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(54) Leaf spring biassed check valve

(57) A check valve comprises a bevelled disc valve member (26) biassed into engagement with seat (14) by a curved-disc leaf spring (56). The valve member is guided in its opening movement by fingers (44) on the bridge member (30).

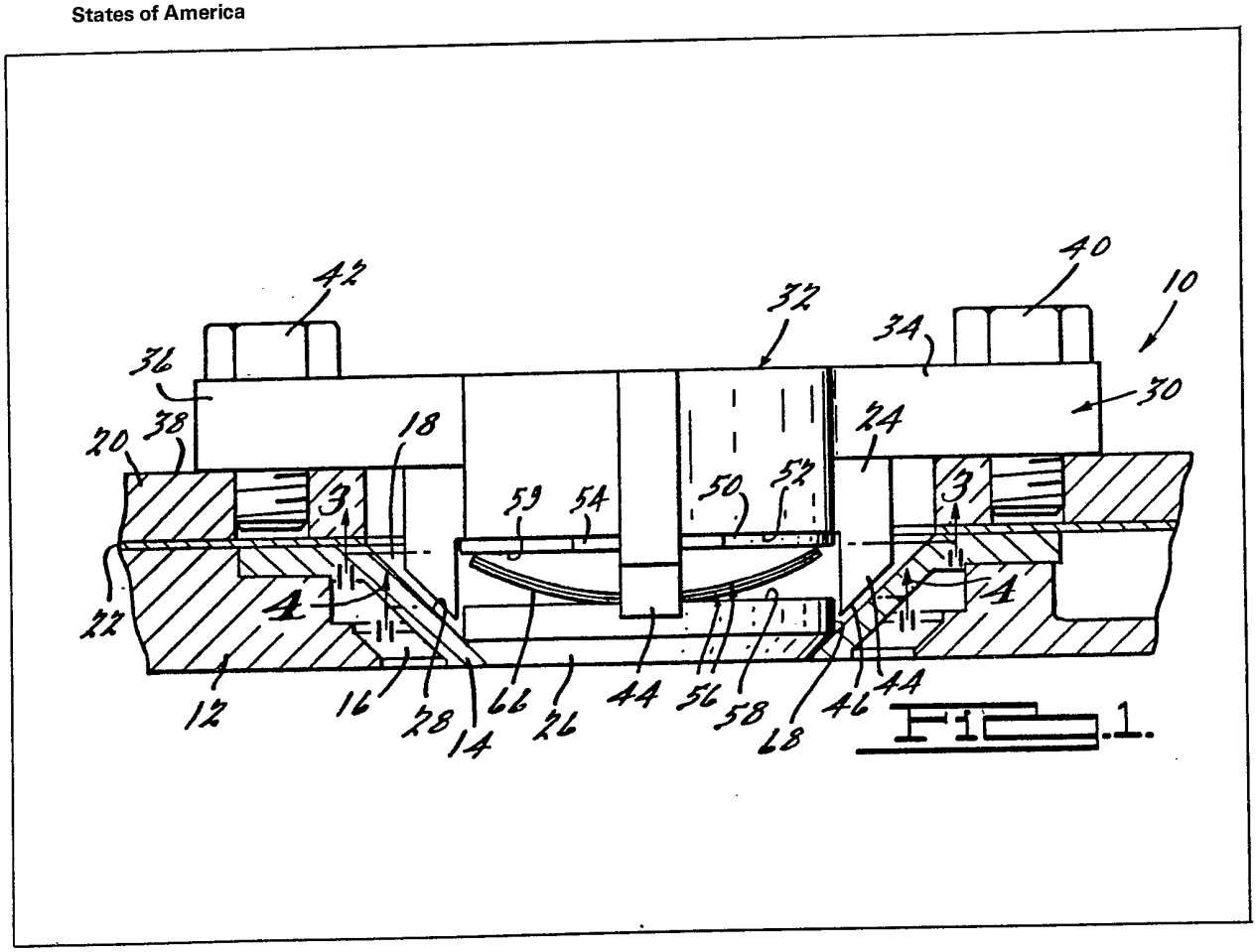


Fig.1.

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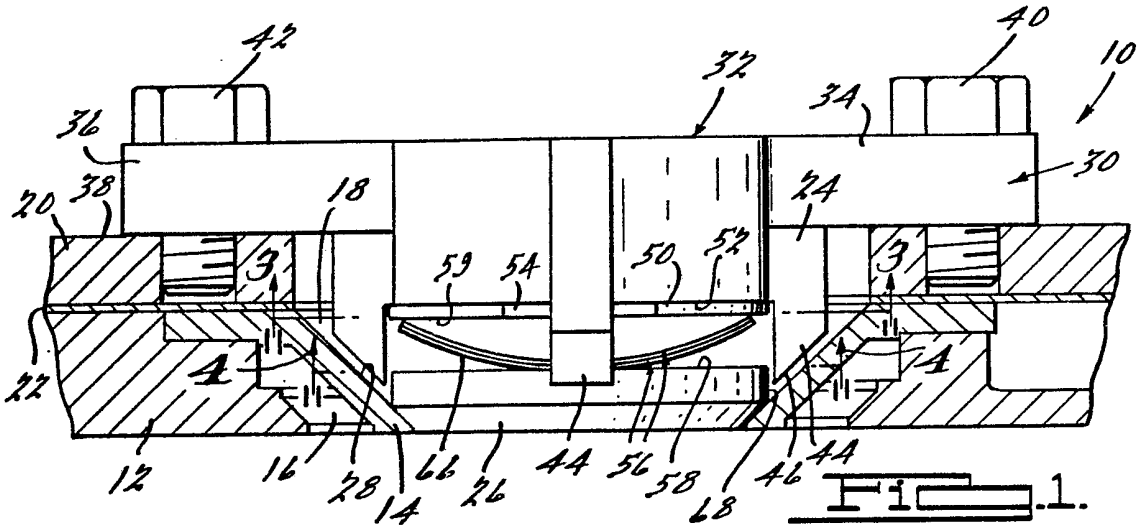


Fig. 1.

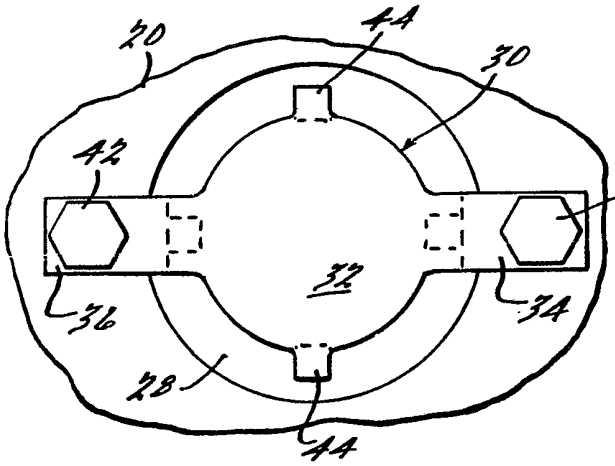


Fig. 2.

Fig. 3.

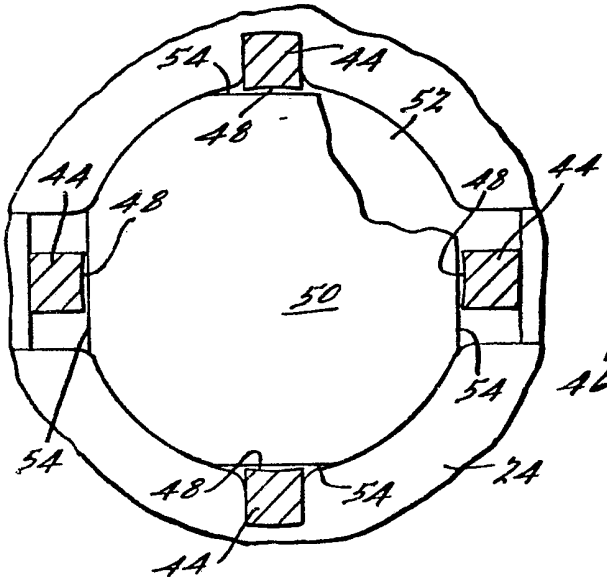


Fig. 4.

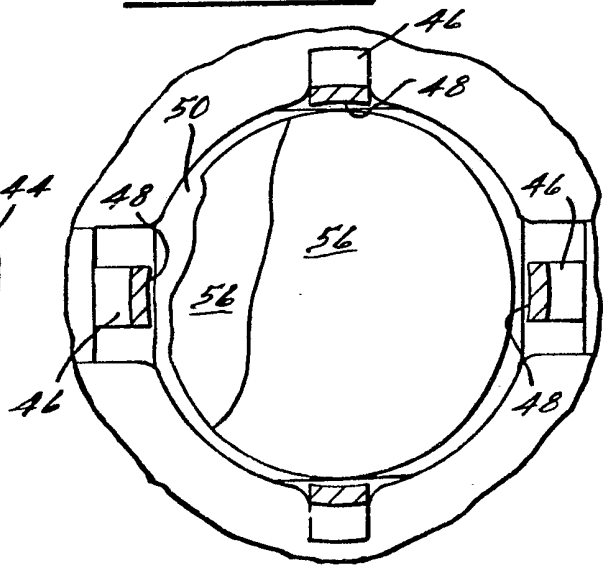
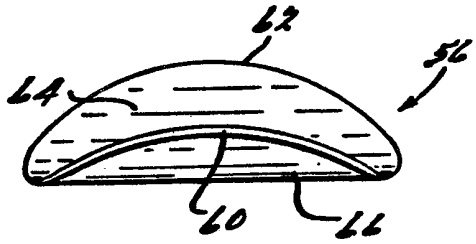


Fig. 5.



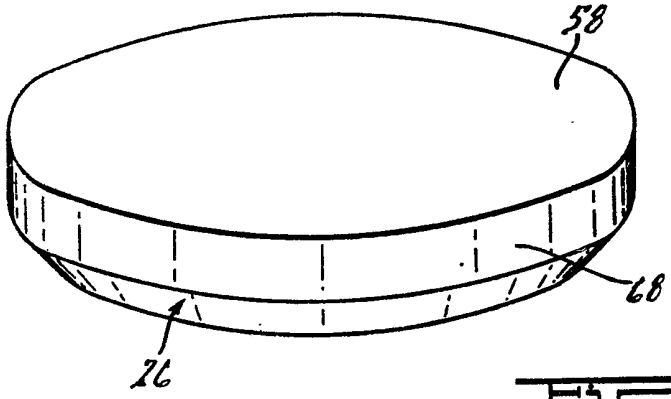


Fig. 7.

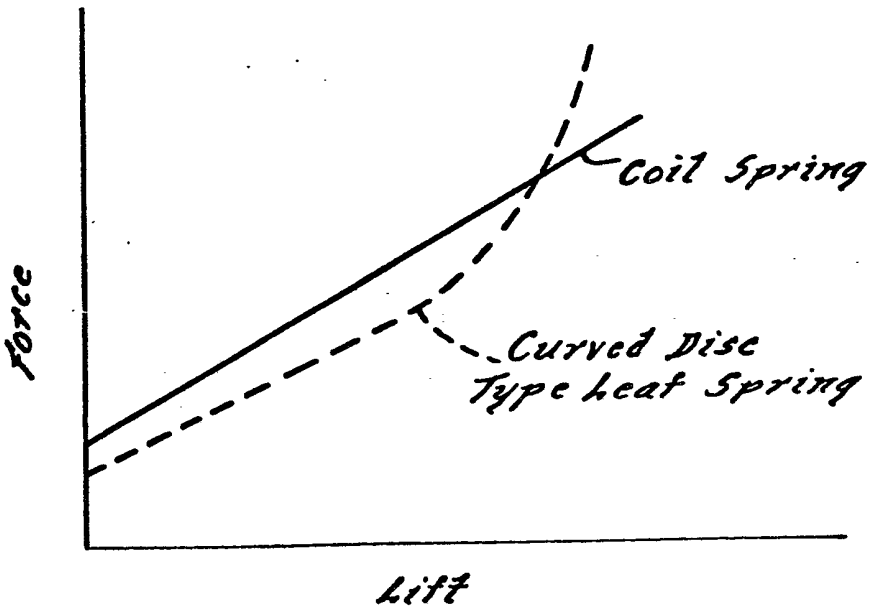


Fig. 6.

SPECIFICATION

Discharge valve assembly

The present invention relates generally to pressure responsive compressor valve assemblies and more particularly to such assemblies employing disc type valve members and particularly adapted for use on refrigeration compressors.

The present invention is particularly well suited for use in combination with the disc-like lightweight valves of the type disclosed in the specification of copending application No. 7943570. It may be used in both rotary and other types of compressors including single and multi-cylinder reciprocating piston type compressors of either hermetic or accessible hermetic type.

Valve plates and cylinder head assemblies can become relatively complex in configuration for certain valve arrangements and as a result may be quite costly to manufacture and sometimes to assemble.

According to the present invention there is provided a valve plate assembly for use in a compressor comprising: a valve plate having a discharge opening extending therethrough, the sidewalls of said opening defining a valve seat; a valve member movably seated within said opening and in engagement with said valve seat when in a closed position; leaf spring biasing means; and support means for retaining said leaf spring biasing means in engaging relationship with said valve member whereby said leaf spring biasing means is operative to bias said valve member into said closed position. Preferably one or more leaf springs of the curved disc type are used in combination with a supporting bridge member having a plurality of guide fingers operative to guide movement of the disc valve member and to retain the valve and leaf spring in relative position. The use of this improved spring biasing member provides numerous advantages over prior coil spring type biasing arrangements. For example, because the leaf spring provides a variable spring rate, the required preloading on the valve member when in a closed position may be reduced thereby reducing residual stress on the valve member. Similarly, the spring rate of the leaf spring may be lower for the initial opening of the valve member. Further, it is possible to easily control or vary the preloading and spring rate for different compressors by merely increasing the number of leaf springs incorporated in the valve assemblies. Additionally, when multiple leaf springs are employed, the frictional forces acting between the leaves provides a damping action which is particularly desirable to eliminate vibration of the valve member at high frequency operation as well as providing a redundancy so as to assure continued operation even in the event one of the leaf springs should fail.

Additional advantages and features of the present invention will become apparent from the subsequent description and the appended claims taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a fragmentary section view of a portion of a refrigeration compressor showing a valve plate assembly in accordance with the present invention;

Figure 2 is a fragmentary plan view of the valve plate assembly of Figure 1;

Figures 3 and 4 are section views of the valve plate assembly of Figure 1, the sections being taken along lines 3—3 and 4—4 respectively thereof;

Figure 5 is a perspective view of a leaf spring member designed for use in the valve plate assembly of the present invention;

Figure 6 is a graph plotting the relationship between biasing force and lift for both the leaf spring forming a part of the present invention and a conventional coil spring; and

Figure 7 is a perspective view of the discharge valve shown in Figure 1.

Description of the Preferred Embodiment

Referring now to the drawings and in particular to Figure 1 thereof, there is shown a valve plate assembly 10 in accordance with the present invention and comprising a valve plate 12 having a ring valve seat member 14 positioned within a generally conically shaped opening provided therein so as to define substantially concentric suction and discharge gas passages 16 and 18 respectively therethrough. A second plate member 30 is positioned on the upper surface of valve plate 12 with a suitable sealing gasket 22 disposed therebetween so as to isolate suction and discharge gas passages 16 and 18. An opening 24 is provided extending through plate 20 which is adapted to allow discharge gas to pass upwardly (as shown) therethrough.

A lightweight compliant polymeric discharge valve member 26 is also provided seated against conical surface 28 which defines a valve seat within discharge passage 18. Discharge valve 26 is preferably of the general type described in detail in the above mentioned copending application 7943570.

A bridge member 30 is provided having a generally cylindrically shaped central portion 32 positioned approximately coaxially with opening 24 and a pair of diametrically outwardly extending arms 34 and 36 are secured to the upper surface 38 of plate member 20 by means of bolts 40 and 42 extending through openings provided in arms 34 and 36 and into threaded engagement with suitably positioned openings provided in plate member 20. Central portion 32 of bridge member is of a diameter substantially less than the diameter of opening 24 provided in plate member 20 so as to leave a substantially unrestricted area for passage of discharge gas and also includes a plurality of substantially identical circumferentially spaced depending guide fingers 44 projecting through opening 24 and into discharge passage 18 in valve plate 12. The lower surface 46 of each

of guide fingers 44 is beveled or inclined so as to enable it to be positioned in very close, slightly spaced relationship to valve seat surface 28 of ring member 14. The inwardly facing surface 48 of each of guide fingers 44 has a concave shape defining segments of a cylinder having a diameter slightly greater than that of valve member 26 so as to provide a clearance therebetween.

A wear plate member 50 is also provided positioned in engaging relationship with under surface 52 of bridge member 30. Wear plate member 50 has a generally circular shape with a diameter approximately equal to the diameter of the central portion of bridge member and includes a plurality of flat edge surfaces 54 positioned adjacent each of the guide fingers 44 and cooperating therewith so as to prevent relative rotation of the wear plate.

In order to bias valve member into a closed position as shown a pair of substantially identical leaf springs 56 of the curved disc type are provided being positioned between upper surface 58 of valve member 26 and lower surface 59 of wear plate 50. As best seen with reference to Figure 5, leaf springs 56 are each in the form of relatively thin metal discs having diametrically opposite edges 60 and 62 bowed upwardly as shown therein so as to define a generally arcuate shape in transverse cross section. As clearly shown in Figure 4, leaf springs 56 do not have any openings provided therein and are positioned with concave surface 64 facing lower surface 59 of wear plate 50, the convex surface 66 forming a pivotal engagement with surface 58 of valve member 26 which is also preferably flat or planar over the entire extent thereof (Figures 1 and 4, or Figure 7). This orientation prevents excessive wear on the valve member as well as possible wear of the guide fingers during compression of the leaf spring which could result from movement of edges 60 and 62 during compression of leaf springs 56. Also, leaf springs 56 will preferably have a maximum diameter when in a flattened fully compressed condition slightly less than the diameter of wear plate 50 and the inner surfaces 48 of guide fingers 44 will operate to prevent leaf spring 56 from slipping over the edge thereof. It is also important that the maximum diameter of leaf spring 56 be selected to provide a slight minimal clearance with guide fingers 44 when properly centered so as to avoid the possibility of leaf springs 56 becoming locked in a fully compressed condition. It should be noted that the use of such a continuous planar or flat upper surface 58 on discharge valve 26 eliminates any potential points of stress concentration which could possibly contribute to valve failure.

In operation, as the suction gas is compressed by operation of the compressor the increasing pressure acting on the lower surface of valve member 26 will cause it to move upwardly (as shown) thereby opening the compression chamber to the discharge passage 18 and compressing leaf spring 56. The inner surfaces 48 of guide fingers 44 will cooperate with the cylindrical sidewall 68 of valve member 26 to restrict or inhibit lateral movement thereof thereby maintaining proper alignment of valve member 26. Compressive movement of leaf spring 56 into substantially full surface contact with surface 59 of wear plate 50 will operate to provide a positive stop thereby limiting the maximum opening of valve member 26. However, because as shown in Figure 6 the spring rate increases with increasing lift, the velocity at which the valve member moves into this maximum open position may be less than with a comparable fixed rate coil spring. Further, because of the variable spring rate offered by such leaf springs, it is possible to reduce the preloading on the valve member as shown on the graph of Figure 6 below that generally required for a comparable coil spring valve assembly. This may be particularly desirable for polymeric valve members of the type disclosed in assignee's aforementioned '309 application. It should also be noted that it is possible to adjust both preloading and overall spring rate without altering the geometry or dimensions of the various components by merely inserting additional leaf springs 56. Additionally, when multiple leaf springs are employed such as is shown, there will be a slight relative movement between the engaged surfaces thereof during compression and relaxation. The frictional forces resulting from this movement will provide a damping action which is particularly desirable at high frequency operation to inhibit vibration of valve member 26. Also, the use of multiple leaf springs provides redundant biasing means thereby improving operating reliability. It also appears that the use of leaf springs offers the advantage of quieter operation as compared with the use of coil springs.

CLAIMS

1. An improved valve plate assembly for use in a compressor comprising:

a valve plate having a discharge opening extending therethrough, the sidewalls of said opening defining a valve seat;

a valve member movably seated within said opening and in engagement with said valve seat when in a closed position;

leaf spring biasing means; and

support means for retaining said leaf spring biasing means in engaging relationship with said valve member whereby said leaf spring biasing means is operative to bias said valve member into said closed position.

2. A valve plate assembly as set forth in claim 1 wherein said leaf spring biasing means comprise a bowed disc having convex and concave surfaces.

3. A valve plate assembly as set forth in claim 2 wherein a portion of said convex surface engages said valve member.

4. A valve plate assembly as set forth in claim 3 wherein said convex surface engages a planar surface of said discharge valve.

5. A valve plate assembly as set forth in claim 1 wherein said leaf spring biasing means comprise a plurality of bowed discs each having convex and

concave surfaces.

6. A valve plate assembly as set forth in claim 5 wherein said plurality of discs are arranged with respective of said convex surfaces engaging respective concave surfaces of an adjacent disc.

7. A valve plate assembly as set forth in claim 1 wherein said support means includes a plurality of guide fingers extending into said discharge opening and positioned so as to inhibit lateral movement of said valve member.

8. A valve plate assembly as set forth in claim 7 wherein said support means includes a planar surface spaced from said valve member and operative to limit opening movement thereof.

9. A valve plate assembly as set forth in claim 1 wherein said valve member has a continuous planar upper surface.

10. An improved valve assembly for use in compressors comprising:

a valve plate having a conically shaped opening therethrough, the sidewalls of said opening defining a valve seat;

a disc shaped valve member movably positioned within said opening and in engagement with said valve seat when in a closed position;

biasing means; and

a bridge member secured to said valve plate, said bridge member having a plurality of peripheral spaced guide fingers positioned in opposed spaced relationship to a peripheral edge of said valve member and operative to guide movement thereof between closed and open positions, said bridge member further cooperatively supporting said biasing means so as to urge said valve member into said closed position.

11. A valve assembly as set forth in claim 10 wherein the end surface of each of said guide fingers is positioned in closely spaced substantially parallel relationship with said sidewalls.

12. A valve assembly as set forth in claim 10 further comprising means associated with said bridge member defining a stop surface positioned a predetermined distance from said valve member and operative to limit opening movement thereof.

13. A valve assembly as set forth in claim 12 wherein said biasing means is a bowed leaf spring having a concave surface facing said stop surface.

14. A valve assembly as set forth in claim 13 wherein said leaf spring has a convex surface, a portion of which pivotably engages said valve member.

15. A valve assembly as set forth in claim 13 wherein said guide fingers are operative to retain said leaf spring in position.

16. An improved valve plate assembly for use in a compressor comprising:

a valve plate having a discharge opening extending therethrough and means defining a valve seat;

a valve member engageable with said valve seat to close said discharge opening;

leaf spring biasing means having a convex surface and a concave surface, a portion of said convex surface engaging said valve member; and

support means overlying said discharge opening and engaging a portion of said concave surface, said support means cooperating with said leaf spring to bias said valve member into a closed position.

17. An improved valve plate assembly for use in a compressor comprising:

a valve plate having a disharge opening extending therethrough and means defining a valve seat;

a valve member engageable with said valve seat to close said discharge opening;

leaf spring biasing means; and

a bridge member secured in overlying relationship to said discharge opening and supporting said leaf spring in biasing engagement with said valve member so as to bias said valve member into a closed position, said bridge member further including a plurality of spaced depending guide fingers positioned in opposed relationship to the peripheral edge of said leaf spring and said valve member and operative to restrict lateral movement thereof.

18. A valve plate assembly as set forth in claim 17 wherein said leaf spring comprises a bowed disc member having a convex surface and a concave surface, a portion of said convex surface engaging said valve member.

19. A valve plate assembly as set forth in claim 18 wherein said valve member has a continuous substantially planar upper surface engaging said biasing means.

20. A valve plate assembly constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

21. A compressor embodying the valve or valve plate of any preceding claim.

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