

"HERMETIC COMPRESSOR WITH INTERNAL THERMAL INSULATION"

Field of the Invention

The present invention refers to a hermetic compressor of the type used in refrigeration appliances, such as refrigerators and freezers, and which allows the thermal insulation of the hot regions inside the compressor that are heated by the heat generated with the compression of gas during the operation of the compressor and, more particularly, of the region of the cylinder cover, in which the gas is discharged.

Background of the Invention

Refrigeration compressors have been object of studies that aim at improving the performance of these compressors. Among the various points of this performance to be improved, one can point out the increase of the amount of refrigerant gas drawn during suction and the reduction of the power required to compress the refrigerant gas. In order to achieve such objectives, it is necessary to reduce the temperature of the refrigerant gas in the suction (increasing its specific mass) and also to reduce the temperature of the compression chamber wall which contacts the refrigerant gas. The development of solutions which promote the reduction of the temperature levels of the compressor and of the flows dissipated by the hot parts thereof is one of the feasible ways to reach these goals.

Hermetic compressors of the type used in refrigeration systems usually comprise, in the interior of a housing, a motor-compressor assembly having a cylinder block in which is defined a cylinder having an end closed by a head and internally defining a discharge chamber in selective fluid communication with a compression chamber defined inside the cylinder and closed by a valve plate provided between the cylinder

closed end and the head, said fluid communication being defined through suction and discharge orifices provided in the valve plate and which are selectively and respectively closed by suction and discharge
5 valves, which are usually carried by the valve plate. One of the major causes responsible for heating the internal components of the compressor is its discharge system, which comprises the entire path of the refrigerant gas, from its exhaustion from the
10 compression chamber to the discharge of said refrigerant gas from the inside the compressor. This is because the refrigerant gas reaches the highest temperature levels during its compression inside the cylinder of the motor-compressor assembly, and the
15 heat generated by said compression is dissipated for the other components of the compressor, during the path of the refrigerant gas from the compression chamber inside the cylinder to its discharge from the inside the compressor housing.

20 One solution to avoid this energy dissipation is to insulate the gas discharge system from the rest of the compressor. By doing this, the extremely hot gas exhausted from the compression chamber will pass through the discharge system without transferring heat
25 to the other components, thereby reducing the temperature levels of the compressor as a whole. Solutions to insulate the discharge system may be found in patent US3926009, in which the gas discharge tube is defined having a double wall, in order to
30 minimize heat transfer of the gas under compression to the interior of the housing, and in patent US4371319, in which each of the parts of cylinder cover, discharge muffler and discharge tube is surrounded by a thermal insulating element with the same purpose of
35 minimizing heat transfer of the gas under compression

to the interior of the housing disclosed in US3926009. In the vast majority of the refrigeration hermetic compressors, mainly of the reciprocating type, the compressor discharge system comprises a first
5 discharge chamber defined inside the cylinder cover, and located after the valve plate and which receives the gas coming from the compression cylinder. This gas passes subsequently through other chambers before reaching a compressor discharge tube, which leads the
10 compressed refrigerant gas out from the compressor housing to a refrigeration system to which said compressor is usually associated.

Studies have proved that one of the major causes responsible for heating the compression cylinder is
15 the heat flow generated by the gas in the cylinder cover, which heats the valve plate and, by conduction, heats the top of the cylinder block, in the region of the compression chamber of the compression cylinder. The reduction of this heat flow has a positive impact
20 in reducing the temperature of the cylinder and consequently in reducing the compression power.

The known prior art presents different alternatives to make possible a reduction of the heat transfer from the cylinder cover region to regions inside the
25 housing distant therefrom. There are known devices, such as heat exchangers, for example "Stirling" machines, as taught in patent US6347523; the provision of fins on the heads and the use of an auxiliary air motion system; the use of heat pipes; the use of fluid
30 pumping system using pumps driven by mechanic or electric oscillating motion, among others. However, said known solutions do not minimize the heat transfer between the cylinder cover and the cylinder block, due to the gas discharge from the compression chamber to
35 the discharge chamber.

Objectives of the Invention

Thus, it is an object of the present invention to provide a hermetic compressor with internal thermal insulation, particularly in the cylinder block, which
5 increases the compression efficiency, increasing the gas suction capacity of the compressor and reducing the power required for compressing said gas.

It is also an object of the present invention to provide a compressor as mentioned above, which reduces
10 the temperature in the region of the cylinder block adjacent to the region of the cylinder cover mounted thereto.

It is a further object of the present invention to provide a hermetic compressor as mentioned above,
15 which presents a reduced thermal profile.

Summary of the Invention

These and other objectives are achieved through a hermetic compressor with internal thermal insulation, comprising: a housing internally carrying a cylinder
20 block in which is defined a compression cylinder, having one end closed by a valve plate provided with a discharge orifice and a suction orifice, said valve plate having a front face against which is mounted a cylinder cover internally defining a discharge
25 chamber, said hermetic compressor further comprising a spacing duct having one inlet end hermetically mounted to the front face of the valve plate and open to the discharge orifice of the valve plate, external to the suction orifice thereof, and an outlet end
30 hermetically mounted to the cylinder cover and open to the interior of the discharge chamber, with the inlet end of the spacing duct presenting a cross-section area at least equal to that of the discharge orifice, said spacing duct defining a hermetic fluid
35 communication between the interior of the compression

cylinder and the discharge chamber through the discharge orifice, said spacing duct maintaining the cylinder cover spaced from the valve plate and defining, with the latter, an annular plenum around
5 said spacing duct.

The present invention, as described above, provides the insulation for the heat flow between the gas in the cylinder cover and the compressor block. In one construction of the present invention, this insulation
10 is effected by the provision of a gap between the valve plate and the cylinder cover, generating a gas volume which allows reducing the transfer of heat from the hot discharge gas to the valve plate and, consequently by conduction, to the top of the
15 compression cylinder of the compressor.

Brief Description of the Drawings

The invention will be described below with reference being made to the attached drawings, given by way of example of the possible embodiments of the invention
20 and in which:

Figure 1 represents a schematic vertical sectional partial view of a hermetic compressor illustrating the region of the cylinder cover built according to the prior art;

25 Figure 2 represents a schematic cross-sectional partial view of the cylinder block illustrated in figure 1, indicating, by means of solid arrows, the path of a refrigerant gas under compression being discharged inside the cylinder cover, and by means of
30 dashed arrows, part of the heat propagation direction from the discharge chamber in the cylinder cover;

Figure 3 represents in a schematic view similar to that of figure 2, a first constructive option for the internal thermal insulation system of the compressor,
35 according to the present invention;

Figure 4 presents one way of carrying out the present invention, as illustrated in figure 3 and in which the spacing duct is carried by the valve plate;

Figure 5 is a perspective view of a cylinder cover
5 mounted to a valve plate built according to the present invention and as illustrated in figure 4;

Figure 6 is a perspective view of a cylinder cover construction having the front face thereof shaped to be mounted to a valve plate of the type illustrated in
10 figure 4;

Figure 7 represents, in a schematic view similar to that of figure 3, a second constructive option for the internal thermal insulation system of the compressor, according to the present invention;

Figures 8 and 8a are, respectively, perspective views of a cylinder cover and a spacing duct, built according to the second way of carrying out the present invention, as schematically illustrated in figure 7 and in which the spacing duct is carried by
20 the cylinder cover;

Figures 9 and 9a present, respectively and in a perspective view, a valve plate and a sealing gasket for mounting the cylinder cover and spacing duct of the present invention, as illustrated in figures 8 and
25 8a;

Figure 10 is an exploded perspective view of a construction of valve plate, spacing duct and cylinder cover of the present invention, as illustrated in figure 7;

Figure 11 is a front view of a different construction for the second embodiment of the invention, in which the spacing duct is carried by the cylinder cover, by mounting said spacing duct to an intermediate plate to be mounted to the cylinder cover;

35 Figure 12 is a perspective view of the cylinder cover

and intermediate plate mounted to the valve plate, according to the embodiment of the present invention illustrated in figure 11; and

Figure 13 is an exploded perspective view of the construction of the valve plate, spacing duct, cylinder cover and sealing gaskets of the present invention, as illustrated in figures 11 and 12.

Detailed Description of the Illustrated Embodiments

The internal thermal insulation system for a hermetic compressor of the present invention is designed to be applied to a reciprocating compressor driven by a linear or conventional motor of the type used in refrigeration systems of refrigeration appliances, said compressor being, for example, of the type illustrated in figure 1 and comprising, inside a hermetic housing 1, a motor-compressor assembly having a cylinder block 2, in which is defined a compression cylinder 3 lodging, in one end, a piston 4 for compressing a refrigerant fluid and having an opposite end closed by a cylinder cover 5 or head, internally defining a discharge chamber 5a which maintains selective fluid communication with a compression chamber 6 defined inside the compression cylinder 3, between a top portion of piston 4 and a valve plate 7 provided between the opposite end of the compression cylinder 3 and the cylinder cover 5, said valve plate 7 having a front face 7c, against which is mounted the cylinder cover 5, and a rear face 7d, facing cylinder block 2.

The fluid communication between the interior of the compression chamber 6 and the discharge chamber 5a of the cylinder cover 5 is defined by a discharge orifice 7a provided in the valve plate 7 and closed by a respective discharge valve 8a, usually carried by the valve plate 7.

The gas drawn by the compressor comes from a suction line (not illustrated) of the refrigeration system to which the compressor is coupled, being selectively drawn, by operation of piston 4, during its suction cycle, to the inside of the compression chamber 6 through a suction orifice 7b, due to the selective opening of a suction valve 8b mounted on the valve plate 7, said gas being subsequently compressed until its discharge to the discharge chamber 5a in the cylinder cover 5. Heat is generated during compression of the refrigerant gas, as described above.

Figure 2 is a schematic view of the compression cylinder and of part of the discharge system generally used in reciprocating compressors, according to the prior art. The gas is compressed inside the compression chamber 6 by piston 4, until the opening of the discharge valve 8a, allowing the discharge of the gas at high temperature and pressure through the discharge orifice 7a into the discharge chamber 5a of the cylinder cover 5 (as indicated by the solid arrows in said figure 2), and thence to the remaining part of the discharge system of the compressor. With the compression process, part of the thermal energy of the gas inside the discharge chamber 5a, generated by the compression, returns to the cylinder block 2, as shown by the dashed arrows in figure 2, resulting in an increase of the temperature of the cylinder, even considering the use of a sealing gasket 9, which usually has thermal insulation properties, said sealing gasket 9 being located between the valve plate 7 and the cylinder block 2.

The present solution provides a thermal insulation inside the housing 1, which allows reducing the heat flow of the hot gas from inside the discharge chamber 5a to the region of the cylinder block 2, which has a

positive impact in reducing the temperature of the cylinder block 2 and, consequently, in reducing the compression power and losses due to gas overheat.

The thermal insulation of the present invention is achieved by providing the hermetic compressor with a spacing duct 20 having an inlet end 21, open to the discharge orifice 7a of the valve plate 7 and external to the suction orifice 7b thereon, and an outlet end 22, open to the interior of the discharge chamber 11, said spacing duct 20 defining a hermetic fluid communication between the interior of the compression cylinder 3 and the discharge chamber 11, and keeping the cylinder cover 10 spaced from the valve plate 7 by a value calculated so as to reduce the heat transfer from the gas in the discharge chamber to the valve plate 7.

In a constructive option of the present invention, the spacing duct 20 has its inlet end 21 hermetically mounted to the front face 7c of the valve plate 7 and open to the discharge orifice 7a, and its outlet end 22, for example, being axially aligned with the inlet end 21 and hermetically mounted to the cylinder cover 10 and open to the interior of the discharge chamber 11, the inlet end 21 of the spacing duct 20 having a cross-section area at least equal to that of the discharge orifice 7a, said spacing duct 20 defining the fluid communication between the interior of the compression cylinder 3 and the discharge chamber 11, through the discharge orifice 7a.

According to the present invention, the discharge orifice 7a of the valve plate 7 is contained inside the cross-section contour of the inlet end 21 of the spacing duct 20, said cross-section circumscribing, more particularly, the contour of the discharge valve 8a. In a non-illustrated embodiment, the contour of

the inlet end 21 of the spacing duct 20 may be of any type, matching or not the one of the outlet end 22 of the spacing duct 20, also being lower or laterally displaced in relation to that of the discharge valve 8a, as long as it does not interfere with the gas flow through the discharge orifice 7a.

The illustrated embodiments for the spacing duct 20 present the latter with a constant cross-section along its length, including the inlet end 21 and outlet end 22 thereof. However, it should be understood that within the concept presented herein, the spacing duct 20 may have a constant cross-section between the inlet and outlet ends 21, 22 thereof, which cross-section can be or not distinct from that of said inlet end 21 and outlet end 22. Said inlet end 21 and outlet end 22 may, for example, have the same cross section, although this is not mandatory.

According to one way of carrying out the present invention, as illustrated in figures 3 to 5, the valve plate 7 carries, for example incorporating in a single piece, the inlet end 21 of the spacing duct 20, said incorporation being obtained during the formation of the valve plate 7 or afterwards by means of an adequate fixation means, such as, for example, welding, glue, etc..

In this construction, the cylinder cover 10 carries, incorporating in a single piece, as illustrated in figure 6, or securing by conventional means, as mentioned above, a front wall 12 for closing said cylinder cover 10 and which is seated against the outlet end 22 of the spacing duct 20, with the interposition of at least one sealing gasket 9 therebetween, which is made for example of a thermal insulating material, in order to minimize the transfer by conduction of part of the heat flow through the

spacing duct 20.

According to the illustration in figure 4, between the valve plate 7 and cylinder cover 10 are also provided tubular fixation spacers 30, each being aligned with a
5 fixation orifice 7e defined on the valve plate and with a corresponding fixation hole 14 provided on the cylinder block 2, particularly on the cylinder cover 10, to allow a fixation element, such as a screw (not illustrated) to pass, securing the cylinder cover 10
10 to the cylinder block 2.

In another way of carrying out the invention, as illustrated in figures 7 to 13, the cylinder cover 10 carries, for example, incorporated therein in a single piece during the formation thereof or by fixation
15 through adequate means, such as welding, glue, etc., the outlet end 22 of the spacing duct 20. In this constructive option, the spacing duct 20 carries, in the region of its outlet end 22, a peripheral flange 23 fixed against the cylinder cover 10 and defining a
20 wall portion of the latter.

According to the illustrations, the spacing duct 20 is provided orthogonal to a plane containing the front face 7c of the valve plate 7, being also orthogonal to the wall portion of the cylinder cover 10 defined by
25 the peripheral flange 23.

In the constructive embodiment illustrated in figures 7 to 10, the peripheral flange 23 is incorporated in a single piece to the spacing duct 20 during the formation thereof, defining part or the whole of the
30 front face 12 of the cylinder cover 10.

In a different embodiment of this construction, illustrated in figures 7, 8 and 10, the peripheral flange 23 of the spacing duct 20 defines the entire front face 12 of the cylinder cover 10, being secured
35 against the latter and also against the valve plate 7,

by placing therebetween a respective sealing gasket 9. However, in the cases in which the cylinder cover 10 incorporates, in a single piece, the peripheral flange 23 of the spacing duct 20, the sealing gasket 9 is provided only between said spacing duct 20 and the valve plate 7.

In this embodiment is also foreseen the provision of an outer cover 10a, as illustrated in figure 10, located surrounding the cylinder cover 10 and allowing the fixation of the latter to the valve plate 7.

In another construction for the second embodiment of the present invention, illustrated in figures 11 to 13, the peripheral flange 23 is defined by an intermediate plate 40 secured to the outlet end 22 of the spacing duct 20 by adequate means, such as welding, etc., defining the entire front face 12 of the cylinder cover 10. In this different construction, the intermediate plate 40 may be previously directly fixed to the spacing duct 20, without the placement of a sealing gasket 9 therebetween, and later be fixed to the cylinder cover 10, directly or with the use of a sealing gasket 9 therebetween, or also be previously fixed to the cylinder cover 10, before receiving the spacing duct 20.

In a constructive option, the intermediate plate 40 carries, or incorporates in a single piece, the tubular fixation spacers 30, as illustrated in figure 11, providing, upon mounting and securing of the cylinder cover 10 to the valve plate 7, a space between the latter and the intermediate plate 40.

In this assembly, the spacing duct 20 fixed to the intermediate plate 40 surrounds the discharge valve 8a region, creating a hermetic tubular region which guides the gas coming from the discharge orifice 7a to the inner region of the cylinder cover 10, defining

the discharge chamber 11 therein. Thus, the discharge gas is retained in the volume provided by the cylinder cover 10 and intermediate plate 40, preventing the passage of the heat flow of this gas to the cylinder block 2, exactly due to the presence of the space between the intermediate plate 40 and the valve plate 7.

With the solution of the present invention, the reduction of the direct heat transfer from the discharge chamber 11 of the cylinder cover 10 to the already hot region of the cylinder block 2 allows reducing the temperatures in this region of the inside of the compressor, increasing the energy efficiency of the compression operation of the compressor.

Although only a few modes of carrying out the invention have been described and illustrated herein, it should be understood that modifications in the form and arrangement of the elements comprising the compressor may be effected, without departing from the inventive concept defined in the accompanying claims.

CLAIMS

1. A hermetic compressor with internal thermal insulation, comprising: a housing (1) internally carrying a cylinder block (2) in which is defined a compression cylinder (3), having one end closed by a valve plate (7) provided with a discharge orifice (7a) and a suction orifice (7b), said valve plate (7) having a front face (7c) against which is mounted a cylinder cover (5, 10) internally defining a discharge chamber (5a, 11), characterized in that said compressor comprises a spacing duct (20) having one inlet end (21) hermetically mounted to the front face (7c) of the valve plate (7) and open to the discharge orifice (7a) of the valve plate (7) external to the suction orifice (7b) thereof, and an outlet end (22) hermetically mounted to the cylinder cover (10) and open to the interior of the discharge chamber (11), with the inlet end (21) of the spacing duct (20) presenting a cross-section area at least equal to that of the discharge orifice (7a), said spacing duct (20) defining a hermetic fluid communication between the interior of the compression cylinder (3) and the discharge chamber (11) through the discharge orifice (7a), said spacing duct (20) maintaining the cylinder cover (10) spaced from the valve plate (7) and defining, with the latter, an annular plenum around said spacing duct (20).

2. Compressor, according to claim 1, characterized in that the discharge orifice (7a) is contained within the cross-sectional contour of the inlet end (21) of the spacing duct (20)

3. Compressor, according to claim 2, in which the valve plate (7) externally carries in the front face (7c) thereof a discharge valve (8a), characterized in that the cross-section of the inlet end (21) of the

spacing duct (20) circumscribes the discharge valve (8a).

4. Compressor, according to claim 1, characterized in that the inlet end (21) and the outlet end (22) of the
5, spacing duct (20) have the same cross-section.
5. Compressor, according to claim 4, characterized in that the spacing duct (20) has a constant cross-section between the inlet and outlet ends (21, 22) thereof.
- 10 6. Compressor, according to claim 5, characterized in that the spacing duct (20) has a constant cross-section along its length.
7. Compressor, according to claim 6, characterized in that the inlet and outlet ends (21, 22) of the spacing
15 duct (20) are axially aligned with each other.
8. Compressor, according to claim 1, characterized in that the inlet end (21) and outlet end (22) of the spacing duct (20) are hermetically fixed to the front face (7c) of the valve plate (7) and to the cylinder
20 cover (10), respectively.
9. Compressor, according to claim 8, characterized in that the valve plate (7) incorporates in a single piece the inlet end (21) of the spacing duct (20).
10. Compressor, according to claim 8, characterized in
25 that the spacing duct (20) carries, in the region of its outlet end, a peripheral flange (23) fixed against the cylinder cover (10) and defining a wall portion of the latter.
11. Compressor, according to claim 10, characterized
30 in that the peripheral flange (23) is incorporated in a single piece to the spacing duct (20).
12. Compressor, according to claim 11, characterized in that the peripheral flange (23) comprises an intermediate plate (40).
- 35 13. Compressor, according to claim 10, characterized

in that the peripheral flange (23) is fixed to the cylinder cover (10) in order to define a single piece with the latter.

14. Compressor, according to claim 10, characterized
5 in that the spacing duct (20) is provided orthogonal to the plane of the valve plate (7).

15. Compressor, according to claim 14, characterized
in that the spacing duct (20) is provided orthogonal to the wall portion defined by the peripheral flange
10 (23).

16. Compressor, according to claim 1, characterized in that it comprises tubular fixation spacers (30) carried by one of valve plate (7) or cylinder cover (10), each of said tubular fixation spacer (30) being
15 located in alignment with a fixation orifice (7e) defined on the valve plate (7) and aligned with a corresponding fixation hole (14) defined on the cylinder cover (10).

17. Compressor, according to claim 1, characterized in
20 that the spacing duct (20) is fixed to at least one of the parts of cylinder cover (10) and valve plate (7), with at least one sealing gasket (9) made of thermal insulating material being placed therebetween.