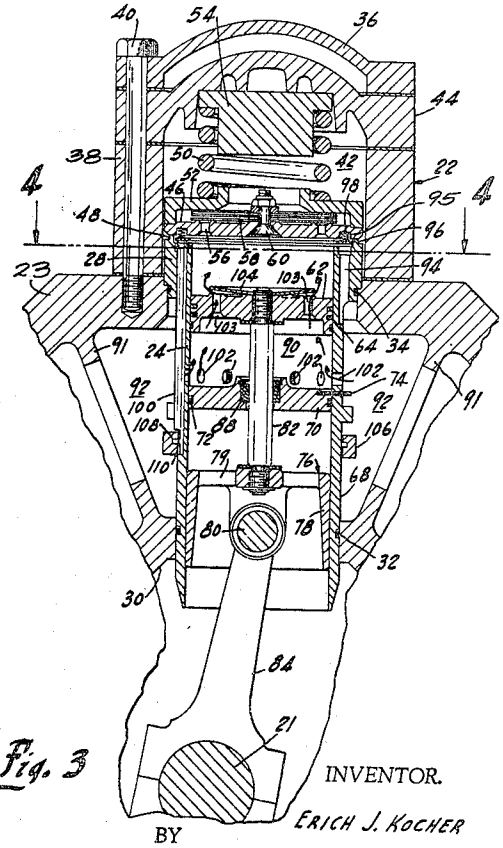


Fig. 3

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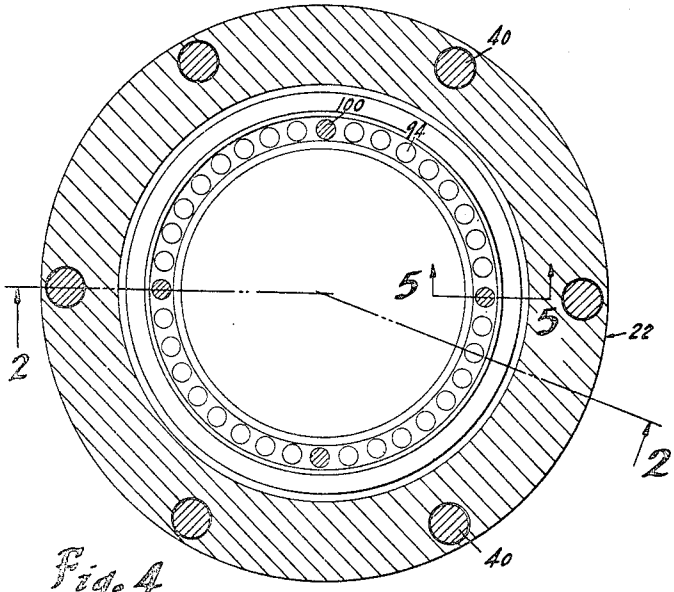


Fig. 4

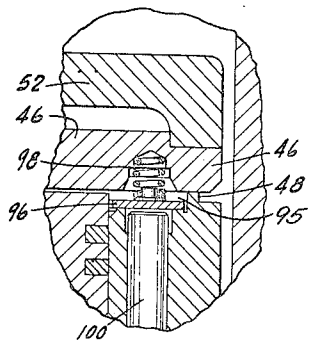


Fig. 5

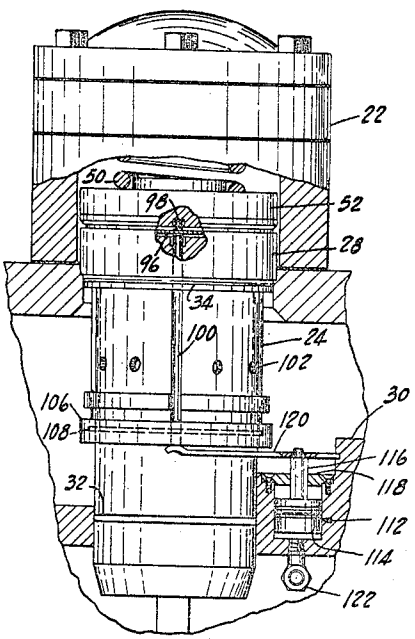


Fig. 6

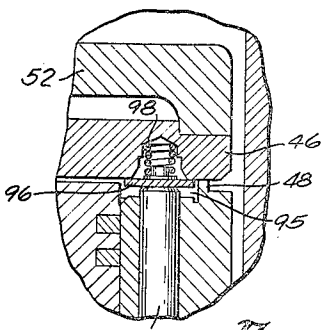


Fig. 7

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GAS COMPRESSOR

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U.S. Cl. 230—46 10 Claims

ABSTRACT OF THE DISCLOSURE

A reciprocating gas compressor has a compression chamber sealed from the crankcase to excluded oil from the compression chamber, and low pressure gaseous refrigerant is admitted to the compression chamber on opposite sides of the piston. The gas admitted above the piston is drawn into the chamber through suction ports extending along the cylinder wall and past valve means at the upper periphery of the cylinder, and the gas admitted below the piston is drawn into the chamber through ports in the cylinder wall adjacent the sealing means and then through valve controlled ports in the piston.

BACKGROUND

For many years, it has been customary to utilize reciprocating compressors embodying one or more cylinders having pistons operating therein for acting upon the gaseous refrigerant in refrigerant systems. In such compression devices, the gas is drawn into the cylinders on the suction stroke of the piston and compressed and discharged on the compression stroke. The pistons are generally reciprocated by a rotary crankshaft driven in a suitable manner by an electric motor or the like. U.S. Patent No. 3,131,856, dated May 5, 1964 illustrates an example of this general type of apparatus.

In such apparatus, heat is generated during compression of the gas. The friction produced by the crankshaft and pistons during the reciprocal operation of the compressor produces additional heat. For efficient operation, heat from both of the above sources must be removed from the compressor, and particularly from the cylinders and pistons. It is customary practice to remove this heat by lubricating the working parts by maintaining an abundance of lubricant in the crankcase which splashes over the working parts as they operate.

However, in such oil lubricated compressors, lubricant applied to the cylinder walls and pistons inevitably becomes intermixed with the gas undergoing compression. The lubricant thus entrained in, and carried by the gas, reduces the efficiency of the attendant refrigeration system, clogging its other mechanisms, and requiring expensive traps and/or other devices to remove the oil. Even so, some oil frequently remains intermixed with the gas to the detriment of the system.

Thus, it has been heretofore proposed to operate the compressor with the cylinders in an unlubricated or "dry" state. To this end, each cylinder of the compressor has been sealed from the crankcase by a partition, and the rotary motion of the crankshaft has been converted to a reciprocal motion by means of a cross head or dummy piston, operated in a guide coaxial with the cylinder. In such structures, the motion of the cross head is transmitted to the piston by a shaft or the like extending through the partition, and a stuffing box or other seal surrounds the shaft to isolate the cylinder. See, for example, the structure shown in U.S. Patent No. 1,529,258, dated Mar. 10, 1925 to Lipman.

The sealing partition thus permits the crankshaft, cross head and cross head guide to be lubricated by oil in the crankcase while at the same time prevents excessive

amounts of oil from getting into the cylinder and contaminating the gas. Further, the cross head absorbs the radial forces generated by the crankshaft and supplies a purely reciprocal motion to the piston, thus reducing the friction between the piston and the walls of the cylinder.

However, the heat generated in the cylinder, due to both the compression of the gas and the remaining friction between the piston and the cylinder caused by the lack of lubrication, still presents operation problems and generally requires the addition of cooling jackets or fins surrounding the cylinder. The use of a gaseous or liquid coolant to cool the compressor cylinders requires pumps or blowers to circulate the coolant and seals to prevent the coolant from leaking out or contaminating the gas undergoing compression. In addition, compressors of this type which incorporate one or more suction valves on the piston are lacking in the ability to unload the compressor when full capacity is not required, thus necessitating inefficient and objectionable starting and stopping operations.

Moreover, the capacity of prior gas compressors of the reciprocating piston type has, in most instances, been undesirably restricted due to the fact that the suction valves have been located in a single common area as, for example, either in the general vicinity of the end closure head of the cylinder or in the piston per se. In such devices, it has accordingly been necessary to either increase the size of the compressor or to increase the sizes of the suction ports and the effective areas and/or movement of the valves. However, such attempts to obtain increased capacities have not been entirely satisfactory because of increased costs and problems resulting from valve wear and breakage as well as slower resultant operational speeds and loss of efficiency.

SUMMARY

The present invention provides an improved compressor construction which furnishes sufficient cooling to both the moving and stationary parts of the cylinder, solely by means of the suction gas to the cylinder, to permit the cylinder to be operated without lubrication and without external cooling, thereby preventing entrainment of the lubricant in the gas undergoing compression and eliminating the expense of cooling jackets and the associated coolant circulating means.

Another object of the present invention is to provide a compressor and cylinder construction therefor by means of which the volume of gas drawn into the cylinder during each suction stroke of the piston is increased, to thus afford greater capacity to the compressor, increase in the efficiency of the compressor at high speeds, and reduction in the lift, or amount of opening, required by the individual valves.

A further object of the present invention is to provide a compressor adapted to run with dry cylinders and having an improved multiple suction valve means which splits or divides the inlet suction gas to the cylinder into a plurality of streams effectively distributed about the exterior and interior of the cylinder and on opposite sides of the piston to furnish sufficient cooling and permit the compressor to be operated in a dry state while also increasing the volume of gas drawn into the cylinder during each suction stroke of the piston.

Still another object of the present invention is to provide an improved gas compressor embodying a novel cylinder construction permitting dry operation and which embodies unloading means for retaining certain of the suction valves in an open position to permit operation of the compressor in the unloaded state under reduced loads.

In the improved device, each reciprocating piston is confined and operates within a dry compression chamber which is sealed from the crankcase by a partition spanning

the interior of the cylinder. The cylinder is surrounded by the suction chamber which contains the relatively cool gaseous refrigerant to be compressed, and the wall of the cylinder is thus cooled exteriorly by the gas. In turn, the interior of the compression chamber adjacent the sealing partition is in open communication with the suction chamber via a plurality of unrestricted suction ports, and the outer end of the compression chamber remote from the sealing partition is also communicable with the suction chamber by way of one or more valve controlled inlet ports extending through or directly along the cylinder wall. The piston itself is also provided with valve controlled ports communicable with the compression chamber on opposite sides of the piston. Accordingly, cool low pressure gas is drawn from the suction chamber into the compression chamber between the piston and the partition during the compression stroke thereof and through the piston into the chamber between the piston and end head during the return stroke. Cool suction gas is also drawn along the cylinder wall and into the compression chamber between the piston and the cylinder head upon the return or suction stroke of the piston, thus cooling the exterior and interior of the cylinder wall and both sides of the piston during its entire operation. Such continual cooling of both the cylinder and the piston enables the piston to operate without need for lubrication, and the use of a multiplicity of suction valves in the improved assemblage permits maximum volume and increased capacity, while the arrangement of the ports and valves also permits unloading.

THE DRAWINGS

A clear conception of the features constituting the present improvement and of the construction and operation of a typical refrigerant compressor embodying the invention may be had by referring to the drawings accompanying and forming a part of this specification wherein like characters designate the same or similar parts in the various views.

FIGURE 1 is a diagrammatic side view of a multicylinder piston type gas compressor and the drive means therefor, a portion of the compressor being broken away and shown in section for purposes of illustration;

FIGURE 2 is a fragmentary transverse sectional view of one of the compressor cylinders taken along the line 2—2 of FIGURE 4 and showing the piston at the end of its compression stroke;

FIGURE 3 is a similar fragmentary section through the compressor cylinder but showing the piston during one of its suction strokes;

FIGURE 4 is a transverse section taken along the line 4—4 of FIGURE 3 immediately adjacent the cylinder head and through the outer suction ports;

FIGURE 5 is a somewhat enlarged fragmentary sectional view taken along the line 5—5 of FIGURE 4 and showing a portion of the unloading device;

FIGURE 6 is a fragmentary part sectional view of the compressor adjacent one of its cylinders and showing additional details of the unloading mechanism; and

FIGURE 7 is a view similar to FIGURE 5 but showing the suction valve lifted from its seat by the unloading mechanism.

DETAILED DESCRIPTION

While the invention has been shown and described herein as being embodied in a particular type of gas compressor especially adapted for use in the refrigeration field and as embodying a specific number of cylinders, it is not intended to thereby unnecessarily limit the invention or the use of the improvements to such specific embodiment, and it is also contemplated that certain specific descriptive terms employed herein shall be given the broadest possible interpretation consistent with the disclosure.

Referring particularly to FIGURE 1, a typical reciprocating gas compressor **10** embodying the present invention is illustrated therein. In the illustration, the compressor **10** is mounted on a base **12** along with an electric motor **14** which serves to drive the compressor as by means of a belt **16**. The compressor **10** includes a crankcase **18** having an abundant supply of oil **20** contained therein. Revolvable within the crankcase and driven by the motor **14** is a crankshaft **21**. The compressor **10** also includes a plurality of cylinder assemblies **22** mounted in its frame **23** and radiating from the axis of the crankshaft **21**, the cylinders and their attendant structures being shown in detail in the other figures. For a detailed description of the general assemblage and the operation thereof, reference is made to U.S. Patent No. 3,131,856 hereinabove referred to.

Each cylinder **24** is suitably secured within the compressor frame **23** so as to extend outwardly into the suction manifold **92** and may be formed with an outer annular flange or collar **28** seated on the frame to position the cylinder. Each cylinder may also be provided with O-ring seals **32** and **34** to seal the cylinder in the frame or housing **23**.

An annular wall **38** capped by a closure cover **44** and water jacket **36** for each cylinder are fastened to the frame of the compressor **10** as by bolts **40**, and the wall **38** and cover **44** forms a compressed gas outlet chamber or manifold **42**. A flat end closure plate **46** for each cylinder **24** housed in the chamber **42** is urged into sealing relationship with an upstanding flange **48** on collar **28** of the cylinder by a relatively strong helical spring **50** bearing on spring guide **52**. Spring **50** reacts against another spring guide **54** seated against the manifold cover **44**. Closure plate **46** contains discharge ports **56** and a discharge valve **58** is fastened to the plate as by a bolt **60**. The discharge valve **58** controls the flow of gas through the ports **56**, and while only two such ports are shown in the cross sectional view of FIGURE 2, it will be appreciated that a plurality of these ports may be provided in an annularly spaced configuration about closure plate **46**.

A piston **62** is slidably confined in the bore of each cylinder **24** for reciprocal movement away from closure plate **46** to provide the suction stroke of the piston and toward plate **46** to form the compression stroke of the piston. Piston rings **64** provide a gas tight seal between the piston **62** and the inner walls of cylinder **24** during both the suction and compression strokes.

Each cylinder of the compressor **10** also includes a cross head guide portion **68** located in coaxial alignment with the bore of each cylinder **24**. This cross head guide portion may be in the form of a separate structure or it may comprise an integral portion of cylinder **24**. The integral constructions provides certain advantages with respect to compactness and ease of construction and is therefore generally preferred. Thus, in the structure illustrated herein, the inner portion of cylinder **24** in effect serves as the cross head guide section **68**.

The inner extension of cylinder **24** serving as the cross head guide portion **68** is open to the crankcase **18** but is sealed from the compression chamber portion of cylinder **24** which confines the piston **62** by a sealing partition **70**. Partition **70**, which includes an O-ring seal **72** or other suitable sealing means forming a fluid tight seal, is retained in the cylinder **24** as by a pin or pins **74** extending through the cylinder **24** and into the sealing partition **70**.

A cross head **76** is mounted in the cross head guide section **68** for reciprocal movement. The cross head **76** may be in the nature of a ring **78**, or similar structure designed to slidably fit within the cross head guide section **68** and having struts **79** to support a wrist pin **80** and and axially extending shaft **82**. Wrist pin **80** is inserted through the end of the connecting rod **84**, the other end of which is connected to crankshaft **21**. Crankshaft **21** is rotated by the motor **14** transmitting power through a belt **16** or the like to cause the cross head **76** to reciprocate.

The shaft or rod **82** which is carried by cross head **76** passes through the sealing partition **70** and is attached to the piston **62** to thereby transmit the reciprocal motion

of the cross head 76 to the piston 62. A stuffing box or other sealing means, such as a V-ring seal 88, embraces the shaft 82 where it passes through the sealing partition 70 to provide a fluid tight seal.

As the crankshaft 21 rotates, it dips into the oil 20 in the crankcase and splashes this oil about and over the crankshaft 21, connecting rod 84, wrist pin 80, cross head 78, and within the cross head guide portion 68 thereby thoroughly lubricating these parts. The oil, however, is kept out of the upper part of cylinder 24 forming the compression chamber 90 and away from the piston 62 by the sealing partition 70, thus permitting piston 62 to reciprocate in an unlubricated or dry state and preventing oil from contaminating the gas undergoing compression.

The frame 23 includes an inner wall 30 spaced from the outer wall of the compressor and from the crankcase 18 by struts or braces 91 to form a suction gas inlet manifold 92 which is supplied with gaseous refrigerant from the low pressure side of the refrigerant system in a customary manner. As distinguished from prior apparatus of this general type, the gas is drawn into the compression chamber 90 of the cylinder 24 on both sides of the piston 62 in a plurality of streams to cool both the exterior and entire interior of the cylinder and both sides of the piston by passage over the entire surfaces thereof prior to compression. Since the suction gas supplied from the manifold 92 is cool, the cylinder and piston are maintained at extremely low temperatures during compressor operation, and the need for lubricating the same in accordance with customary practice is thereby obviated.

In accordance with the present invention, suction gas is supplied to the outer end of each compression chamber 90 about the peripheral edge of the cylinder 24 through a plurality of ports 94 drilled in the flange or collar 28 of the cylinder and communicating with the suction gas inlet manifold 92 and with the interior of the cylinder 24, above the piston 62 and adjacent the closure plate or head 46, via an annular chamber 95. These ports 94 are circumferentially spaced around the periphery of the cylinder 24 as is shown most clearly in FIGURE 4 and are parallel with the cylinder wall. The flow through these ports is controlled by a suction valve 96 in the form of a thin metal ring 96 seated over the ports 94 and within the annular chamber 95. The ring 96 is retained in seated position to normally close ports 94 from the inlet or suction manifold 92 by a number of springs 98 seated on the closure plate 46 within the chamber 95, as shown in FIGURE 5, and bearing against the ring 96. Preferably, these springs are positioned at 90 degree intervals around valve ring 96, but any number may be provided at equally spaced intervals. Also, as shown in FIGURE 5, the ports 94 lying immediately below springs 98 contain rods 100 which form part of the unloading mechanism, hereinafter described.

In addition to the above described suction gas supply means communicable with the outer end of the compression chamber 90, a plurality of unobstructed ports 102 are formed in the wall of the cylinder 24 immediately adjacent the partition 70 below the piston 62, these ports also being circumferentially spaced about the cylinder to place the interior thereof in direct communication with the space 92. In turn, the piston 62 is provided with ports 103 extending therethrough, and flow through these ports is controlled by a suction valve 104 located on the piston 62 and shown as comprising a flexible metallic disc spanning the ports 103 in the piston and normally closing the same. Each of the cylinders 24 of the compressor 10 is, of course, constructed in the same manner as described above and a separate description of each is therefor unnecessary.

In operation, the electric motor 14 is energized to supply rotary power to the crankshaft 21 through belt 16. Rotation of the crankshaft 21, in turn, reciprocates the connecting rod 84 and cross head 76 and splash lubricates these parts with oil 20 from the crankcase. However, the sealing partition 70 prevents the oil from getting into the upper portion of cylinder 24. As previously indicated, the inlet manifold 92 is supplied with suction gas which may, for example, be the cool, gaseous discharge from the evaporator of an associated refrigeration system. This gas fills the space 92 surrounding the wall of the cylinder 24 and serves to remove heat therefrom prior to undergoing compression.

The reciprocation of cross head 78 also reciprocates the piston 62 through the rod 82. As piston 62 moves downward in cylinder 24, away from closure plate 46 and toward partition 70, as shown in FIGURE 3, the decreased pressure in the displacement chamber of the cylinder 24 above the piston 62, resulting from its downward movement, causes the valve ring 96 to raise from its seat out of sealing relationship with ports 94 and permits suction gas to flow from manifold 92 upwardly along the outside of the wall of cylinder 24 through the several ports 94 and into the annular chamber 95 and the upper end of the cylinder 24 above the piston 92. This flow of incoming suction gas cools the exterior of the cylinder 24, including the upper wall portion thereof adjacent closure plate 46 where the greatest amount of gas compression and heat generation occurs. The gas also cools the interior of cylinder 24 and the top side of piston 62 as it is drawn into cylinder 24. Additionally, during this suction stroke of the piston, the decreased pressure inside cylinder 24 above piston 62 causes the valve disc 104 to uncover the ports 103 in piston 62 and permits suction gas from the inlet manifold 92 to flow from below the piston through the ports 103 and into the interior of the cylinder 24 above the piston. This second source of low pressure gaseous refrigerant further cools the interior surfaces of cylinder 24 below the piston 62 as well as the underside of the piston.

At the same time, the discharge valve disc or discs 58 are drawn firmly against the exhaust ports 56 to prevent compressed gas in the outlet manifold 42 from leaking back into the cylinder. The compression chamber 90 above the piston thus becomes filled with an abundance of gas to be compressed as supplied thereto from two separate sources.

As the piston 62 moves upwardly in cylinder 24, away from partition 70 and toward the closure plate 46, the compression stroke is effected. During this stroke, the increased pressure inside cylinder 24 above piston 62, resulting from its upward movement, aids the springs 98 in firmly and positively seating the valve ring 96 over the ports 94, thus sealing the ports and preventing the escape of gas from the compression chamber 90 into inlet manifold 92. Valve disc 104 is likewise forced downward to seated position across ports 103, also preventing the escape of gas from the compression chamber of cylinder 24 during the compression stroke of the piston. Exhaust valve discs 58, on the other hand, are raised by the increased pressure in cylinder 24, permitting the gas in cylinder 24 to be discharged from the compression chamber 90 into compressed gas outlet manifold 42. The above cycle of operation is, of course, repeated as necessary to produce the desired volume of compressed gas.

Partition 70 prevents the oil in sump 20 from reaching the compression chamber 90 so that no oil can become entrained in the gas undergoing compression and the compressed gas in outlet manifold 42 is therefore oil free. The sealing function of partition 70 may also be supplemented by pressurizing the crankcase 18 from the suction gas line 94 so that inlet manifold pressure exists on both sides of the partition, thus eliminating or at least reducing pressure differentials. By reason of this arrangement, thorough cooling is provided to all frictional surfaces in cylinder 24 to thus permit the piston 62 to reciprocate in the dry state by reason of the cooling provided by suction gas entering cylinder 24 on both sides of the piston and entirely about the cylinder wall through

the valves adjacent both the closure plate **46** and the partition **70**.

In addition to the cooling effect afforded by the low pressure gaseous refrigerant, the abundance of gas admitted to the cylinder **24** by the spaced sets of suction valves increases the capacity of the compressor **10** without the necessity of increasing the size or physical volume of cylinders **24**. The efficiency of the compressor at high operating speeds is also increased since an adequate amount of gas flow into cylinders **24** through the ports and past the separate sets of valves is assured even though piston **62** is reciprocated rapidly and the ports are open for only a short time. Furthermore, the lift, or required, opening, of the valve discs **96** and **104** is also decreased due to the increased gas flow afforded by the several ports and the spaced sets of valves, and this further results in less strain and fatigue on these elements.

In addition to these advantages, the cylinder construction of the present invention may be readily provided with an unloading mechanism for the compressor **10** which prevents a compressive load from being applied during periods of little or no demand. Such unloaded operation of the compressor is desirable if, for example, a lessened cooling load on the associated refrigeration system reduces the requirement for compressed gas. Unloaded operation of the compressor is accomplished by a simple unloading means which lifts the valve ring **96** from seated condition to uncover the ports **94** on the compressive stroke of piston **62**. The gas drawn into cylinder **24** on the suction stroke is thus returned to the inlet manifold on the compression stroke and no compression of gas results.

To accomplish unloading, the rods **100** located in ports **94** serve as means to unload compressor **10**. These rods are located in the ports alined with the springs **98** which assist in normally seating the valve ring **98** on ports **94**. The rods are adapted to be extended upwardly by suitable load responsive means to raise ring **96** off its seat and hold the ports open on the compressive stroke, as shown in FIGURES 6 and 7.

The rods **100** may be actuated by apparatus which includes a ring **106** surrounding cylinder **24** and having a groove **108** therein to engage a corresponding flange **110** on the lower ends of rods **100**. The rods **100** may thus be extended or retracted by raising or lowering ring **106**. In turn, the ring **106** may be raised or lowered by any satisfactory mechanical, hydraulic, pneumatic, or electric means. A pneumatic means, such as pneumatic cylinder, is most often used since it may be operated by gas pressure from the system associated with the reciprocating gas compressor **10**. Such a cylinder is shown in FIGURE 6 by the numeral **112** and is formed as an integral part of frame **30**. The cylinder has a piston **114** therein having an extension **116** passing through a cover **118**. Arm **120** mounted on extension **116**, bears on ring **106**. Cylinder **112** is actuated by gas pressure supplied through inlet **122** so that the unloading mechanism is responsive to the requirements of the system.

To unload compressor **10**, gas is forced into cylinder **112** through inlet **122** to raise piston **114**. This, in turn, raises ring **106** by means of arm **120** bearing thereon and extends rods **100** to raise valve ring **96** out of sealing relationship with ports **94**, preventing these inlet ports from sealing on the compression stroke of piston **62** and preventing a compressive load from being applied to compressor **10**. For a more complete description of the unloading operation, reference is again made to U.S. Patent No. 3,131,856.

Thus, it is apparent that the proposed apparatus provides a compressor wheerin low pressure gaseous refrigerant is effectively utilized to cool not only the exterior and interior of the cylinder throughout its entire area but also both sides of the piston over its entire area, thereby eliminating the need for lubricating the same and also eliminating need for providing water cooling or the like. In addition, the improved compressor has greater capacity without increasing the size of the unit or the compression cylinders and attendant structure, and by reason of the greater capacity obtained through use of two separately ported and valved areas, higher speeds are permitted without undesirable reduction in the efficiency of the unit. Furthermore, the arrangement of the ports **94** and valves **96** is such that unloading is permitted by use of a simple unloading mechanism, and due to the increased capacity obtained in the present instance, the lift required on each of the suction valves **96** and **104** is minimized.

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. In a reciprocating gas compressor, a casing having a crankcase therein, a crankshaft operable within said crankcase, means providing a suction chamber sealed from the crankcase, at least one cylinder mounted within and having its wall cooperating with said casing to expose the exterior of said wall to the suction chamber and thereby provide a cooling passage communicable with the interior of said cylinder, valve means in said cooling passage and operable to admit cooling gas to the interior of said cylinder, one end of said cylinder being closed by a head containing high pressure discharge ports communicable with a high pressure discharge line, a partition spanning the interior of said cylinder remote from said head and cooperating with said head to form a compression chamber sealed from said crankcase, said cylinder wall having ports placing the interior of said compression chamber adjacent the partition in communication with said suction chamber, and a piston including valve means and slidably confined within said sealed compression chamber and connected to the crankshaft for reciprocation of said piston, whereby when said piston is moved in the suction direction gas is admitted from the suction chamber to the interior of said sealed compression chamber through the valve means in said cooling passage and also through the cylinder wall and said piston, the cooling passage and the cylinder wall ports thereby providing the sole means for cooling the interior and exterior of the cylinder with the gas thus admitted to the compression chamber being compressed by said piston and discharged through the ports in said cylinder head upon movement of said piston in the compressing direction.

2. A reciprocating gas compressor according to claim **1**, wherein the means connecting the piston to the crankshaft includes a rod extending through the partition and connected at one end to the piston and at its opposite end to a member guided for sliding movement coaxially of said piston and rod, said member being exposed only to the crankcase and being connected to the crankshaft by a connecting rod.

3. A reciprocating gas compressor according to claim **1**, wherein the cooling passage is communicable with the suction chamber and with the compression chamber adjacent the end head under control of said valve means responsive to the movement of said piston.

4. A reciprocating gas compressor according to claim **3**, wherein the cooling passage is comprised of a plurality of ports extending along the cylinder wall and communicable with the suction chamber and with the compression chamber adjacent the end head.

5. A reciprocating gas compressor according to claim **1**, wherein the piston is provided with ports extending therethrough to opposite sides thereof and with valve means for controlling flow of gas through the ports upon reciprocation of said piston.

6. A reciprocating gas compressor according to claim **1**, wherein the cooling passage is communicable with the suction chamber and with the compression chamber under the control of said valve means which is normally re-

sponsive to movement of the piston, and unloading means is provided for rendering said valve unresponsive to piston movement.

7. A reciprocating gas compressor according to claim 6, wherein the valve means is constantly resiliently urged toward seated position to close the cooling passage, and the unloading means for rendering the valve unresponsive to piston movement acts to unseat the valve under certain operation conditions.

8. A reciprocating gas compressor according to claim 7, wherein the unloading means for unseating the valve means to render the same unresponsive to piston movement is actuated in response to the loads imposed on the compressor.

9. A reciprocating gas compressor according to claim 4, wherein unloading means cooperable with the valve means is provided for unloading the compressor, said unloading means including at least one actuating rod extending along the cylinder wall in parallelism with the cooling passage ports.

10. In a reciprocating gas compressor, a casing having a crankcase therein, a crankshaft operable within said crankcase, means providing a suction chamber sealed from the crankcase, at least one cylinder mounted within and having its wall cooperating with said casing to expose the exterior of said wall to the suction chamber, one end of said cylinder being closed by a head containing high pressure discharge ports communicable with a high pressure discharge line, the interior of said cylinder being in communication with the suction chamber adjacent said head via a low pressure inlet passage, valve means controlling the flow of gas through the low pressure inlet passage, a partition spanning the interior of said cylinder

remote from said head and cooperating with said head to form a compression chamber sealed from said crankcase, said cylinder wall having ports placing the interior of said compression chamber adjacent the partition in communication with said suction chamber, a ported piston slidably confined within said sealed compression chamber and connected to the crankshaft for reciprocation of said piston whereupon gas is admitted from the suction chamber to the interior of said sealed compression chamber through the inlet passage and the cylinder wall ports on both sides of said piston upon movement of said piston in one direction, a valve for controlling flow through the piston ports responsive to piston movement, the gas thus admitted to the compression chamber being compressed by said piston and discharged through the ports in said cylinder head upon movement of said piston in the opposite direction, and means for unseating said valve means controlling flow of gas through the low pressure inlet passage to unload the compressor independently of piston movement.

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WILLIAM L. FREEH, Primary Examiner

U.S. Cl. X.R.

230—30, 190