July 15, 1941. C. W. LEEGARD 2,249,480

COMPRESSOR VALVE

Filed July 14, 1939

Fig. 1.

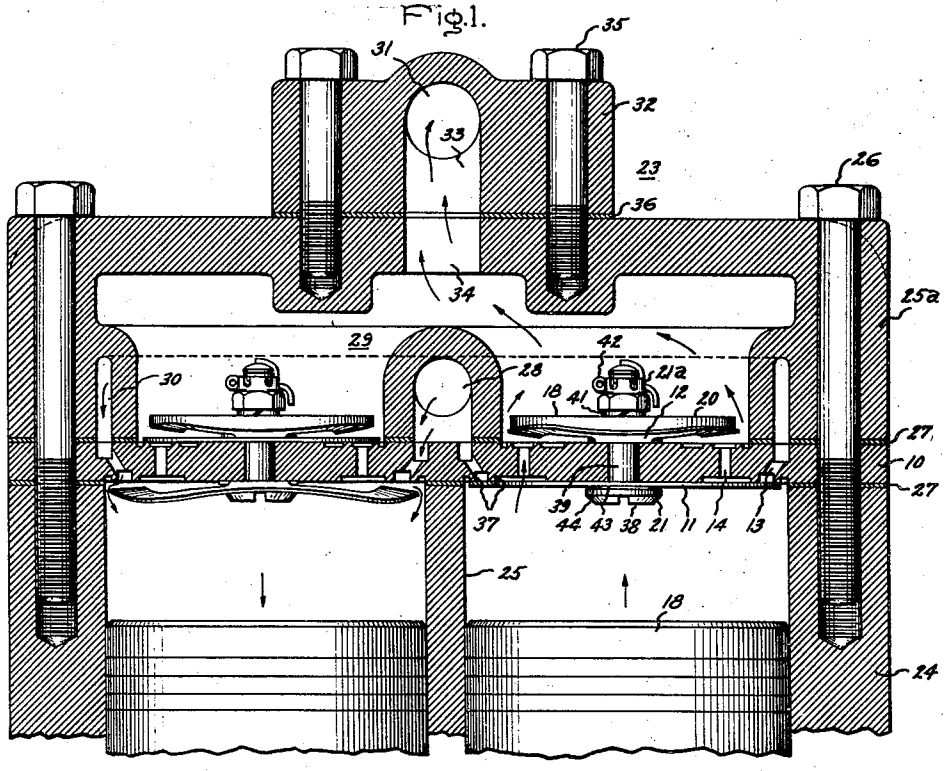


Fig. 2.

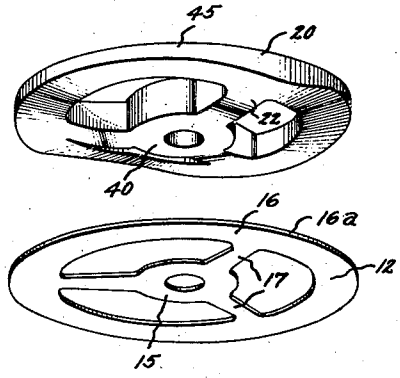
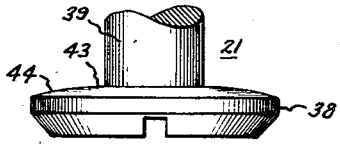


Fig. 3.



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2,249,480

COMPRESSOR VALVE

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5 Claims. (Cl. 251—119)

My invention relates to compressors or the like and more particularly to valve assemblies for compressors or the like.

It is an object of my invention to provide a new and improved valve mechanism for use in compressors which has a relatively low clearance volume, minimum pressure losses, low internal stresses in the valve mechanism, quiet operation and simplicity of construction.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize 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 an enlarged elevational view, partly in section, of a compressor embodying the principles of my invention; Fig. 2 is an exploded view in perspective of the exhaust valve and valve retainer therefor illustrated in Fig. 1, and Fig. 3 is an enlarged view of a detail of the valve assembly shown in Fig. 1.

In the drawing, I have illustrated a valve assembly including a valve plate 10 having an intake valve 11 and an exhaust valve 12 secured thereto to control the passage of working medium through intake passages 13 and exhaust passages 14, respectively. The valves 11 and 12 are similar in form and, as best shown in Fig. 2, each valve comprises a central securing portion 15 and a valve portion or ring 16 supported from the clamping portion 15 by means of a plurality of tapered arms 17. In order to limit the lift of the exhaust valve 12 and to absorb the violent opening shock thereof, I have provided a retainer or stop member 20 adjacent the exhaust valve 12 and substantially coextensive therewith. The intake valve is not subjected to violent opening shock and, accordingly, no intake valve stop is required.

In operation, as the rim 16*a* of valve member 16 of the valve 11 or 12 lifts, the diameter of the rim circle decreases because the center portion 15 is clamped to the valve plate 10 as by means of a threaded fastening member 21 and castle nut 21*a* and the spokes 17 bend on a radius thereby decreasing the distance of the rim 16*a* from the vertical center line through the valve. As the lift increases and the diameter of the valve ring circle decreases, it becomes necessary for the ring 16 of the valve 12 to buckle between the junctions of spokes 17 and ring 16 in order to allow the normally relatively large periphery of the rim 16 to assume the position of a smaller diameter circle having a smaller mean circumference.

In order to insure maximum efficiency of the valve, it is desirable to permit the valve to lift as high as possible without exceeding permissible stress limits. The intake valve is free to bend to the fullest extent because no retainer is provided to restrain or otherwise guide the valve lift but with respect to the exhaust valve 12, this aim has been accomplished by shaping the retainer 20 to restrict the lift of the ring 16 at the spoke junction to a point that will give maximum allowable stress in the spoke. It then becomes desirable to allow the valve to lift above this point intermediate the spoke junctions because the ring 16 is now on a smaller diameter. Therefore, the retainer 20 is constructed so that the ring 16 of the valve 12 intermediate the spoke junctions can lift a sufficient amount above the lift at the spoke junctions to compensate for the decreased diameter of the valve 12 in the open position. Thus, the degree of valve lift at the various points on the ring 16 is limited by the retainer 20 so that substantially constant bending stress is maintained at all points on the ring. The arm portion 22 of the retainer 20 corresponding to the arm or spoke portions 17 of the valve 12 are formed so that an even curvature of the valve spokes 17 is maintained in order that a constant bending stress may be maintained at all points in the spokes 17. The arms 22 may be tapered to correspond to spokes 17 of exhaust valve 12, if desired.

Describing my invention in greater detail, I have provided a compressor 23 comprising a cylinder block 24 with a plurality of longitudinal cylinder bores 25 within which pistons 18 are arranged for reciprocation in any suitable manner. Inasmuch as the details of the apparatus required to reciprocate the pistons 18 form no part of my invention, it is believed to be unnecessary to describe the structure used. While I have illustrated a two-cylinder compressor, it will be understood that as many cylinders and stages of compression as desired may be provided.

The open ends of the cylinder bores 25 are closed by valve assemblies embodying the principles of my invention. Each valve assembly includes the valve plate 10 formed from steel, for example, provided with a plurality of intake passages 13 and a plurality of exhaust passages 14 therethrough. While I have illustrated two passages 13 and two exhaust passages 14 in connection with each cylinder bore 25, it will be under-

stood that any desired number of passages may be employed. Preferably, the intake and exhaust passages 13 and 14, respectively, are disposed in concentric annular rings. A cylinder head 25a and the valve plate 10 are suitably secured to the compressor casing 24 as by means of threaded screws 26, gaskets 27 being clamped between the valve plate 10 and cylinder block 24 and also between the valve plate 10 and the cylinder head 25a in order to insure fluid-tight joints between the adjacent parts of the compressor assembly.

The cylinder head 25a is arranged to provide an intake passage 28 and a discharge manifold 29. The intake passage 28 communicates with an annular passage 30, intake passages 13 being formed in valve plate 10 to complete the intake path for the working fluid between the intake passage 30 and the cylinder bore 25. The discharge passages 14 in the valve plate 10 communicate between the cylinder bore 25 and the discharge manifold 29. An outlet passage 31 terminating in a discharge block 32 communicates with the discharge manifold 29 through passage 33 in the block 32 and passage 34 in the cylinder head 25a. The block 32 is suitably secured to the cylinder head as by means of threaded screws 35, a gasket 36 being provided to insure a fluid-tight joint between the cylinder head 25a and the block 32.

The intake valve 11 is formed from relatively resilient material, such as steel, and as previously described, may be provided with a valve portion in the form of an outer ring 16 maintained in position to cover the intake ports 13 by means of arms or spokes 17 which may be integral with the ring 16. The ring 16 of the valve is just sufficiently wide to cover the valve seats 37 except at the junction of spokes 17 in order to allow free passage of working fluid on both outside and inside of the valve ring 16. The inner ends of the arms or spokes 17 are suitably joined to the clamping portion 15 of the valve. While I have illustrated a valve portion in the form of a ring, any suitable shape, such as an arcuate valve portion, supported by spokes or arms may be used. It will be observed that the spokes or arms 17 are tapered from the clamping portion 15 toward the valve portion 16 so that when the valve opens and causes flexing of the arms 17, the flexing occurs in such a manner that the bending stress is evenly distributed throughout the length of the arms 17. Two or more arms or spokes 17 may be used depending upon the degree of opening desired. Thus, the principles of my invention are also applicable to a valve having an outer valve portion and an inner clamping portion, the spokes being formed by punching openings in a concentric circle between the valve portion and the clamping portion. It will be observed that spokes or arms 17 of the valves act as springs tending to limit the lift of the valve and also as a closing force when the intake stroke of the piston 18 is completed. When the valve 11 opens, the valve portion 16 also flexes between the sections where it is attached to the tapered arms 17 thereby giving the maximum lift or opening of the valve at the point on the valve ring 16 which is substantially midway between the arms or spokes 17. This necessarily decreases the amount of lift required at the point where the arms meet the valve ring 16 and consequently decreases the amount of stress which the arms must sustain.

The discharge valve mechanism is substantially the same in construction as the intake valve so that the maximum opening is at a point on the periphery of the valve ring 16a that is most remotely connected to the center or clamping section 15. The spokes 17 are also tapered to obtain even stress throughout their length.

In order to limit the opening or the lift of the discharge valve 12, I have provided a valve retainer or stop 20. The discharge valve retainer 20 is substantially the same shape as the discharge valve 12 or co-extensive therewith and is formed so that when supported adjacent to the discharge valve 12 it limits the amount of opening or lift of the discharge valve. The spokes or arms 22 of the retainer 20 are arranged to lie over the valve spokes 17 and formed, preferably curved, in such a manner that even curvature of the valve spokes is maintained when the valve lifts. Inasmuch as substantially constant stress is desired at all points on the valve portion, the surface of the retainer is so shaped that in the fully open position of the valve, substantially even stress results. Because the unsupported part of the valve flexes most easily, the greatest lift takes place at that point, between the spokes in the drawing, and considerably more lift can be permitted than at the spoke junctions where the valve is relatively stiff. Thus, for example, if the upper surface of the retainer is flat, the retainer will be thinnest midway between the spoke junctions and thickest at the junctions. In order to minimize the noise of the valve 12 or arms 17 striking the retainer 20, it is desirable to prevent all parts of the valve 12 from touching the retainer simultaneously. Therefore, the rim portion 45 of retainer 20 is suitably modified, as by slightly decreasing the distance between the unstressed valve and the retainer, i. e., by thickening the retainer, as above formed, in the vicinity of the area midway between spokes in order that the point on the valve portion, 16, which tends to lift most readily, namely, the area midway between the spokes 22 will strike the retainer first and limit its lift. With this arrangement, the area of contact between valve portion 16 and valve retainer 20 will increase progressively in both directions from the point of initial contact until finally, the valve portion at the junction with the spokes or arms 17 will touch the formed surface of retainer 20. Similarly, the area of contact between the arms 17 and 22 of the valve 12 and the adjacent surface of the retainer 20, respectively, will increase progressively from the clamping portions outwardly to the valve portion 16 of the valve 12. Thus the retainer finally limits the lift of the valve at all points thereof in such a manner that sudden and uneven stresses are largely obviated.

Securing means have been provided in order to maintain the valves 11 and 12 and the retainer 20 in position. For this purpose, I have illustrated the use of a screw 21 having a head portion 38 and a threaded body portion 39 arranged to extend through a suitable opening in the valve plate 10 and suitable openings in the centrally located clamping portions 15 and 40 of the valves 11 and 12 and the retainer 20, respectively. The fastening means 21 is completed by means of a nut 21a and lock washer 41. I have also illustrated the use of a cotter pin 42 to insure that the nut 21a cannot turn after the assembly has been completed. With this arrangement, it will be seen that the valves 11 and 12 and retainer 20 are rigidly clamped to the valve plate 10 at the central or clamping portions thereof. The

under side of the head 38 of the screw 21, illustrated as facing the intake valve 11, is provided with relatively narrow flat surfaces or areas 43 adjacent the body portion 39 of the screw which serves to clamp the intake valve in its place. The under side of the head 38 adjacent to the flat section is tapered, preferably curved, as indicated by numeral 44 to limit the degree of lift of the valve 11 near the outer edge of the head 38 thereby helping to distribute the stress near the clamping section 15 of the valve. The face of the clamping portion 40 of the valve retainer 20 presented to the exhaust valve 12 is preferably formed in a similar manner for the same purpose.

In operation, as the piston 18 starts its downward stroke, the pressure difference existing between the intake passage 28 and the cylinder bore 25 forces the intake valve 11 off its seat and the cylinder bore 25 is filled with low pressure working medium. When the piston 18 reaches the bottom of the stroke, the intake valve 11 reseats itself and the working medium is then compressed on the upward stroke of the piston 18. When the working medium in the cylinder bore 25 reaches a pressure exceeding the pressure in the exhaust manifold 29 and the tension caused by the resiliency of the exhaust valve 12, the exhaust valve 12 lifts off its seat and allows the compressed medium to pass into the exhaust manifold 29. When the piston reaches the top of its stroke, the pressures in the cylinder bore 25 and exhaust manifold 29 will equalize permitting the exhaust valve 12 to re-seat and check any flow of high pressure working medium back into the cylinder bore 18. The right-hand cylinder, as viewed in Fig. 1, is illustrated in the compression stroke while the left-hand cylinder of Fig. 1 is illustrated in the intake stroke.

While I have shown a particular embodiment of my invention, 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 of the United States, is:

1. A valve assembly comprising a resilient valve member including a clamping portion, a valve portion, a plurality of portions for supporting said valve portion from said clamping portion and a retainer member for limiting movement of said valve in one direction, the surface of said retainer member presented to said valve member being so shaped that as the valve moves to its open position one portion of said valve portion remote from the supported portion contacts said retainer member first and the area of contact between said valve portion and said retainer surface increases progressively from said first point of contact until said valve portion engages substantially all the adjacent surface of said retainer in order to minimize noise caused by said valve portion striking against said retainer member.

2. In a valve assembly for compressors or the like, a relatively resilient valve member comprising a clamping portion, a valve portion and a plurality of arms for supporting said valve portion from said clamping portion, and a retainer member for limiting movement of said valve member in one direction, the surface of said retainer member presented to said valve member being so shaped that the part of said valve portion which is intermediate the junctions of said valve portion and said arms contacts said retainer first and the area of contact between said valve portion and said retainer surface increases progressively from said first point of contact toward said junctions as said valve moves to its open position.

3. In a valve assembly for compressors or the like, a relatively resilient valve member comprising a clamping portion, a valve portion and a plurality of arms for supporting said valve portion from said clamping portion and a retainer member for limiting movement of said valve in one direction, the surface of said retainer member presented to said valve member and said arms being so shaped that the section of said valve portion which is intermediate the junction of said valve portion and said arms contacts said retainer first, the area of contact between said valve portion and said retainer surface increasing progressively from said first point of contact toward said junctions, and the area of contact between said arms and said surface increasing progressively from said clamping portion toward said junctions as said valve moves to its open position.

4. A valve assembly comprising a relatively resilient valve, said valve comprising a central clamping portion, an outer ring portion, and a plurality of tapered arms extending radially from said clamping portion to said ring portion for supporting said ring portion, a valve retainer supported adjacent said valve, said retainer having substantially the same cross section as said valve whereby corresponding portions of said retainer and said valve are substantially co-extensive, the surfaces of said retainer presented toward said valve being shaped to maintain substantially constant bending stress at all points on said ring portion and an even curvature throughout the extent of said arms as said valve moves to open position.

5. In a valve assembly, a valve formed of relatively resilient material and comprising a central securing portion, an outer valve portion and a plurality of arms extending from said securing portion to said valve portion, said arms tapering from said central portion to said valve portion, a valve retainer supported adjacent said valve, said retainer having substantially the same cross section as said valve whereby corresponding parts of said retainer and said valve are substantially co-extensive, the surface of said retainer presented toward said valve being shaped to maintain substantially constant bending stress at all points on said valve portion and an even curvature throughout the extent of said arms as said valve moves to its open position.

CLIFFORD W. LEEGARD.