VALVE ASSEMBLY FOR COMPRESSORS AND THE LIKE

Owen H. Scheldorf, Ferrin Creek, Ky., assignor to General Electric Company, a corporation of New York
Filed Mar. 20, 1961, Ser. No. 96,801
8 Claims. (Cl. 137—516.15)

The present invention relates to valve assemblies and is more particularly concerned with an improved valve assembly for compressors of the reciprocating type adapted to operate at relatively high speeds.

High speed reciprocating compressors, such as those employed in the refrigeration industry generally include flexible, pressure-actuated valves. Because of their greater resistance to breakage, ease of manufacture within given tolerances and for a number of additional reasons, such valves are composed of a flexible valve member including one portion securely anchored or clamped adjacent the port area and a flexible portion overlying and controlling the flow of gas through one or more gas ports or openings. In one valve of this type which is generally used as the intake valve for a compressor, the valve assembly comprises a plate or member having an annular port surrounding and adjacent to the upper end of the compressor cylinder and a centrally apertured flexible valve in the form of a ring or equivalent shape arranged so that the annular inner port overlies the annular porting zone while the outer edge portion is secured to maintain the valve in its proper position relative to the port. The unanchored inner portion of the valve overlying the annular port is free to flex conically from its position seated against the port to a port open or raised position during each compressor stroke. In the presently known valve assemblies of this type, the flexible valve is concentrically arranged with reference to the annular port and the clamping element is designed to apply the clamping pressure along a continuous line concentric with the port and with the inner periphery or edge of the valve. In other words, the width or diameter of the conical valve 8 engaging the flat face of the valve is uniform about its entire circumference with the result that as the compressor piston travels downwardly on an intake stroke, the pressure difference across the valve causes a symmetric and simultaneous lifting of the entire flexing portion of the valve from the seat followed by a flexing of all portions thereof to the seat during the compression stroke.

The present invention is based on the discovery that this uniform and evenly distributed flexing of the valve between the open and closed positions is responsible for a significant portion of the valve noise. Accordingly, it is an object of the present invention to provide a valve assembly in which this action is avoided and the valve is caused, during the opening movement thereof, to peel from the valve seat starting at one point about its periphery and continuing to the opposite side and to return to the valve seat by the reverse rolling action.

A more general object of the invention is to provide a valve assembly including means designed to reduce valve noises during operation of the compressor.

Further objects and advantages of the invention will become apparent as the following description proceeds and it is to be understood that the objects and features of the invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of the present invention, there is provided a valve assembly for compressors and the like comprising a valve plate or member including an annular port, a flexible member engaging the valve member and having an annular inner edge portion overlying the annular port and concentric therewith, and a valve clamping member having a surface that clamps the flexible valve to the valve member along a continuous, substantially annular line extending on the opposite side of the annular port from the inner valve edge. Accordingly, with the present invention and with the result that there is obtained a substantial reduction in valve noise over prior "ring" valve constructions, this clamping line is non-concentrically arranged with reference to the inner valve edge so that the free or unanchored flexing portion of the valve overlying the port will have a width, and hence a flexibility, which decreases from a maximum at a first point about the circumference of the inner valve portion to a minimum at a second point remote from the first. As a result, in flexing from its port closing to the port open position, the valve will initially flex open at the first point and then progressively peel or roll away from the valve member surface. Conversely, the free flexing portion overlying the inner edge portion of the valve which affects the closing action of the valve varies with the effective width thereof and is greatest at the second and narrowest point. As a result the valve closes first at its narrowest point and then progressively rolls onto the surface of the valve member.

For a better understanding of the invention, reference may be had to the accompanying drawing in which:

FIG. 1 is a sectional view of a portion of a reciprocating compressor embodying the present invention; and
FIG. 2 is a sectional view along line 2—2 of FIG. 1.

With reference to the drawing, the compressor as illustrated comprises a cylinder 1 suitably secured, as by means of brazing, within an opening in a supporting bracket 2 in such a manner that the upper edge 3 of the cylinder 1 and the flat upper surface of the bracket 2 are in the same plane to provide the flat surface of a valve member 4. An annular port 5 opening into the surface of this member is obtained by circumferentially recessing the portion of the bracket 2 surrounding the cylinder 1. A passage 6 communicating with the annular port 5 is provided for the flow of gas to the compressor cylinder 1. To control the flow of gas through port 5, there is provided a thin metallic valve 8 engaging the flat face of the valve member 4 with the annular inner periphery or edge thereof overlapping the upper edge 3 of the cylinder 1 and concentric with the annular port 5. The outer edge portion 10 of the valve 8 is securely clamped into engagement with the flat surface of the valve member 4 by means of a valve clamping or backing member 11 secured to the valve member by means of bolts 12 extending also through the backing member 11 and the compressor head 14. The clamping member 11 and head 14 cooperate to form a discharge chamber 15 from which compressed gas is discharged through the discharge line 16.

In the illustrated compressor, the valve backing member 11 which backs the intake valve 8 also functions as a valve plate for a discharge valve assembly including a disk valve 17 secured to the member 11 by a rivet 18 in such a manner that the flexing movement of the outer periphery of the valve 17 controls the flow of gas through discharge ports 19 and into the discharge chamber 15.

In accordance with the usual practice, the lower surface of the backing member 11 has a centrally positioned recess 20 generally overlying the annular port 5 and adjacent areas so that the inner portion 21 of the valve 8 engages the inner flex bending position in which it covers and closes the annular port 5 and a raised position during the intake stroke of piston 23 to permit the flow of gas into the cylinder 1. Preferably, the recess is in the form of a frusto-conical surface with the sloping walls 24 conforming substantially to the shape of the flexing portion 21 of the valve when in its open or flexed position.

The difference between the transverse or diametrical
dimensions of the recess 20 and the size of the valve aperture defined by edge 9 determines the effective flexing width of the flexing portion 21 of the valve 8. In other words, the annular line of intersection 26 between the sloping conical wall 24 of the recess 20 and the flat clamping surfaces of the member 11 in effect divides the valve 8 into a flexing or valving inner portion 21 extending from edge 9 to line 26 and a clamped or anchored portion 10. The distance between the clamping line 26 and the inner edge 9 of the valve 8 determines or controls the flexibility of the flexing portion 21 of the valve.

In accordance with the prior practices, this clamping line 26 has been of the same shape or configuration as the inner edge 9 of the valve and has been arranged concentrically with that edge so that the width and flexibility of the flexing portion 21 has been uniform about the entire circumference of the valve portion 21. As a result, the flexing movement of the valve away from the port is completely and uniformly conical about its entire area. In other words, the free or flexing portion 21 of the valve would undergo a symmetrical lifting and return action during each stroke of the compressor.

It has been found that the return of the valve to its port closing position, the simultaneous contact of the entire flexing portion of the valve with the cooperating surface of the valve member was responsible for much of the valve noise of known compressors including valves of the type of which the present invention is made. This noise, which is produced when much of the slapping type of noise is eliminated by a simple and practically cost-free modification of the valve clamping member which causes the valve to open and close unsymmetrically, i.e., with a peeling or rolling action.

This improvement is obtained by providing a recess 20 which is offset relative to the inner edge 9 of the valve 8 or more specifically provides a clamping line 26 offset an amount sufficient to provide a significant difference in the widths of the flexing portion 21 of the valve on one side of the cylinder as compared with that on the other side. More specifically, it has been found that by designing the back member 11 so that instead of the clamping line 26 being concentric with the inner periphery or edge 9 of the valve 8, it is eccentric with reference to the valve edge, there is obtained a substantial reduction in the valve noise due presumably to the fact that the valve is subjected to an opening pressure differential, the wider and hence more flexible portion thereof will open first followed by a progressive peeling of the remaining portion of the valve along the opposite sides thereof. When the pressure is removed, a reversal of this action takes place during the closing of the valve with the narrower or less flexible portion closing first.

For the purpose of illustration, the section of FIG. 1 has been taken along a vertical plane intersecting the center line of the annular inner periphery 9 of valve 8 and also the center line of the offset recess 20. As illustrated in both figures of the drawing, the result of offsetting the recess 20 with reference to the annular inner edge 9 of the valve 8 is to provide a configuration for the flexing portion 21 of the valve 8 such that the portion of the valve 33 at the left side is significantly wider than the portion 34 at the diametrically opposite side. With this non-concentric arrangement, the intervening portions of the valves between the points 33 and 34 are, of course, of an intermediate and gradually changing width.

Only a relatively slight offset of the center line of the recess 20 from the center line of the inner periphery is needed to accomplish a substantial decrease in valve noise. For example, an eccentricity of at least 3%, preferably 5%, relative to the diameter of the annular edge 9, or in other words, at least 6%, preferably at least 10%, difference in the radial width of the flexing portion 21 of the valve along side portion 33 as compared to the width of the opposite side portion 34 results in a peeling or rolling action and a substantial decrease in the impact noise of the valve.

Since the annular port 5 and the inner valve edge 9 are concentric, the effective gas pressures about the entire valve periphery during the operation of the piston 23 are the same. In other words, the leverage action of the gas stream from the annular port 5 is applied uniformly and at the same time the valve edge 9 about the entire periphery of the valve edge 9. However, since the portion 33 is significantly wider than the remaining portions of the valve or more specifically since the clamping line 26 is farther away from the port 5 at this point, even though there is a uniform gas pressure acting upon the valve at the opposite side of the port 5, there is a non-uniform or unsymmetrical opening of the valve as the more flexible portion 33 will be the first to lift from the valve member as the valve moves to its open position and the remaining portions of the valve will then peel about the opposite sides thereof until the least flexible portion 34 lifts.

Similarly because the spring tension is greater in the vicinity of the portion 34, the valve closes first at this point as the gas pressure diminishes and thereafter rolls shut until the portion 33 is the last to close.

While there has been shown and described a specific embodiment of the present invention, it is to be understood that the invention is not limited thereto and that the appended claims cover all modifications within the spirit and scope of the invention.

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

1. A valve assembly for compressors and the like comprising a valve member having an annular porting zone, a flexible valve engaging said valve member and having an annular edge concentric with said porting zone, the portion of said valve adjacent said edge overlying said annular porting zone, and a clamping member having a surface clamping a portion of said said valve member along a continuous line on the opposite side of said porting zone from said valve edge, said annular line being non-concentric to said valve edge whereby the free width and therefore the flexibility of the portion of said valve overlying said porting zone gradually varies from a maximum at one portion to a minimum at a diametrically opposite portion.

2. A valve assembly for compressors and the like comprising a valve member having an annular porting zone, a flexible valve engaging said valve member, said valve having an annular inner edge concentric with said porting zone and a continuous inner portion adjacent said edge covering said porting zone, and a clamping member having a surface clamping the outer portions of said said valve to said valve member along a continuous annular line outwardly from said porting zone whereby the inner portion of said valve is free to flex conically to an open position away from said valve member, said annular line being eccentric to said valve edge so that the flexibility of said inner portion gradually varies from a minimum at one portion to a maximum at a diametrically opposite point whereby said valve closes progressively from said one portion to said opposite point.

3. A valve assembly for compressors and the like comprising a valve member having a flat face and an annular porting zone in said face, a flexible valve engaging said face, said valve having an annular inner edge concentric with said porting zone and a continuous portion adjacent said edge overlying said porting zone, a valve clamping member clamping said valve to said valve member along a continuous annular line on the opposite side of said porting zone from said valve edge, said annular line being eccentric to said valve edge whereby the free width and therefore the flexibility of the portion of said valve overlying said porting zone gradually varies from a maximum at one side to a minimum at a diametrically opposite side.

4. A valve assembly for compressors and the like comprising a valve member having a flat face and an annular porting zone opening in said flat face, a flexible flat valve
engaging said face and having an inner portion overlying said annular porting zone for controlling the passage of gas through said porting zone, said valve being mounted on said face with the inner edge thereof concentric with said porting zone, a valve backing member including a surface portion engaging the outer edge portion of said valve and an annular relieved surface overlying said inner edge portion of said valve to permit said inner portion to flex relative to said valve member, said backing member being disposed eccentrically with said valve whereby the inner edge portion of said valve is of non-uniform width to provide non-uniform flexing movement thereof.

5. A valve assembly for compressors and the like comprising a valve member having a flat face and an annular porting zone opening in said flat face, a flexible flat valve engaging said face and having an annular inner edge portion overlying said annular porting zone for controlling the passage of gas through said porting zone, said valve being mounted on said face concentric with said porting zone, a valve clamping member including an engaging surface engaging the outer edge portion of said valve and a relieved surface overlying said inner edge portion of said valve and being disposed eccentrically with said inner edge of said valve whereby the free inner edge portion has a first portion which is wider than a second diametrically opposite portion.

References Cited in the file of this patent

UNITED STATES PATENTS

1,834,038 15 Summers  . Dec. 1, 1931
2,547,377  De Juhasz . Apr. 3, 1951