Sept. 10, 1968 A. F. ENEMARK ET AL 3,400,885

PISTON-TYPE COMPRESSOR PARTICULARLY FOR SMALL REFRIGERATING UNITS

Filed Oct. 10, 1966

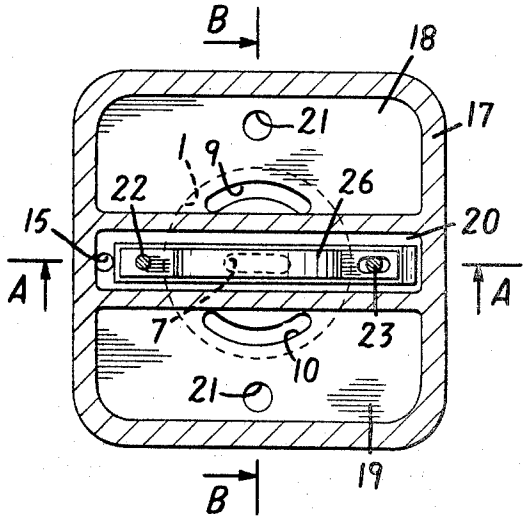


FIG. 1

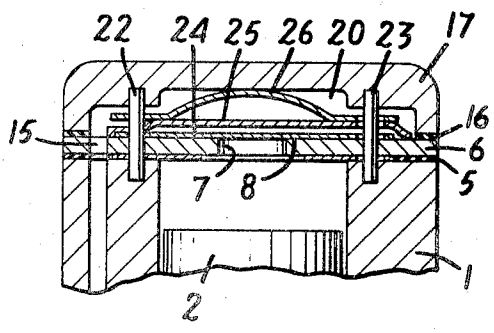


FIG. 2

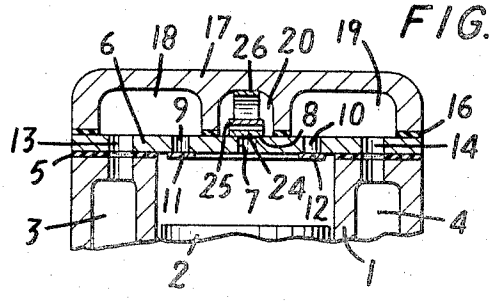


FIG. 3

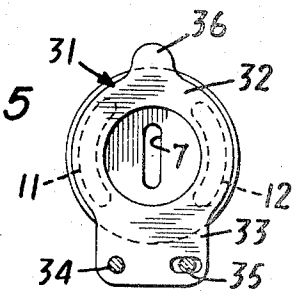


FIG. 5

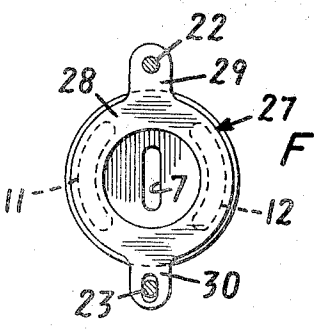


FIG. 4

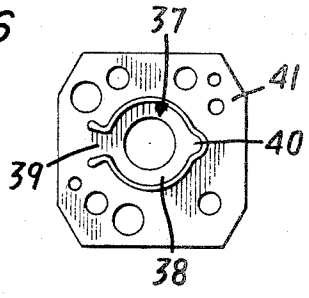


FIG. 6

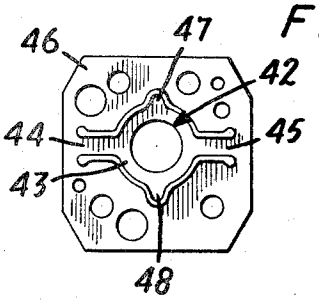


FIG. 7

United States Patent Office 3,400,885
Patented Sept. 10, 1968

3,400,885

PISTON-TYPE COMPRESSOR PARTICULARLY FOR SMALL REFRIGERATING UNITS

Arne F. Enemark, Sonderborg, Knud V. Valbjorn, Nordborg, and Bendt W. Larsen, Augustenborg, Denmark, assignors to Danfos A/S, Nordborg, Denmark, a company of Denmark

Filed Oct. 10, 1966, Ser. No. 585,500
4 Claims. (Cl. 230—231)

ABSTRACT OF THE DISCLOSURE

A compressor of the reciprocating piston type for small refrigeration units in which gas flow is carried out without excessive velocities and in which temperature distribution is kept substantially symmetrical. The compressor has a valve plate having a pressure valve seat about the longitudinal axis of the compressor cylinder circumferentially of a discharge port. Suction ports are disposed spaced about the axis concentric therewith. A pair of flat flexible springs bear on opposite sides of the valve plate and are clamped at one end. The springs function as valves as a suction valve and discharge valve.

This invention relates generally to piston-type compressors and more particularly to suction and discharge ports and valve arrangements for refrigeration compressors.

Reciprocating piston-type refrigeration compressors for compressing a gaseous refrigerant medium are made very small. Refrigeration compressors are known in which the cylinder diameter may be only a few centimeters, for example, 3 centimeters. In this type of compressor it is very difficult to accommodate the suction and pressure valves within the cylinder head. Valves with flat springs have been successfully used in such constructions. Generally, the flat springs act as moving valve elements in which the flat spring forming the suction valve is clamped between the valve seat plate and the cylinder and end face of the cylinder. However, flat springs of known construction and configuration have a disadvantage in that the valve elements cooperate with suction and discharge valve apertures or ports which are asymmetrically arranged relative to a longitudinal plane or radial plane. The suction aperture or port is arranged on one side of the plane and the discharge aperture or port is arranged on an opposite side of the plane. As a result of such construction, the heat distribution on the valve plate is not symmetrical. Moreover, during the pressure or compression stroke of the piston, a certain volume of the gas under pressure has to travel a longer distance than the remainder of the gas to reach the discharge port. Consequently, gas speeds are not uniform and in some cases will reach an undesirably high value.

It is a principal object of the present invention to provide a suction and pressure aperture or port arrangement obviating the disadvantages of the known compressors.

Another object of the invention is to provide a new and improved suction valve construction and arrangement.

Still another object of the invention is to provide a new and improved suction and pressure valve cooperating to carry out optimum results in conjunction with optimum positions of the suction and discharge ports as well as optimum dimensions and configurations thereof.

A feature of the compressor structure, in accordance with the invention, is the provision of a discharge aperture or port along a central axis and configured as an elongated port. The construction of the discharge port, and the suction ports or apertures, and its position results in a substantially symmetrical temperature distribution in

the valve plate of the compressor, as well as reduced gas speeds and provides a position and dimension of aperture so that substantially uniform gas pressures obtain in the cylinder.

The suction ports are arranged symmetrically about the discharge port and the longitudinal axis of the compressor cylinder. These ports are likewise constructed as elongated apertures providing a very large or relatively large opening area. The disposition and dimension of the ports contributes toward minimum gas flow velocities during the suction stroke of the compressor and provide substantially uniform cooling of the valve plate.

The suction valves, in accordance with the invention, are constructed as a flat, spring valve having a substantially annular spring portion underlying the suction valve apertures in a valve plate. The central opening of the spring portion is sufficiently large to maintain the discharge port or aperture in the valve plate completely in communication with the interior of the cylinder. The suction valves are provided with at least one lug extending outwardly and away from the annular spring portion for positioning and mounting the spring suction valve.

The pressure discharge valve, according to the invention, is provided with a flat, spring element and an arcuate spring having mounting openings through which pins for mounting and aligning are disposed. The arched or arcuate spring element has the centers of the openings at a distance less than the centers of the pins when the spring element is in an unloaded condition. When mounted, the centers coincide with the centers of the pins and the arcuate spring bears against the cylinder head and is pre-stressed or loaded thereby so that the flat suction spring element of the discharge valve is properly biased or loaded for operation.

Constructions of the discharge and suction valve springs provided for mounting and alignment by pin arrangements common to both valves and extending through the valve plate. The provision of common mounting and alignment means for the flat suction and pressure valve springs and the arcuate spring are made possible in view of the positions of the valves and their related ports or apertures.

Other features and advantages of the compressor port arrangement and construction and valves, in accordance with the present invention, will be better understood as described in the following specification and appended claims, in conjunction with the following drawings in which:

FIG. 1 is a cross-section view of a cylinder head of a piston-type compressor provided with a valve construction and arrangement in accordance with the invention;

FIG. 2 is a fragmentary section view taken along section line A—A of FIG. 1;

FIG. 3 is a fragmentary cross-section view taken along section line B—B of FIG. 1;

FIG. 4 is a plan view of a first embodiment of a flat suction valve spring in accordance with the invention;

FIG. 5 is a plan view of a second embodiment of a flat suction valve spring in accordance with the invention;

FIG. 6 is a plan view of a third embodiment of a flat suction valve spring on a scale smaller than FIGS. 4 and 5; and

FIG. 7 is a plan view of a fourth embodiment of a flat suction valve spring on the same scale as FIG. 6.

As illustrated in the drawing, a refrigerant compressor is provided with means 1 defining a cylinder in which a piston 2 is reciprocably driven by motive means, not shown. The compressor cylinder is provided with suction-silencing chambers 3, 4 on ether side of the cylinder. The compressor is provided with a seal gasket 5 disposed over the end of the cylinder and on which is mounted a

valve plate 6 having an elongated centrally disposed discharge port or aperture 7 disposed substantially coaxial with a longitudinal axis of the cylinder. The valve plate is provided with a valve seat 8 circumferentially of the discharge port 7 and is provided with two suction ports or intake apertures 9, 10 disposed symmetrically relative to the discharge port and circumferentially of which are defined valve seats 11, 12. The discharge ports are on opposite sides of a plane passing through the longitudinal axis of the cylinder.

The cylinder 1 of the compressor is provided with passageways 13, 14 providing communication to the respective suction-silencing chambers 3, 4 and other chambers or compartments in the head of the compressor in communication with the inlet or suction ports, as later described. A passageway 15 provides for discharge, from the compressor, of a gaseous medium, for example a refrigerant, under pressure after compression in the cylinder by the reciprocably driven piston.

Gasket means 16 overlie the valve plate 6 and provide a seal between it and the cylinder head or cover 17 defining suction or inlet chambers 18, 19 in communication with the suction or inlet ports or apertures heretofore described and a central pressure chamber 20 which is in communication with the pressure discharge or outlet port 7 and discharge passageway 15. A plurality of screws 21 mount the compressor head 17 and the valve plate onto the cylinder 1, as illustrated.

The compressor is provided with valve mounting and alignment pins 22, 23 which extend through the valve plate 6 and engage suitable bores in the cylinder 1 and the valve head or cover 17. These pins function to a align the various elements and for mounting thereof as hereinafter described. Within the pressure chamber 20 of the compressor head is disposed a beam-type pressure or discharge valve comprising a flat spring valve element 24, movable for uncovering or opening the outlet port during a pressure stroke and closing it during an intake or suction stroke, overlying the flat valve plate and is provided with openings through which the mounting-aligning pins 22, 23 extend. A stop plate 25 is held by a pin 23 in registry with the flat spring valve element for limiting opening of the discharge valve and a clamping spring 26 constructed as an arcuate spring having flat extensions at opposite ends thereof, through which extend the pins 22, 23, holds the discharge valve assembly together.

The openings, on opposite ends of the spring 26, receiving the pins 22, 23 have the centers spaced thereon, in an unloaded condition of the arcuate spring 26, at a distance less than the distance between the centers of the pins 22, 23. Thus, when the compressor unit is assembled the pins 22, 23 and the spring 26 hold the pressure valve parts in assembled condition, in proper relative positions, with the valve plate. When the compressor head 17 is disposed on the compressor it bears against the arcuate portion of the spring 26 reliving the clamping action thereof and pre-stresses the spring 26 thereby constantly biasing the spring element 24 toward a direction closing the outlet aperture 7. The openings at one end of the components 24–26 are preferably provided with a slot at one end to allow a certain degree of ease of adjustment of the members.

A first embodiment of the inlet or suction valve construction in accordance with the invention is illustrated in FIGS. 1–4 inclusive in which a valve spring 27 having an annular portion 28 with diametrically opposite lugs 29, 30 provided with openings, one of which is elongated, for receiving the pins 22, 23, comprises the entire valve. These pins mount and align the entire assembly as heretofore described. The annular portion defines a central opening in the valve spring 27 which is relatively large thereby permitting a relatively large discharge port 7 to be constructed in the valve plate and the use of a large pressure or discharge valve. The annular portion 28 underlies the seats 11, 12 of the pressure valve that are disposed circumferentially of the intake or inlet ports 9, 10.

It will be noticed that the intake or suction ports defined by the edges of the seats 11, 12 thereof are arcuate in configuration and have substantially the same center as the annular portion of the valve spring so that the annular portion underlies the suction ports. In view of the arrangement and construction, the suction ports may be made relatively large and as indicated heretofore, their general arrangement and dimensions provides for optimum heat distribution on the valve plate and optimum gas pressures in conjunction with the discharge gas velocities. The annular portion is movable in operation; it will uncover or open the suction ports during a suction stroke and close these ports during a compression stroke.

Another embodiment of a flat, spring suction valve 31 is illustrated in FIG. 5. This construction is provided with an annular portion 32 functioning in the manner of the annular portion of the suction or inlet valve heretofore described and is provided with a mounting lug 33 having two side-by-side fastening holes or apertures designed to receive a pair of pins 34, 35 arranged side-by-side instead of diametrically opposed in the manner of the structure illustrated in FIG. 4. These pins carry out functions similar to the pins before described. As can be seen, one of the openings, the opening receiving the pin 35, is elongated. Instead of a second mounting lug, a projection 36 is provided on the annular portion 32 and functions as a stroke-limiting catch during valve operation.

The invention makes provision for construction of the suction valves as a plate disposed between the end of the cylinder and the pressure valve and having a portion thereof functioning as the suction valve annular portion. Such constructions eliminate the need of a gasket between the cylinder and the valve plate. Two types of construction of plate valves are shown in FIGS. 6 and 7. The construction illustrated in FIG. 6 comprises a flat, spring suction valve 37 having an annular spring portion 38 and a spring lug 39 connecting the valve to the plate 41. The lug 39 is integral with the plate 41 while the annular portion 38 and a stroke-limiting catch or projection 40 are spaced from the plate portion thereof and have an integral connection to the plate 41 only through the lug 39. The plate 41 is provided with a plurality of apertures as illustrated. These apertures correspond to openings for mounting and aligning pins such as pins 21, 23. Furthermore, since the plate 41 is disposed between the plate 6 and the cylinder, provision is made in the plate for the suction ports 13, 14 and openings illustrated in the plate 41 registered with these suction ports.

A related plate construction but somewhat different than that of FIG. 6 is illustrated in FIG. 7 in which a flat, spring suction valve 42 having an annular spring portion 43 is connected through flexible lugs 44, 45 to a flat plate 46. The spring valve 42 is provided with two projections 47, 48 extending outwardly from the annular portion 43 which function as stroke-limiting catches in the manner of the projections heretofore described with respect to the other valve constructions. The annular portion of this valve and that of the valve in FIG. 6 operate to uncover the inlet ports under an intake stroke of the piston and cover or close these ports during a discharge stroke.

Those skilled in the art know that concentric annular valve constructions are known in large piston-type compressors. The valve elements in such compressors execute vertical reciprocating movements within guides. These known valve constructions are expensive and bulky and are not applied to small compressors due to the lack of space in these small compressors and for economic reasons. The valves according to the invention are made of flat strip spring material, have a memory and are capable of operating as before described. The valves do

not take up much space and are economically manufactured.

Furthermore, those skilled in the art will understand that the valve constructions and port arrangements result in the heating of the valve plate centrally and cooling thereof from the incoming gas. The gas velocities are kept at a minimum since relatively large ports are provided. These ports while shown as elongated may consist of side-by-side openings that are the equivalent to an elongated continuous port. Moreover, the centrally located outlet allows the gases to exit at substantially uniform speeds and the intake openings allow intake of the gas at substantially uniform speeds.

While preferred embodiments of the invention have been shown and described, it will be understood that many modifications and changes can be made within the true spirit and scope of the invention.

What we claim and desire to secure by Letters Patent is:

1. A compressor of the reciprocating piston type for small refrigeration units comprising, a cylinder, a piston reciprocably driven in said cylinder, the improvement which comprises means for causing gas flow in said compressor cylinder to flow without excessive velocities and to keep temperature distribution therein substantially symmetrical comprising, a valve plate having a pressure valve seat disposed about the longitudinal axis of said cylinder circumferentially of a discharge aperture, said valve plate having suction apertures disposed each on an arcuate locus spaced from said axis and concentric therewith, valve means opening and closing respectively said discharge aperture and said discharge apertures comprising a pair of flat flexible springs bearing on opposite sides of said valve plate and clamped at one end thereof, one of said springs comprising a suction valve clamped between said valve plate and a cylinder end face and having an annular obturating region for closing and opening said suction apertures, and said suction valve having mounting means extending outwardly in the plane of the flat spring.

2. A compressor of the reciprocating piston type for small refrigeration units according to claim **1**, in which said suction apertures are disposed on opposite sides of an axial plane passing through the longitudinal axis of said cylinder.

3. A compressor of the reciprocating piston type for small refrigeration units according to claim **2**, in which said suction apertures are disposed adjacent the cylinder wall.

4. A compressor of the reciprocating piston type for small refrigeration units according to claim **1**, including a plate clamped between the valve plate and the cylinder end face, and said suction valve mounting means comprising a flexible lug connecting said spring with the last-mentioned plate.

References Cited

UNITED STATES PATENTS

1,719,572	7/1929	Stoll	230—231
1,871,285	8/1932	Tursky	230—231 XR
2,000,735	5/1935	Arnold	230—231
2,592,343	4/1952	Scheldorf	230—228
2,703,102	3/1955	Neugebauer	137—493.8

ROBERT M. WALKER, *Primary Examiner.*

U.S. DEPARTMENT OF COMMERCE

PATENT OFFICE

Washington, D.C. 20231

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,400,885 September 10, 1968

Arne F. Enemark et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading to the printed specification, between lines 7 and 8, insert -- Claims priority, application Germany, Oct. 15, 1965, D 48,430 --.

Signed and sealed this 21st day of April 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents