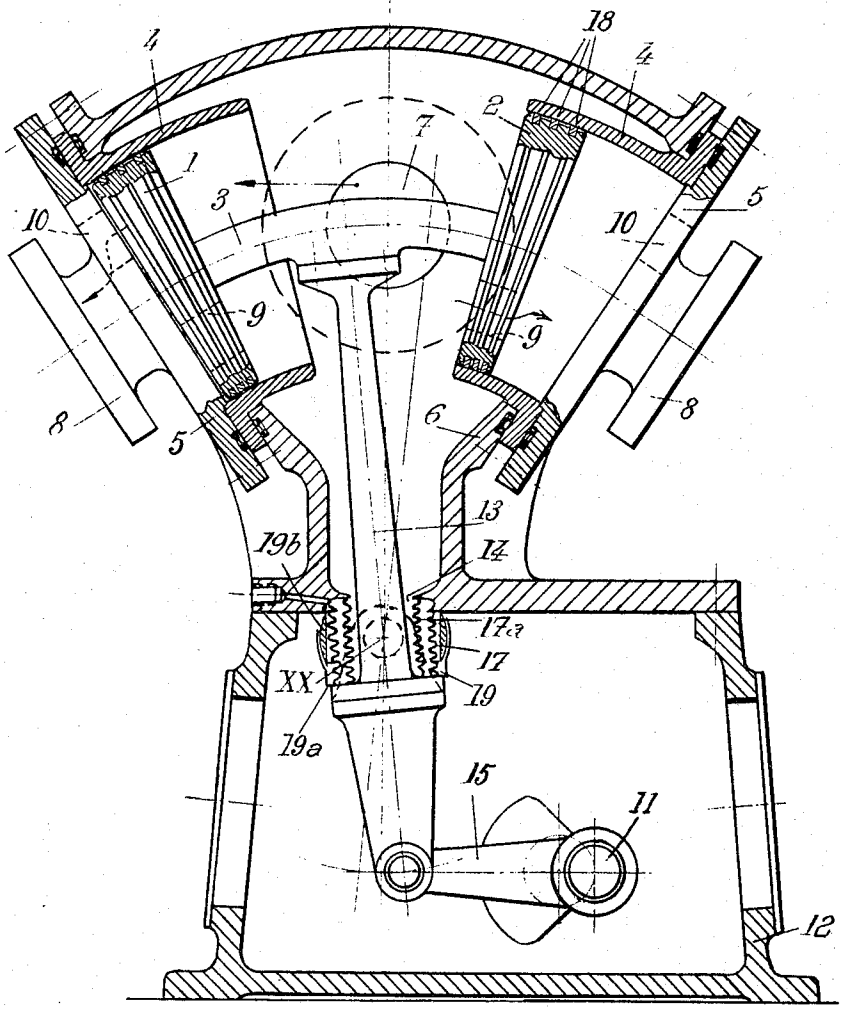
Oct. 25, 1966 P. P. CHAFFIOTTE 3,281,065

GAS COMPRESSORS

Filed Sept. 9, 1964

Fig. 1.



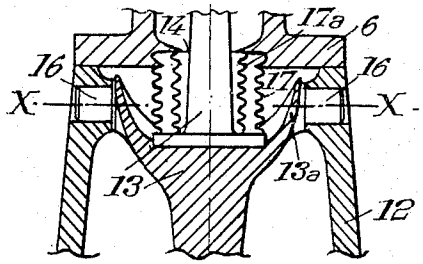


Fig. 2.

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GAS COMPRESSORS

Pierre Philippe Chaffiotte, Cormeille-en-Parisis, France, assignor to Societe d'Exploitation des Materiels Hispano-Suiza, Bois-Colombes, France

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This invention relates to gas compressors and more particularly to compressors used in hermetically sealed systems.

The present invention is directed towards fluid compressing pumps employing one or several pistons oscillating in a hermetically sealed cylinder which completely isolates the circulating fluid from the region surrounding the system. Such an arrangement is particularly desirable in systems for circulating refrigerants or noxious fluids.

Compressors of this type always present a sealing problem because the driven piston must be in contact with the fluid while the piston driving source is preferably placed outside the hermetically sealed region to facilitate repair and maintenance, with the result that, in order to convey mechanical power from the driving source to the piston, a hermetic connection must be created between a moving element and the stationary piston housing.

The difficulty of creating such a seal has been reduced in the prior art devices by making the driving member oscillatory about a pivot point and by placing this pivot point close to the point of entry into the housing, so that the flexible connection need only move by a small amount. Because the driving member oscillates, its end describes a circular arc, with the result that, in the prior art devices, a relatively complicated, flexible connection had to be created between the driving member and the piston, in order to permit the latter to move in a straight line.

It is therefore an object of this invention to simplify the structure of the compressor in a hermetically sealed fluid circulating system.

It is another object herein to eliminate the need for a lubricant between the cylinder and the piston of the compressor of such a system.

A further object herein is to increase the dependability of the flexible hermetic compressor seal.

The improved compressor of this invention comprises a pair of mobile pistons joined together by a rigid shaft for alternating movement in a hermetically sealed housing under the action of an oscillating driving rod passing through said housing and having its axis of oscillation situated in the vicinity of an orifice arranged in the housing wall for the passage of said rod, the impermeability of the housing, in the vicinity of the orifice, being assured by at least one deformable wall surrounding said orifice and attached in an impermeable manner to said housing and to said rod, this compressor being of particular interest because the arrangement of the pistons and their connecting shaft, as well as the cylinders in which the pistons move, have the form of a toroid whose axis of revolution is coextensive with the axis of oscillation of said driving rod, the latter being rigidly connected to said arrangement of the pistons and their connecting shaft and, preferably, being supported by two pivot pins mounted on the extremities of a yoke, the axes of said pins forming the axis of oscillation of said driving rod, and said yoke being rigidly connected to said rod.

These and other objects, features and advantages of the present invention will become more readily understood from the following detailed description when taken together with the attached drawings, in which:

FIG. 1 is a side, cross-sectional view of one preferred embodiment of the present invention; and

FIG. 2 is a cross-sectional view, taken along a plane containing pivot axis X—X and perpendicular to that of FIG. 1, showing the structure of the pivot region for the driving rod.

The device shown in FIG. 1 comprises a unit consisting of two pistons **1** and **2** rigidly connected together by a connecting shaft **3**. The pistons are arranged so that each cooperates with a respective one of cylinders **4** having heads **5**, the simultaneous movement of said pistons being such that the movement of one piston with respect to its cylinder head is in phase opposition to the corresponding movement of the other piston. Because of this relation between the piston movements, it results that the region enclosed by housing **6** and the facing ends of pistons **1** and **2** remains constant during the entire period of operation of the device. This region is supplied with gas to be compressed by inlet passage **7**.

The compressor system shown in the drawings is connected to a circulation system and pistons **1** and **2** are arranged so that their alternating movements in their respective cylinders will cause gas in housing **6** to be drawn into the cylinders and then forced into the circulation system through the outlet pipes **8** connected to cylinder heads **5**. Such a distribution could, for example, comprise the arrangement shown in FIG. 1 as consisting of inlet valves **9** carried on pistons **1** and **2** and outlet valves **10** carried on cylinder heads **5**. These valves are simple pressure-actuated valves which are widely used in gas circulating systems and which are therefore neither shown nor described in detail in the present specification and drawings. These valves are mounted so that valve **9** will only open when the pressure existing in its respective cylinder is less than that existing in housing **6** and valve **10** will open only when the pressure in cylinder **4** is greater than that in pipe **8**. Thus, in effect, valve **9** will open only when its respective piston-cylinder unit is going through an expansion phase, so that the gas being circulated will flow from housing **6** to the interior of cylinder **4** during this phase, and valve **10** will open only during the compression phase of its respective piston-cylinder unit, permitting the gas in cylinder **4** to be forced into pipe **8**.

Pistons **1** and **2** are driven, through the intermediary of their connecting shaft **3**, by a suitable driving mechanism powered by a motor unit. Such a motor unit is shown in FIG. 1 to consist of a crank shaft **11** driven excentrically by any suitable, commercially available motor (not shown) but its shaft is indicated by the shaft shown in broken lines slightly to the left of, and overlapping, shaft **11**. The motor unit is placed outside hermetically sealed housing **6**, to facilitate maintenance, and may be housed, as shown, in socle **12**.

Said driving mechanism comprises at least one oscillating rod **13** passing into housing **6** through an ovaloid orifice **14** arranged in the wall separating housing **6** from socle **12**. Orifice **14** is made large enough to permit rod **13** to fully traverse its intended oscillating path. The end of rod **13** which is disposed outside of housing **6** is pivotally connected, by means of a connecting rod **15**, to crank shaft **11**, while the other end of rod **13**, the one inside housing **6**, is rigidly connected to the midpoint of shaft **3**.

The axis of rotation XX of oscillating rod **13** is located outside housing **6**, and as close as possible to orifice **14**. The rod may advantageously be pivoted in the manner shown in detail in FIG. 2 in which the rod is supported by a pair of pivot pins **16** connected to the outer ends of an upwardly extending yoke **13***a* rigidly connected to rod **13**.

The impermeability of housing **6** at the point of entry of rod **13** is effected by at least one deformable wall

surrounding the orifice **14** and attached in an impermeable manner to housing **6** and rod **13**. Such an arrangement could advantageously be constituted, as is shown in the figures, by a membrane or, preferably, a bellows-like sleeve **17** which, for example, may be made of a thin sheet of metal or other synthetic material which is resistant to deterioration due to the action of the gas being circulated. This sleeve is preferably located between pins **16** and has its ends respectively connected in an impermeable manner, by cementing or welding for example, to housing **6** and rod **13**.

In order to improve the dependability of the device, a second sleeve **17***a* may be provided around sleeve **17** and fastened in exactly the same way as the latter.

One great advantage of the above described arrangement resides in the fact the location of sleeves **17** and **17***a* around the axis of rotation of rod **13** causes them to be subjected only to flexural deflections (and not to substantial elongations or compressions), while the placing of these sleeves inside of pivot pins **16** permits the sleeves to be very close to the longitudinal axis so that the magnitude of these flexions is reduced as much as possible. Moreover, since the volume of the interior of housing **6** remains constant, the sleeves are always subjected to the same pressure.

In accordance with one of the main features of the present invention, the pistons **1** and **2**, shaft **3** and cylinders **4** are all given the form of a circular toroid whose axis of revolution coincides with the axis XX of oscillating rod **13**, the latter being rigidly connected to the mobile unit composed of the pistons and shaft **3**. Rod **13** may be connected to this unit by being soldered, welded, or brazed, for example, to shaft **3**.

Because of the unitary character of the entire oscillating assembly and the rigid connection between shaft **3** and rod **13**, the pistons will always be accurately positioned with respect to their cylinders, regardless of whether or not the pistons touch their cylinder walls. Therefore, the pistons could be given a slight clearance around their entire circumference, thus eliminating all friction contact between adjacent surfaces.

The impermeability of the volume enclosed by cylinders **4** and their respective pistons may be assured by piston rings **18** which are not radially loaded since pistons **1** and **2** are prevented, by their rigid connection to shaft **3**, from moving off-center in such a way as to eliminate the clearance existing in any radial direction. Rings **18** therefore are only urged against the walls of the cylinder by their own radial elasticity and therefore create only small friction forces.

It should be obvious that such an arrangement permits of a "dry" operation wherein the moving parts require no lubrication.

It may occur that the pressure of the gas in housing **6** is substantially greater than atmospheric (30–50 atmospheres, for example). In such a case, it may be desirable to relieve outer bellows **17** by enclosing it in an impermeable enclosure **19**, the enclosure containing a fluid under pressure (for example air or oil) and having rigid walls which could be constituted by a cowl **19***a* mounted on rod **13**, near the pivot point of the latter, and cooperating with a spherical bearing centered on axis XX and carried by a fixed support **19***b*. The pressure of the fluid between bellows **17** and enclosure **19** may be controlled so as to vary as a function of the pressure in housing **6**.

Another technique for protecting bellows **17** and **17***a* from damage due to excessive pressures would be to introduce a fluid through passage **6***a* into the annular space between the two bellows.

This fluid may be at a pressure which is midway between the pressure in housing **6** and that outside bellows **17**, so that the pressure stresses are equally divided between the two bellows.

While one preferred embodiment of the present invention has been shown and described herein, it should be appreciated that many modifications and variations would occur to one skilled in the art without departing from the spirit thereof and that the coverage of this patent should be limited only by the scope of the appended claims.

What I claim is:

1. A compressor which comprises, in combination,
a frame,
a fluidtight casing fixed with respect to said frame, provided with a constantly open fluid inlet,
two toroidal cylinders fixed within said casing having their respective walls located in the same toroidal surface,
two cylinder heads rigid with said cylinders at the outer ends thereof, respectively,
two toroidal pistons fitting slidably in said cylinders, respectively,
an inlet check valve mounted in each of said pistons and adapted to open from the inside of said casing toward the inside of the corresponding cylinder,
an outlet check valve mounted in each of said cylinder heads for the outflow of fluid from the corresponding cylinder,
a rod interconnecting said two pistons, rigidly fixed thereto,
a lever rigid with said rod pivoted to said frame about the axis of said toroidal surface, and
flexible sealing means interconnecting said lever and said casing for sealing said casing as said lever oscillates.

2. A compressor according to claim **1** further comprising, on the outside of said flexible sealing means, means forming a deformable fluidtight envelope secured at one end to said lever and at the other end to said casing, the space between said envelope and said sealing means being filled with a fluid under a pressure substantially equal to the fluid pressure in said casing.

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MARTIN P. SCHWADRON, *Primary Examiner.*

MARK NEWMAN, *Examiner.*

W. L. FREEH, *Assistant Examiner.*