United States Patent [19]

Bunn et al.

[11] 3,829,253

[45] Aug. 13, 1974

[54] PLATE VALVE STRUCTURE

[76] Inventors: **Stuart E. Bunn; Herbert B. Owsley,** both of P.O. 388, Shawnee Mission, Kans. 66201

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[52] **U.S. Cl.** **417/504,** 417/564, 137/512.1

[51] **Int. Cl.** **F04b 49/00**

[58] **Field of Search** 417/502, 504, 564, 569, 417/571; 137/512.1, 514, 516.15

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Primary Examiner—William L. Freeh
Assistant Examiner—G. P. LaPointe
Attorney, Agent, or Firm—Fishburn, Gold & Litman

[57] **ABSTRACT**

A plate valve structure, for mounting in a compressor recess, in which thin discs or plates are positioned between a base plate and a cover plate overlying and selectively closing flow passages through the base plate and cover plate in response to pressure differentials acting thereon. Spring members urge the valve plates to seating position until a predetermined pressure differential is attained. The spring members for each plate or mounting thereof have different characteristics and the lift spaces are different providing a differential in preloading and a differential in opening lift for controlling the opening sequences and speeds of the respective plates and cushioning the shock of seating impact. The plate valve structure includes a retaining ring resiliently mounted thereon for separating intake and exhaust flow streams in the compressor.

8 Claims, 8 Drawing Figures

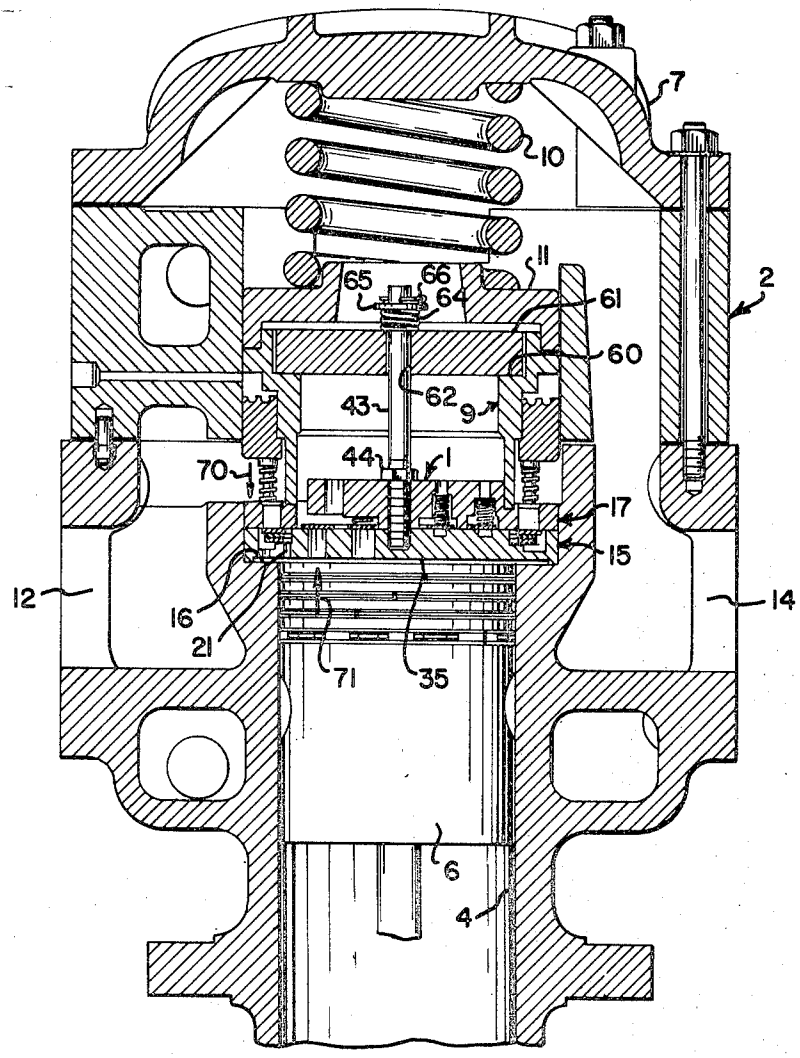


Fig. 1.

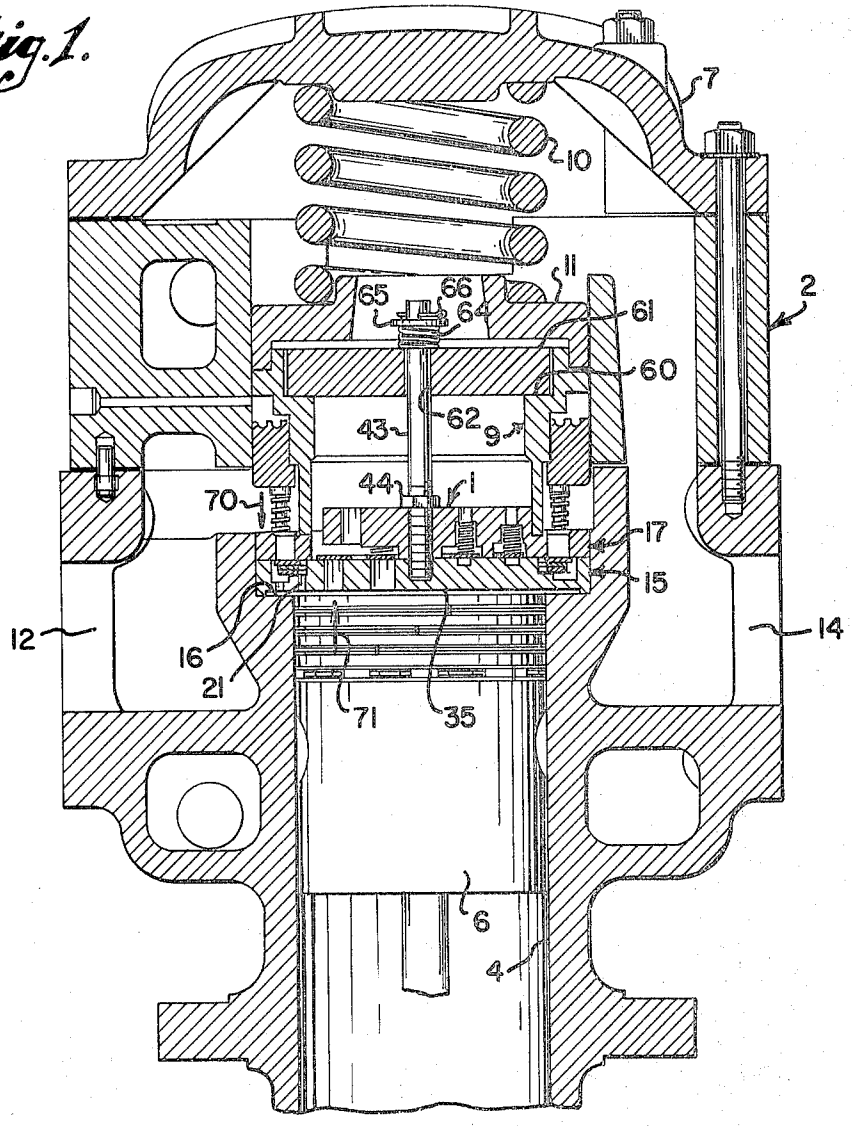


Fig. 2.

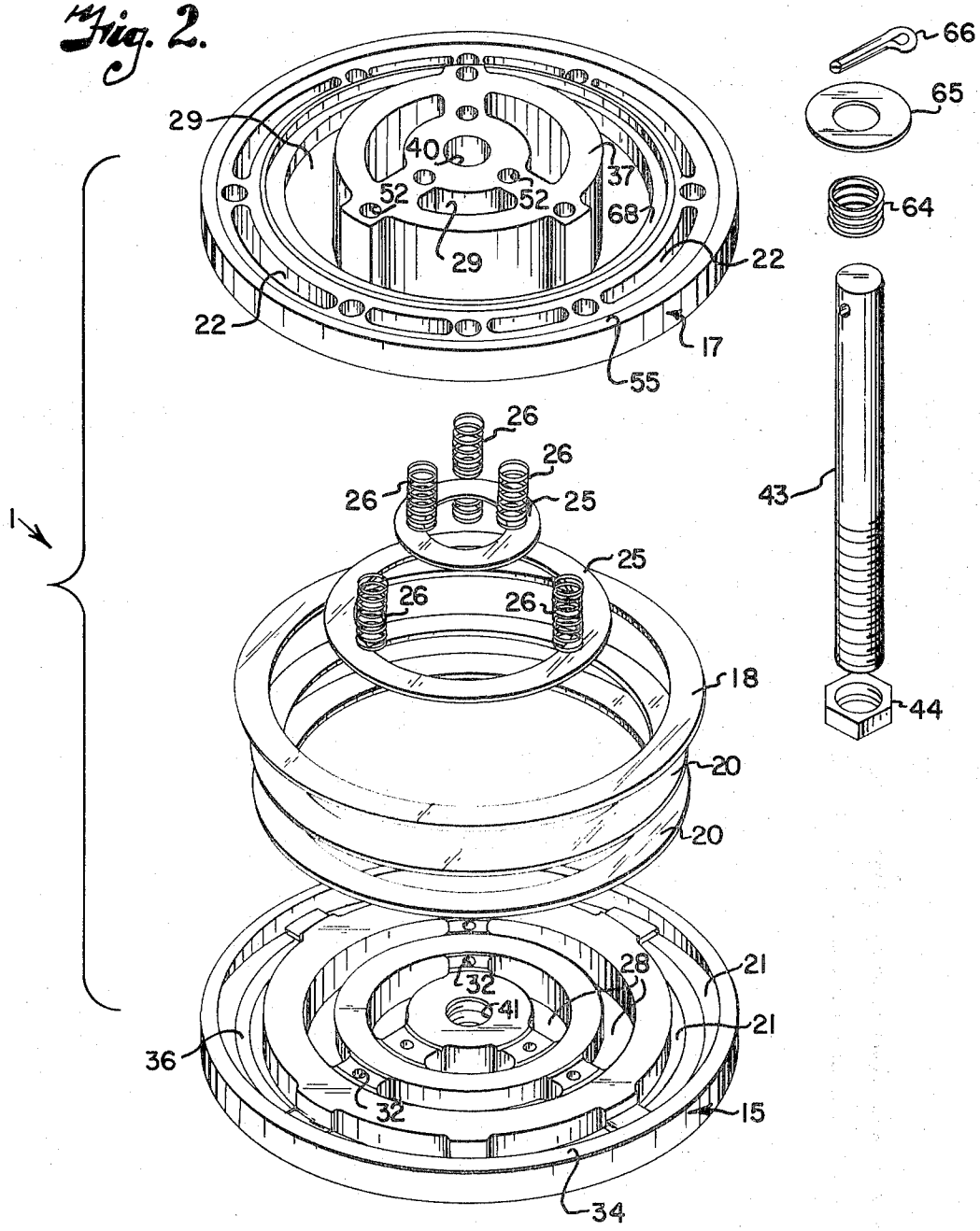

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Fig. 3.

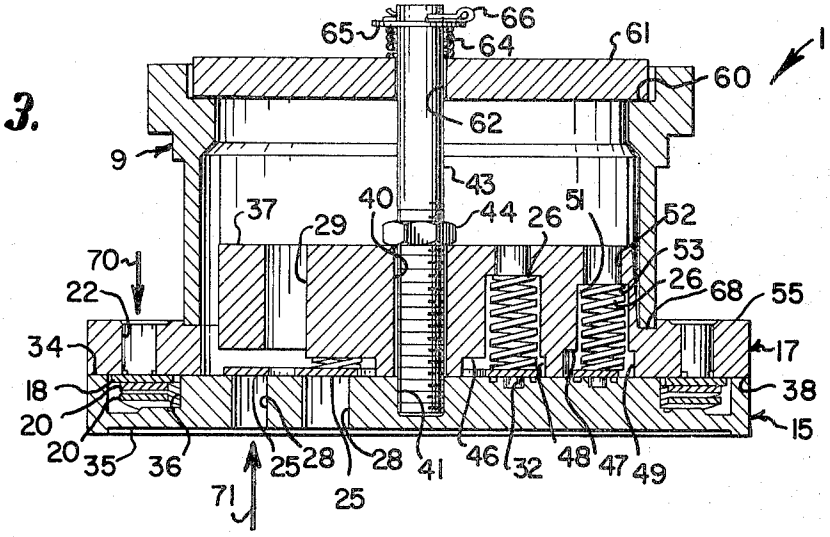

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Fig. 4.

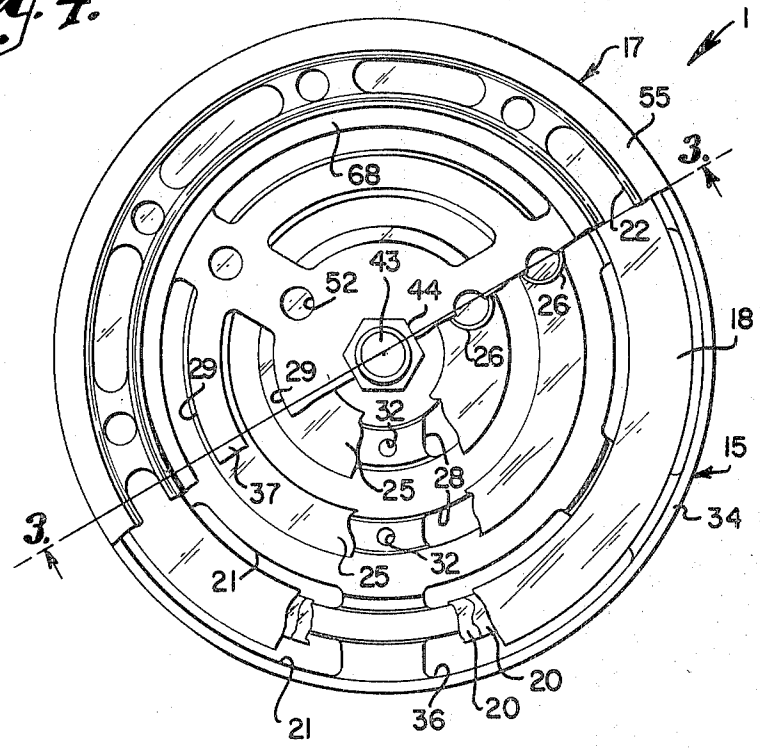

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Fig. 5.

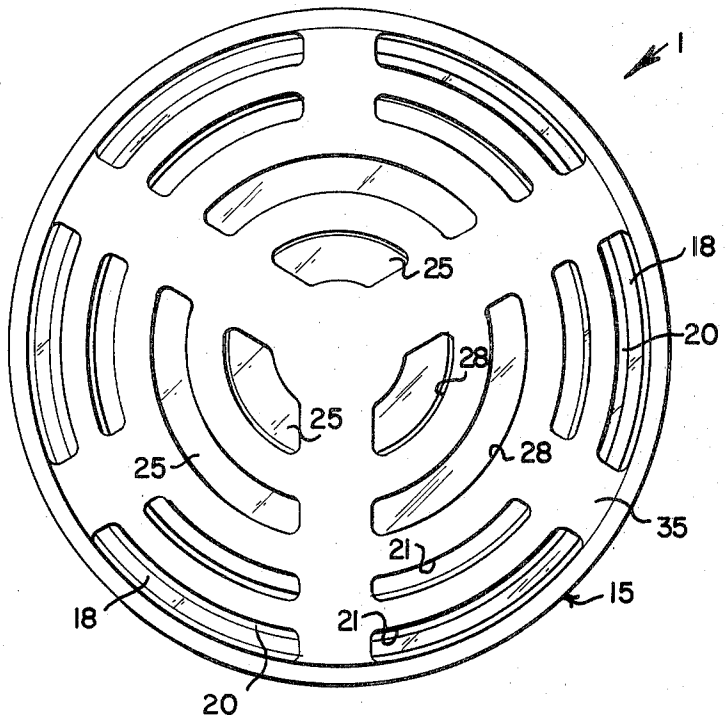

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Fig. 6.

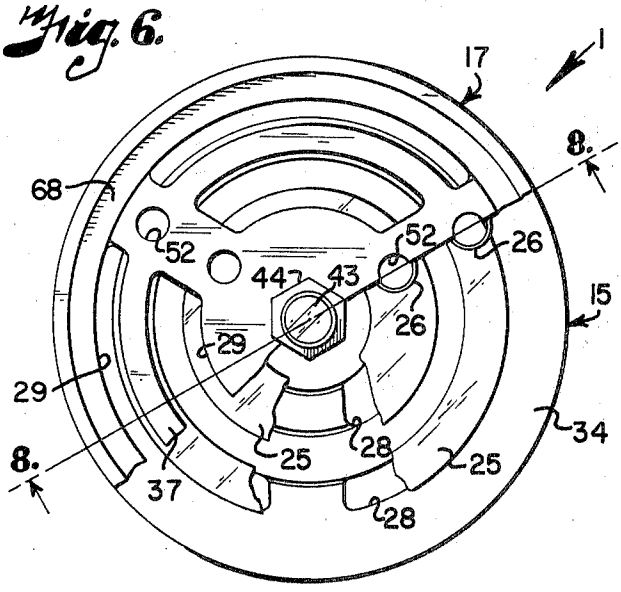

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Fig. 7.

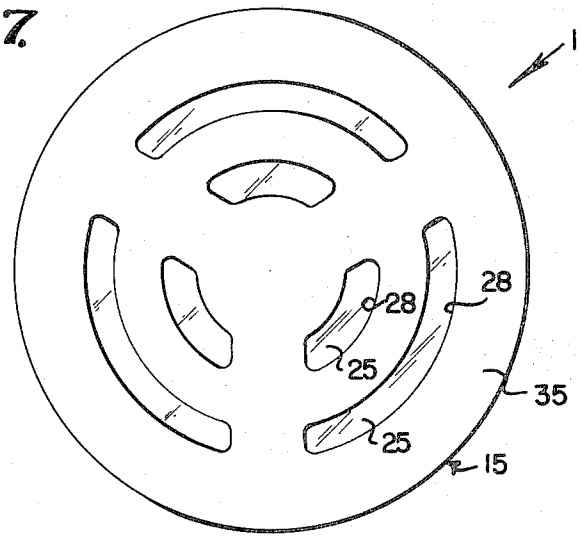

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Fig. 8.

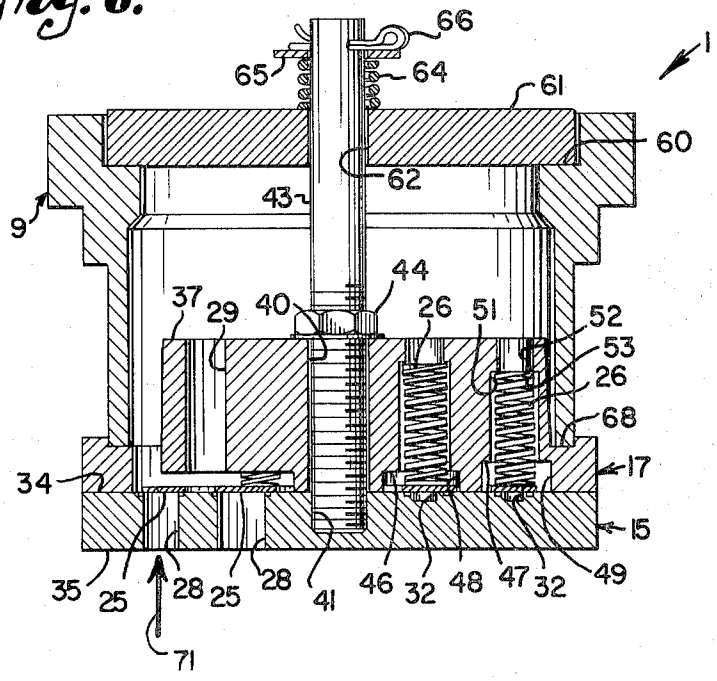

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PLATE VALVE STRUCTURE

The present invention relates to fluid compressors and valve structures in such compressors and more particularly to valves known as plate valve structures.

There have been many variations in designs of plate valves heretofore used and such valves have suffered in their operation from one or more problems. Some typical problems include: excessive number of parts, warpage of parts when secured together due to overtightening, excessive heating of the fluid flowing through the plate valve due to restricted flow passages, and noisy operation and short life because of the striking force between the valve plates and the valve seat.

The principal objects of the present invention are: to provide a plate valve structure which reduces or eliminates the aforementioned difficulties; to provide such a valve structure with valve plates that have different amounts of lift from a closed position and that are held in a normally closed position by springs having different characteristics whereby the valve plates have different opening and closing sequences and speeds to make a smoother and more efficient operating plate valve and thereby using more of the entire stroke of the compressor to increase its operating efficiency; to provide such a valve structure with flow passages and valve openings for a minimum of fluid flow resistance thereby resulting in lower fluid temperature increases when the fluid flows through the valve; to provide such a valve structure wherein the parts cannot be overtightened during assembly thereby eliminating warpage in the valve structure components; to provide such a valve structure with intake and exhaust flow passages in a unitary structure; to provide such a valve structure with pockets for trapping fluid between the valve plates and their seats during closing movement of the valve plates for dampening the closing force of the valve plates striking their seat thereby increasing the life of the valve structure; to provide such a valve structure that has a minimum number of individual parts; and to provide such a valve structure that is easy and inexpensive to manufacture and maintain and that is suitable for its intended use.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and example certain embodiments of this invention.

FIG. 1 is a side elevational sectioned view of a plate valve installed in a compressor.

FIG. 2 is an exploded perspective view of the plate valve.

FIG. 3 is a side elevational sectioned view of the plate valve taken along the line 3—3.

FIG. 4 is a plan view of the plate valve with sections broken away to show structural details.

FIG. 5 is a bottom view of the plate valve.

FIG. 6 is a plan view of a modified form of a plate valve with sections broken away to show structural details.

FIG 7 is a bottom view of the modified plate valve.

FIG. 8 is a side elevational sectioned view of the modified plate valve taken along the line 8—8.

Referring more in detail to the drawings:

As required, detailed embodiments of the present invention are disclosed herein, however, it is to be understood that the disclosed embodiments are merely exemplary of the invention which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriate detailed structure.

A plate valve designated generally by the reference numeral 1 is suitably mounted in a piston type compressor 2 and is operable to control the flow of fluids into and out of the compressor 2.

In the illustrated form, the compressor 2 is a conventional piston type compressor such as ones manufactured by Frick Co. of Waynesboro, Pa. The compressor 2 includes a compressor cylinder 4 having a piston 6 reciprocally mounted therein, a head assembly 7 is secured to the compressor 2 and overlies the compressor cylinder 4 and the piston 6. The plate valve 1 has a retaining ring 9 resiliently mounted thereon and the assembly is suitably mounted in the compressor 2 at the end of the compressor cylinder 4 and in the head assembly 7 having a spring member 10 and spring guide 11 holding same in the mounted position. A suction passageway 12 communicates with the compressor cylinder 4 through the plate valve 1 and is operable for allowing fluid to flow into the compressor cylinder 4 on the intake stroke of the piston 6. A discharge passageway 14 also communicates with the compressor cylinder through the retaining ring 9 and plate valve 1 permitting the discharge of pressurized fluid from the compressor cylinder 4 on the compression stroke of the piston 6.

The plate valve 1 as illustrated includes a base member 15 and a cage member 17 suitably secured thereto wherein the base member 15 engages and is supported by a shoulder 16 in the compressor 2 at the end of the compressor cylinder 4. The base member 15 has suitably mounted therein a valve plate 18 and spring member 20 that permits fluid from the intake passageway 12 to flow through intake passageways 21 and 22 of the base member 15 and the cage member 17 respectively into the compressor cylinder 4 on the downstroke or intake stroke of the piston 6. The valve plate 18 is normally held in seating engagement with the cage 17 by the spring member 20 to prevent fluid from being exhausted back into the suction passageway 12 of compressor 2 during the compression stroke of the piston 6. The cage 17 has suitably mounted therein a plurality of valve plates 25 that are held in seating engagement with the base member 15 by spring members 26. On the compression stroke of the piston 6 the valve plates 25 move to an open position allowing the pressurized fluid to flow through exhaust passageways 28 and 29 of the base member 15 and cage 17 respectively and to be exhausted through the discharge passageway 14 of the compressor 2. The valve plates 18 and 25 are normally held in their seated positions by their respective spring members 20 and 26 and move to open positions in response to pressure differentials thereon. The base member 15 is provided with fluid trapping pockets or cavities 322 that trap fluid therein during closing movement of the valve plates 25 to cushion the impact of their closing force against the base member 15.

In the structure illustrated, the base member 15 has opposed flat surfaces 34 and 35 and has exhaust passageways 28 and intake passageways 21 therethrough.

The exhaust passageways 28 extend between the surfaces 34 and 35 and the intake passageways 21 extend from the surface 35 to an annular groove 36 that extends from the surface 34 toward the surface 35 and is disposed radially outwardly of the sets of exhaust passageways 28. The valve plate 18 and spring 20 are movably mounted in the groove 36 and are limited in lateral movement by portions thereof. As many sets of intake passageways 21 and exhaust passageways 28 as are required to meet the desired volumetric flow rate of fluid therethrough can be included but a minimum of two sets of exhaust passageways 28 and one set of intake passageways 21 are desirable. Preferably, each of the sets of exhaust passageways 28 include three substantially equal in size exhaust passageways 28. The sets of exhaust passageways 28 and intake passageways 21 are disposed substantially about a common center point of the plate valve 1.

The cage 17 is appropriately mounted on the base member 15 and has two opposed substantially flat surfaces 37 and 38 having the surface 38 in engagement with the surface 34 of the base member 15. In the form illustrated, the cage 17 has an aperture 40 therethrough extending between the surfaces 37 and 38 that is in alignment with a threaded pocket 41 in the base member 15. A stud member 43 having one end thereof threaded and extending through the aperture 40 threadably engaging the pocket 41 has an internally threaded member 44, such as a nut also threadably engaging the stud 43 and by tightening same against the surface 37, the cage 17 is secured to the base member 15. The cage 17 has recessed surface portions 46 and 47 facing generally toward the surface 34 of the base member 15 partially defining valve plate containing grooves 48 and 49 respectively. Preferably, the surfaces 46 and 47 are spaced from the surface 38 different distances for a purpose to be later described. The spring members 26 preferably are coil springs, each being mounted in a respective recess or pocket 51 that extends from the respective surfaces 46 and 47 toward the base member 15. Each of the pockets 51 has a bore 52 extending from same to the surface 37 wherein the bores 52 are smaller than the pockets 51 thereby forming shoulder portions 53 for engagement with one end of the respective spring members 26. The other end of each spring member 26 engages the respective valve plate 25 to hold same in seating engagement with the surface 34 for normally closing the exhaust passageways 28. Each of the valve plates 25 are contained or movably mounted in a respective groove 48 and 49 and are limited in lateral movement by portions of the respective groove 48 and 49. The intake valve plate 18 is contained or movably mounted in the groove 36 and is held in seating engagement with the surface 38 by the spring member 20 which is preferably a disc, wavy washer or Bellville type spring washer for normally closing the intake passageways 22. Preferably, the cage 17 has the same number of sets of exhaust passageways 29 therethrough as the sets of exhaust passageways 28 through the base member 15. Each of the sets of the exhaust passageways 29 includes three exhaust passageways 29 each set being radially offset relative to the respective set of exhaust passageways 28. In the innermost set of exhaust passageways 29 is positioned (in the form illustrated) approximately midway between the two sets of exhaust passageways 28 and the outermost disposed set of exhaust passageways 29 is disposed radially outwardly from the outermost disposed set of exhaust passageway 28. The intake passageway 22 extend from the surface 38 through the cage 17 to a shoulder forming surface 55 and are spaced radially from the center of the cage 17 so as to overlie the opening of the groove 36 of the base member 15.

In the illustrated structure, the retaining ring 9 is mounted on the cage 17 and is resiliently held in position. Mounting may be accomplished in one of many various ways, but in the illustrated embodiment of the present invention, the retaining ring 9, which is tubular in form, has a shoulder 60 in the interior thereof. A bar member or clamp 61 has an aperture 62 therethrough wherein the stud 43 extends through the aperture 62 and has a spring member 64 suitably mounted thereon for applying force to the clamp member 61 to resiliently hold it in engagement with the shoulder 60. The upper disposed end of the spring member 64 engages a washer type member 65 that in turn engages a suitable keeper 66 such as a cotter pin for mounting the spring member 64 on the stud member 43. Such a resilient mounting prevents over-tightening and consequently prevents warpage of the base member 15 and the cage 17 that has occurred in prior structures. Preferably, the cage 17 has an annular or circumferential groove 68 extending from the surface 55 toward the surface 38 wherein the bottom portion of the retaining ring 9 engages the bottom surface of the groove 68 for supporting engagement therewith and limiting the lateral movement of the retaining ring 9 relative to the cage 17.

It is to be noted that in the illustrated embodiment of the present invention the cage member 17 and the base member 15 are round and made of a relatively hard and durable material such as cast iron. The valve plates 25 and 18 are preferably rings and made of a durable material such as steel.

The present invention is more fully understood by a description of the operation thereof. As illustrated in FIG. 1, the plate valve 1 is suitably mounted in the compressor 2. The compressor 2 may be of any suitable type used for compressing fluids such as refrigerants, natural gas, etc. On the downstroke or intake stroke of the piston 6, the pressure in the suction passageway 12 exceeds the pressure in the compressor cylinder 4 whereby the force applied by the pressure in the suction passageway 12 exceeds the force applied by the spring member 20 and the pressure in the compressor cylinder 4 thereby urging the valve plate 18 to move to an open position functioning as an intake valve whereby the fluid flows through the intake passageways 22 and 21 and the groove 36 in the direction indicated by the arrow 70. On the upstroke or compression stroke of the piston 6, the increased pressure in the compressor cylinder 4 exceeds the pressure in the suction passageway 12 and the discharge passageway 14 whereby the valve plate 18 returns to a closed position in which it is in seating engagement with a portion of the surface 38 of the cage 17 to seal off or close the intake passageway 22. The force of the increased pressure on the compression stroke on the exhaust valve plates 25 urges same to move to an open position thereby functioning as exhaust valves when the force of the increased pressure exceeds the force applied by the spring members 26 and the pressure in the discharge passageway 14 allowing the compressed fluid to flow through the exhaust passageways 28 and 29, in the di-

rection indicated by the arrow 71, into the discharge passageway 14. The retaining ring 9 separates the intake flow stream from the exhaust flow stream in the compressor 2. The spring members 26 engaging one of the valve plates 25 preferably have different spring characteristics than the spring members 26 engaging the other valve plate 25 to control the opening sequence and speed of the valve plates 21. The spring characteristics can be varied in different ways as for example by having different depths in the pockets 51 controlling the amount of initial pre-load compression therein of the spring members 26 thereby allowing the use of identical spring members 26. The spring members 26 can also have different stiffnesses to accomplish the same results of different initial pre-load compressions in the springs 26. The difference in initial preload compression of the springs 26 on each valve plate 25 results in the valve plates 25 moving to an open position at different pressure differentials. At the start of the compression stroke one of the valve plates 25 opens at a lower pressure differential in advance of the other valve plate 25 thereby not requiring a high pressure build-up to allow exhausting of the pressurized fluid with a minimum of pressure surge through the plate valve 1. It is to be noted that the area of the respective valve plates 25 that is exposed to the pressure in the compressor cylinder 4 may be varied by varying the size of the respective sets of exhaust passageways 28 to also help in controlling the opening sequence and speeds of the valve plates 25. Controlling the opening sequence and speed of the valve plates 25 results in a smoother operating plate valve 1 and increased life thereof. The surfaces 46 and 47 control or limit the maximum amount of movement or lift of the valve plates 25 whereby the flow rates of fluid through the respective exhaust passageways 28 are controlled and also helps to control the opening sequences and speeds of the valve plates. Even though the surfaces 46 and 47 control the amount of lift of the respective valve plate 25, it is desirable to have a space therebetween when the valve plates 25 are in the open position to allow fluid to flow between the valve plates 25 and the respective surfaces 46 and 47. When the increased pressure in the compressor cylinder 4 decreases at or near the end of the compression stroke of the piston 6 to a point at which the force applied by the spring members 25 exceeds the force applied by the pressure in the compressor cylinder 4 and the pressure in the discharge passageway 14, the valve plates 25 will sequentially return to a closed position wherein they seat against the surface 34 of the base member 15. Sequential closing of the valve plates 25 is desired so that a full pressure drop across the valve plate 1 is not required to start the closing movements of the valve plates 25. The sequential movement of the valve plates 25 particularly during closing, decreases the force or impact of the valve plates 25 when seating against the surface 34 thereby increasing the life of the plate valve 1. The sequential opening and closing of the valve plates 25 also permits higher velocity fluid flow through the plate valve 1 than is normally allowed without damage thereto and also allows better utilization of the full stroke of the piston 6 by not requiring as high pressure differentials across the plate valve 1 to urge the valve plates 25 to move from their open and closed positions. To further prevent or reduce damage to the plate valve 1, the pockets 32 are provided in the base member 15 and are covered by their respective valve plates 25. On closing movement of the valve plates 25, fluid is trapped within the pockets 32 wherein the trapped fluid acts as a shock absorber to provide a cushion for the valve plates 25 when seating against the surface 34 to lessen the impact in the engagement thereof. It is desirable to have the intake passageways 21 and 22 and the exhaust passageways 28 and 29 as large as practicable with a minimum of partitions between respective sets of passageways for reducing the resistance to flow of fluid therethrough thereby keeping the temperature increase of the flowing fluid at a minimum.

FIG. 6, FIG. 7 and FIG. 8 illustrate a modified form of the present invention. The modified form is substantially the same as a non-modified form with the exception that the modified form is a uni-directional flow valve wherein the intake flow passageways 21 and 22, the valve plate 18, the annular groove 36 and the spring member 20 are eliminated. The operation of the modified form of the plate valve 1 is the same as the non-modified form of the plate valve 1 with the exception that there is no intake flow through the plate valve 1.

It is to be understood that while I have illustrated and described certain forms of my invention, it is not to be limited to the specific form or arrangement of parts herein described and shown.

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

1. A plate valve comprising:
   a. a base member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said base member having valve seating surfaces surrounding the flow passageways;
   b. a cage member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said cage member being secured relative to said base member with said valve seating surfaces facing said cage member, said cage member sets of flow passageways cooperating with respective said base member sets of flow passageways for allowing fluid to flow therethrough;
   c. a plurality of independent valve plates movably mounted and positioned between said base member and said cage member, each valve plate in covering relation to a respective said set of base member flow passageways and seating against said valve seating surfaces;
   d. spring members mounted in said cage member each engaging and applying force to a respective valve plate for selectively holding same in seating engagement with said valve seating surfaces; and
   e. cavities in said base member opening toward said cage member and underlying a respective valve plate said cavities being operable for trapping some of said fluid therein during closing movement of the valve plates for cushioning their seating impact.

2. In a piston type compressor a plate valve, said plate valve comprising:
   a. a base member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said base member having valve seating surfaces surrounding the flow passageways;

b. a cage member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said cage member being secured relative to said base member with said valve seating surfaces facing said cage member, said cage member sets of flow passageways cooperating with respective said base member sets of flow passageways for allowing fluid to flow therethrough;

c. a plurality of independent valve plates movably mounted and positioned between said base member and said cage member, each valve plate in covering relation to a respective said set of base member flow passageways and seating against said valve seating surfaces;

d. spring members mounted in said cage member each engaging and applying force to a respective valve plate for selectively holding same in seating engagement with said valve seating surfaces;

e. a retaining ring engaging one of said cage member opposite surfaces around and outwardly of said cage member flow passageways and extending from said cage member one opposite surface;

f. an upstanding member secured to one of said base member and said cage member extending from said cage member one opposite surface, said upstanding member having a keeper secured thereto in spaced relation from said cage member one opposite surface; and

g. resilient means acting on said upstanding member, said keeper and said retaining ring for resiliently maintaining said retaining ring in engagement with said cage member one opposite surface.

3. A plate valve comprising:

a. a base member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said base member having valve seating surfaces surrounding the flow passageways;

b. a cage member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said cage member being secured relative to said base member with said valve seating surfaces facing said cage member, said cage member sets of flow passageways cooperating with respective said base member sets of flow passageways for allowing fluid to flow therethrough;

c. a plurality of independent valve plates movably mounted and positioned between said base member and said cage member, each valve plate in covering relation to a respective said set of base member flow passageways and seating against said valve seating surfaces;

d. spring members mounted in said cage member each engaging and applying force to a respective valve plate for selectively holding same in seating engagement with said valve seating surfaces;

e. means cooperating with said cage member and said valve plates for controlling the amount of movement of the valve plates from the base member valve seating surfaces, said means being operable for allowing each valve plate to move a different distance from said valve seating surfaces;

f. at least one set of flow passageways extending between the opposite surfaces of the cage member for opposite direction flow therethrough, said cage member having valve seating surfaces surrounding the opposite direction flow passageways and facing the base member;

g. a second valve plate movably mounted and positioned between said base member and said cage member in selective covering relation to a respective set of cage member opposite direction flow passageways and seating against said valve seating surfaces;

h. at least one spring member mounted in said base member and engaging said second valve plate for selectively holding same in seating engagement with said cage member seating surfaces;

i. flow passageways through said base member communicating with said cage member opposite direction flow passageways for allowing fluid to flow through the base member in the opposite direction;

j. said second valve plate and said valve plates include at least one intake valve plate and a plurality of exhaust valve plates respectively wherein said exhaust valve plates are movably mounted in said cage member and said intake valve plate is movably mounted in said base member, said exhaust valve plates being in selective seating engagement with said base member valve seating surfaces and said intake valve plate being in selective seating engagement with said cage member valve seating surfaces;

k. said base member and cage member through flow passageways being exhaust flow passageways and said base member and cage member opposite direction through flow passageways being intake flow passageways, said intake flow passageways being disposed outwardly of said exhaust flow passageways;

l. one said opposite surface of said cage member and one said opposite surface of said base member being in engagement; and

m. pocket forming portions in said base member wherein the pockets open toward said cage member underlying a respective exhaust valve plate for trapping some of said fluid therein during movement of said exhaust valve plate from an open position to the seating position for cushioning their seating impact.

4. A plate valve as set forth in claim **3** wherein:

a. said exhaust valve plates controlling means including surfaces in said cage member each spaced from a respective said base member valve seating surface and having a respective exhaust valve plate positioned therebetween, each said controlling surface being spaced a different distance from said respective base member valve seating surface thereby allowing the respective exhaust valve plates to move different distances therefrom for controlling their opening movements.

5. A plate valve as set forth in claim **3** wherein:

a. said spring members for one exhaust valve plate having different preload compressions than the spring members for another exhaust valve plate for applying different amounts of force to the respective exhaust valve plate wherein the exhaust valve plates have different rates of opening and closing movements.

6. A plate valve as set forth in claim **5** including:

a. means associated with said cage member and said base member cooperating with the exhaust valve

plates and the intake valve plate for limiting the lateral movement thereof; and

b. second pocket forming portions in said cage member wherein the second pockets open toward the base member each having a respective exhaust valve plate spring member mounted therein, said exhaust valve plate spring members being coil springs.

7. A plate valve comprising:

a. a base member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said base member having valve seating surfaces surrounding the flow passageways;

b. a cage member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said cage member being secured relative to said base member with said valve seating surfaces facing said cage member, said cage member sets of flow passageways cooperating with respective said base member sets of flow passageways for allowing fluid to flow therethrough;

c. a plurality of independent valve plates movable mounted and positioned between said base member and said cage member, each valve plate being in covering relation to a respective said set of base member flow passageways and seating against said valve seating surfaces;

d. said case member having valve plate lift limit surfaces facing respective valve plates and a plurality of spaced spring receiving pockets in said limit surfaces for each valve plate and opening toward the respective valve plate, said spring receiving pockets for one valve plate having a lesser depth from said one valve plate than the depth of the spring receiving pockets for another valve plate;

e. said valve plate limit surfaces being spaced from the seating surfaces for the respective valve plates and said spacing of the limit surface for said one valve plate being greater than the spacing of the limit surface for said other valve plate and providing greater lift of said one valve plate than the lift of said another valve plate;

f. spring members mounted in said spring receiving pockets in said cage member with each spring member engaging and applying force to respective valve plate for selectively holding same in seating engagement with said valve seating surface, the spring members in the pockets of lesser depth having a greater preload compression and a greater seating force on the respective valve plate than the spring members in the pockets of greater depth.

8. A plate valve comprising:

a. A base member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said base member having valve seating surfaces surrounding the flow passageways;

b. a cage member having opposite surfaces and having sets of through flow passageways extending between the surfaces, said cage member being secured relative to said base member with said valve seating surfaces facing said cage member, said cage member sets of flow passageways cooperating with respective said base member sets of flow passageways for allowing fluid to flow therethrough;

c. a plurality of independent valve plates movably mounted and positioned between said base member and said cage member, each valve plate in covering relation to a respective said set of base member flow passageways and seating against said valve seating surfaces;

d. said cage member having a plurality of spaced spring receiving pockets for each valve plate and opening toward the respective valve plate, said spring receiving pockets for one valve plate having a lesser depth than the spring receiving pockets for another valve plate;

e. spring members mounted in said spring receiving pockets in said cage member with each spring member engaging and applying force to respective valve plate for selectively holding same in seating engagement with said valve seating surface, the spring members in the pockets of lesser depth having a greater perload compression and a greater seating force on the respective valve plate than the spring members in the pockets of greater depth;

f. at least one set of flow passageways extending between the opposite surfaces of the cage member for opposite direction flow therethrough, said cage member having valve seating surfaces surrounding the opposite direction flow passageways and facing the base member;

g. a second valve plate movably mounted and positioned between said base member and said cage member in selective covering relation to a respective set of cage member opposite direction flow passageways and seating against said valve seating surfaces;

h. at lease one spring member mounted in said base member and engaging said second valve plate for selectively holding same in seating engagement with said cage member seating surfaces;

i. flow passageways through said base member communicating with said cage member opposite direction flow passageways for allowing fluid to flow through the base member in the opposite direction;

j. an upstanding member secured to said base member and extending through an aperture that extends through the cage member between the opposite surfaces thereof;

k. a keeper secured to said upstanding member in spaced relation from the other opposite surface of said cage member;

l. a retaining ring engaging the other opposite surface of said cage member around and outwardly of said cage member exhaust flow passageways and inwardly of said cage member intake flow passageways, said retaining ring extending from said cage member other opposite surface; and

m. resilient means acting on said keeper, said upstanding member and said retaining ring for maintaining said retaining ring and said cage member in resilient engagement.

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