

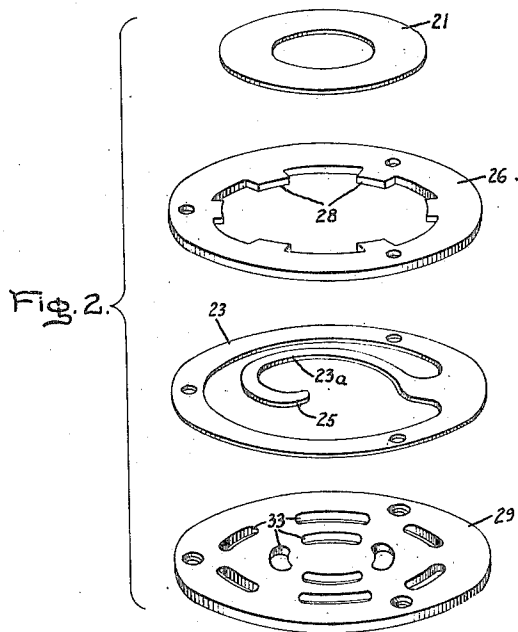
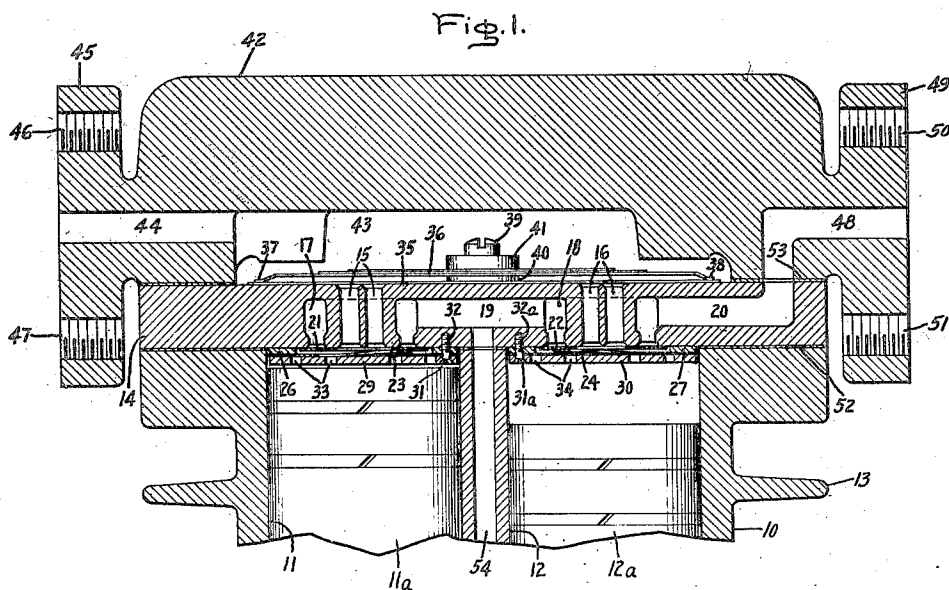
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J. C. DURYEE

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COMPRESSOR

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Inventor:
Jerome C. Duryee,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,036,799

COMPRESSOR

Jerome C. Duryee, Fort Wayne, Ind., assignor to
General Electric Company, a corporation of
New York

Application June 19, 1935, Serial No. 27,355

6 Claims. (Cl. 230-231)

My invention relates to compressors and more particularly to an arrangement for minimizing the noise resulting from the operation of the discharge valve thereof.

Compressors of the reciprocating type are ordinarily provided with a discharge valve which operates automatically in response to the differential fluid pressure existing between the interior of the compressor cylinder and chamber in which the compressed fluid is discharged. Discharge valves of the reed type are frequently employed in compressors utilized in refrigerating systems, and the like, and although these valves have a number of desirable characteristics, they are frequently the source of noise during the operation of the compressor. I have found that one serious source of noise incident to the operation of the discharge valves of the reed type is the sound waves set up in the elastic fluid within the compressor cylinder when the reed type discharge valve strikes its seat upon closing. This is probably due in part to the fact that the reed type valve has an inherent tendency to vibrate when struck a blow, as upon seating, because of its extremely resilient construction. The noise is also due in part to the fact that a reed type valve depends to a greater extent upon pressure for its closing operation, than does a spring loaded valve, for example, and as a consequence the piston in the compressor cylinder has already begun its suction stroke before the reed type discharge valve closes. This means that a chamber of comparatively large volume is available above the piston upon closing of the reed type valve in which sound waves may reverberate. The closing of the reed type valve causes a dull thudding sound which reverberates in the cylinder whereas a spring operated valve seats more quickly and usually the only noise heard is the click of the valve on the seat. The noise incident to the closing of the discharge valve appears to bear a direct relation to the volume of the chamber formed by the cylinder and piston at the time of closing.

It is an object of my invention to provide an arrangement for minimizing the noise resulting from the closing of compressor valves and particularly those of the reed type. I accomplish this by providing a construction in which the formation of a rectilinear column of elastic fluid between the discharge valve and head of the compressor piston is prevented in order that reverberating sound waves may not be set up in

such a column by the closing of the valve element.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterized my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawing in which Fig. 1 is a side elevation, partly in section of the upper portion of a refrigerant compressor embodying my invention and Fig. 2 is an exploded perspective view of the parts of one of the inlet valve assemblies of the compressor shown in Fig. 1.

Referring to the drawing, I have shown in Fig. 1 the upper portion of a two-cylinder reciprocating type refrigerant compressor provided with a cylinder casing 10 having two vertical cylindrical cylinder bores 11 and 12 therein. The cylinder casing 10 is provided with integral cooling fins 13 extending from the side walls thereof which aid in dissipating heat from the cylinder walls to the surrounding air. Pistons 11a and 12a are reciprocated in the cylinder bores 11 and 12, respectively, by an electric motor or other suitable driving arrangement. The upper ends of the cylinder bores 11 and 12 are closed by a valve plate 14 which extends entirely across the top of the cylinder casing 10 and the vertical sides of which are in alignment with the adjacent portion of the vertical walls of the cylinder casing 10. Vertical cylindrical discharge passages 15 extend through the valve plate 14 and communicate with the cylinder bore 11. The valve plate 14 is also provided with a similar pair of cylindrical discharge passages 16 extending therethrough which communicate with the cylinder bore 12. The pairs of discharge passages 15 and 16 are surrounded by annular inlet passages 17 and 18 respectively. A horizontal passage 19 formed in the valve plate 14 connects the inlet passages 17 and 18 in series and an intake passage 20 formed in the valve plate 14 communicates with the annular inlet passage 18.

The provision of a compressor valve plate having a discharge passage therein and an annular inlet passage surrounding the same is not my invention but is the invention of Clark Orr, and is described and claimed in his copending application Serial No. 27,351, filed June 19, 1935,

and assigned to the General Electric Company, assignee of my present invention.

I have provided an arrangement which forms a tortuous passage between the heads of the pistons 11a and 12a in the cylinder bores 11 and 12 and the pairs of discharge passages 15 and 16 respectively. As a result, even though the discharge passages 15 and 16 are in communication with the cylinder bores 11 and 12 respectively, the elastic fluid in the tortuous communicating passage will conduct sound very poorly as compared to a rectilinear column of elastic fluid and the noise resulting from the operation of the discharge valve which closes the pairs of discharge passages 15 and 16 is minimized. In the particular arrangement illustrated in the drawing, the inlet valve structure is designed to prevent the formation of a rectilinear column of elastic fluid between the discharge valve and the head of the adjacent compressor piston in which sound waves might otherwise reverberate. The lower sides of the inlet passages 17 and 18 are closed by flat annular inlet valve elements 21 and 22, respectively, which are seated on flat machined surfaces formed on the valve plate 14 about the inner and outer peripheries of the lower ends of the inlet passages 17 and 18. The inlet valve elements 21 and 22 are supported on inlet valve springs 23 and 24 respectively which bias them to the closed position. The valve spring 23, for example, includes an annular base portion and an integral inner C-shaped spring portion 23a. The springs 23 and 24 are identical and may be stamped from sheets of spring steel or the like and the C-shaped portion thereof bent upwardly in the position illustrated in Fig. 2. The top 25 of the C-shaped portion 23a of the spring 23, for example, is preferably flattened in order to facilitate the support of the flat annular inlet valve element 21 thereon, the spring 24 being similarly formed. Lateral displacement of the valve elements 21 and 22 is prevented by annular spacers 26 and 27 of the same form having internally projecting stops 28 formed thereon which engage the sides of the inlet valve elements 21 and 22 thus preventing lateral movement thereof. The springs 21 and 22 and spacers 26 and 27 are supported on disk-shaped valve retainers 29 and 30. The valve springs 21 and 22, the spacers 26 and 27, and valve retainers 29 and 30 are held in position by machine screws 31 and 31a which pass through registering holes formed therein and engage tapped holes 32 and 32a formed in the lower surface of the valve plate 14. The valve retainers 29 and 30 are provided with a series of slots 33 and 34 therein, respectively, which afford communication between the inlet and discharge passages in the valve plate and the interior of the cylinder bores 11 and 12. The slots 33 and 34 are preferably arranged on the arcs of concentric circles and are disposed at the sides of the pairs of discharge passages 15 and 16, respectively, so that the solid central portions of the valve retainers 29 and 30 are presented to the lower ends of the pairs of discharge passages 15 and 16. As a consequence, fluid passing from the interior of the cylinder bores 11 and 12 to the discharge passages 15 and 16 respectively must follow a tortuous path and the formation of a rectilinear column of elastic fluid between the discharge valve at the end of the discharge passages and the heads of the pistons 11a and 12a is prevented.

The counterbored upper ends of the pairs of discharge passages 15 and 16 are alternately

opened and closed by a reed type discharge valve. The reed type discharge valve illustrated includes a flat rectangular discharge valve element 35 made of a thin piece of flexible spring steel or the like, the valve element is pushed downwardly against the flat upper surface of the valve plate 14 by a series of flat rectangular steel leaf springs 36, the lower one of which has flattened outer ends 37 and 38 which bear against the adjacent end portions of the valve element 35. The springs 36 and valve element 35 are secured to the top of the valve plate 14 by a screw 39 which passes through centrally located holes formed therein and is threaded in a tapped hole formed in the top of the valve plate 14. A washer 40 separates the group of springs 36 and the valve element 35 and a spacing block 41 is pressed between the head of the screw 39 and the upper side of the springs 36. When the pressure of the fluid within the discharge passages 15 or 16, for example, reaches a predetermined value, the portion of the discharge valve element 35 above the ends of the passages 15 or 16 is flexed or bowed upwardly into an arcuate configuration spanning the top of the discharge passages in spaced relation thereto thus permitting the escape of compressed fluid therefrom.

The top of the valve plate 14 is covered by a cylinder head block 42 which is provided with a recess 43 in the lower face thereof entirely surrounding the upper ends of the pairs of discharge passages 15 and 16 and the reed type discharge valve mechanism therefor. The recess 43 communicates with a horizontal discharge passage 44 formed in the cylinder head block 42. An integral annular flange 45 is provided on the side of the cylinder head block 42 surrounding the end of the passage 44. The flange 45 is provided with tapped holes 46 and 47 to which a suitable pipe fitting, or the like, attached to a discharge conduit may be secured. An intake passage 48 is provided at the side of the cover block 42 opposite the passage 44, the passage 48 communicating at one end with the intake passage 20 formed in the valve plate 14. It will be seen that the passage 48 does not communicate with the recess 43 formed in the cover block 42, however. An integral annular flange 49 surrounds the outer end of the passage 48 the flange 49 being provided with tapped holes 50 and 51 to which a suitable pipe fitting, or the like, attached to an intake conduit may be secured. A gasket 52 is provided between the adjacent surfaces of the cylinder casing 10 and the valve plate 14 in order to prevent the leakage of compressed fluid therefrom. A gasket 53 is also provided between the adjacent surfaces of the valve plate 14 and the cylinder head block 42 in order to prevent the leakage of compressed fluid therebetween. The cylinder head block 42 and valve plate 14 are held in their assembled position on the cylinder casing 10 by suitable bolts or the like (not shown).

In the operation of the machine described above, the pistons 11a and 12a are reciprocated in the cylinder bores 11 and 12 respectively by an electric driving motor or other suitable apparatus. Vaporized refrigerant such as sulphur dioxide, or other elastic fluid, is supplied to the intake passage 48 and passes therefrom through the intake passage 20 to the annular inlet passage 18 and from there through the passage 19 to the second annular inlet passage 17. Oil, or other lubricant, entrained in the incoming gaseous refrigerant is separated therefrom in

the passage 19 and flows by gravity through the passage 54 to the crank case or other lubricant reservoir. When the piston 12a, for example, moves downwardly on its suction stroke the fluid pressure on the lower side of the inlet valve element 22 is decreased. When the pressure of the gaseous refrigerant in the inlet passage 18 exceeds the pressure of the gaseous refrigerant in the cylinder bore 12 by a predetermined amount, the inlet valve element 22 and its supporting spring 21 are forced downwardly, thus establishing communication between the inlet passage 18 and cylinder bore 12. Gaseous refrigerant then enters the cylinder bore 12 passing thereto through the slots 33 and 34 formed in the valve retainer 30. The portion of the discharge valve element 35 extending across the outer ends of the discharge passage 16 remains flat, thus maintaining the discharge passages 16 closed, during the suction stroke of the piston 12a since the pressure in the recess 43 exceeds the pressure in the cylinder bore 12 during the suction stroke. When the piston 12a again moves upwardly on the compression stroke, the gaseous refrigerant in the cylinder bore 12 is compressed and the inlet valve element 22 is moved upwardly closing the inlet passage 18 due to the increase in pressure in the cylinder bore 12 with respect to the pressure in the inlet passage 18. When the pressure in the cylinder bore 12 exceeds the pressure in the recess 43 by a predetermined amount, depending upon the stiffness of the discharge valve element 35, the latter is flexed upwardly thus opening the discharge passages 16 and allowing the escape of compressed gaseous refrigerant from the cylinder bore 12 into the discharge recess 43. As the piston 12a again moves downwardly on its next suction stroke, the discharge valve element 35 flexes back to the flat closed position illustrated in the drawing when the pressure in the recess 43 exceeds the pressure in the cylinder bore 12 by a predetermined amount. There is a small time lag in the movement of the reed type discharge valve element 35 so that the piston 12a has moved downwardly, thus forming a chamber of substantial volume in the cylinder bore 12, before the discharge valve element 35 has completed its closing movement. Since the apertures 34 in the inlet valve retainer 30 are laterally displaced with respect to the lower ends of the discharge passages 16, however, the formation of a rectilinear column of elastic fluid between the discharge valve element 35 and the head of the piston 12a is prevented. As a consequence, reverberations incident to the closing of the discharge valve element 35 are minimized even though the piston 12a has moved downwardly a sufficient amount to form a chamber of fairly large volume thereabove. The pistons 11a and 12a are suitably connected to a crank shaft, or other driving arrangement therefor, in such manner that the piston 11a moves through its compression stroke at the time the piston 12a is moving through its suction stroke and vice versa. Thus, except for the difference in relative time of operation, gaseous refrigerant is compressed in the cylinder bore 11 and discharged therefrom in the same manner as described above with respect to the cylinder bore 12.

While I have shown a particular embodiment of my invention in connection with a compression type refrigerating machine, I do not desire my invention to be limited to the particular

construction shown and described and I intend in the appended claims, to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent in the United States is:

1. A compressor for elastic fluid comprising in combination a compression cylinder having a longitudinal cylinder bore therein, a reciprocating piston in said cylinder bore, said cylinder having a discharge passage formed in one wall thereof, a discharge valve element of the reed type for closing said discharge passage, and means for preventing the flow of elastic fluid in a rectilinear column between said piston and said discharge valve element in which reverberating sound waves may be set up by the closing of said valve element.

2. A compressor for elastic fluid comprising in combination a compressor cylinder having a longitudinal cylinder bore therein, a reciprocating piston in said cylinder bore, a valve plate closing one end of said cylinder bore, said valve plate having a discharge passage formed therein, a discharge valve element of the reed type mounted on the exterior side of said valve plate for closing said discharge passage, and means for preventing the flow of elastic fluid in a rectilinear column between said piston and said discharge element in which reverberating sound waves may be set up by the closing of said valve element.

3. A compressor for elastic fluid comprising in combination a compression cylinder having a longitudinal cylinder bore therein, a reciprocating piston in said cylinder bore, said cylinder having a discharge passage formed in one wall thereof, a discharge valve element of the reed type for closing said discharge passage, and means forming a tortuous passage between said discharge valve element and said piston for minimizing the reverberating sound waves set up by the closing of said valve element.

4. A compressor for elastic fluid comprising in combination a compression cylinder having a longitudinal cylinder bore therein, a reciprocating piston for said cylinder bore, said cylinder having a discharge passage and an inlet passage formed in one wall thereof, a discharge valve element of the reed type for closing said discharge passage, an inlet valve assembly for closing said inlet passage said inlet valve assembly including an apertured valve retainer, said valve retainer forming a tortuous passage between said discharge valve element and said piston for minimizing the reverberating sound waves set up by the closing of said valve element.

5. A compressor for elastic fluid comprising in combination a compression cylinder having a longitudinal cylinder bore therein, a reciprocating piston in said cylinder bore, a valve plate closing one end of said cylinder bore said valve plate having a discharge passage and an inlet passage formed therein, a discharge valve element of the reed type mounted on the exterior side of said valve plate for closing said discharge passage, an inlet valve assembly for closing said inlet passage said inlet valve assembly including an apertured inlet valve retainer, said inlet valve retainer forming a tortuous passage between said discharge valve element and said piston for minimizing reverberating sound waves set up by the closing of said discharge valve element.

6. A compressor for elastic fluid comprising

in combination a compression cylinder having a longitudinal cylinder bore therein, a reciprocating piston in said cylinder bore, a valve plate closing one end of said cylinder bore, said valve
5 plate having discharge and inlet passages formed therein, said inlet passage being annular in shape and surrounding said discharge passage, a discharge valve element of the reed type mounted on the exterior side of said valve plate for closing
10 said discharge passage, an annular inlet valve ele-

ment for closing said inlet passage, and means including a disk-shaped valve retainer for supporting said inlet valve element adjacent the inner end of said inlet passage, said valve retainer being provided with a series of apertures laterally
5 displaced from the inner end of said discharge passage for minimizing reverberating sound waves set up by the closing of said discharge valve element.

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