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(54) COMPRESSOR VALVE

(71) We, IIC MECHANICAL PRODUCTS LIMITED, of 180, Dundas Street West, Suite 410, Toronto, Ontario, Canada M5G 1Z8, a Canadian Company,

do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates generally to compressor valves of the type used in compressors for air and other gases.

In order to ensure reliable trouble-free operation, the valves of the compressors require regular maintenance and the replacement of worn parts. With existing valves, the cost of replacement parts is a very significant factor as is the labour cost involved in carrying out such maintenance.

Conventional compressor valves have, in the past, incorporated a relatively large number of separate replaceable parts which are subject to wear during valve operation and this has, in turn, increased the time and consequently the cost involved in regular maintenance and replacement of such worn parts.

While various types of valves have heretofore been suggested, there are two principal types of compressor valves in actual and extensive use at this time.

One known type of compressor valve is the so-called linear valve. In this type of valve, a valve body is provided with a series of mutually parallel and spaced apart elongated and linear slotted openings through which the air or gases pass when the valve is open. A plurality of separate linear valve closure members are arranged in registration with such openings and are urged by respective and separate spring members against the valve body so as normally to close the opening therethrough.

Another known type of compressor valve is the so-called annular type. In that particular type of valve, the valve body is formed with a plurality of annular gas flow openings and individual annular valve closure members are located in registration with respective ones of such openings and are urged by separate spring means into their closed positions.

While it has previously been proposed to avoid the high maintenance costs of the known valves of the aforesaid types by the use of so-called plate-type valves, the valves of that type as heretofore proposed have presented certain practical disadvantages.

An object of the present invention is to provide an improved plate-type valve which is suitable for use in compressors for air and other gases.

In accordance with this invention we provide a plate-type valve which comprises:

a valve body having a plurality of spaced apart openings therethrough for the flow of fluid;

a valve head located above said valve body in spaced apart position relative thereto to define therewith a valve chamber;

a peripheral wall disposed between said valve body and said valve head outwardly to define said valve chamber, at least one discharge opening being provided for the flow of fluid out of said valve chamber;

an integral one-piece valve closure plate disposed within said valve chamber and having at least one opening therethrough for the flow of fluid and imperforate portions located in registration with said openings in said valve body to close those openings when said valve closure plate is disposed in a closed position in sealing proximity to said valve body;

a resilient spring means disposed within said valve chamber between said valve head and said valve closure plate and acting therebetween to urge said plate into said closed position thereof; and

a valve closure plate guiding means constituted by at least one portion of said peripheral wall, which portion guidingly engages a corresponding edge portion of said valve closure plate and which portion of said peripheral wall is removably and separately secured in position between said valve body and said valve head.

The invention will now be described by

way of example with reference to the accompanying drawings, in which:—

Figure 1 is a cut-away perspective illustration through a compressor valve of a type heretobefore known;

Figure 2 is a cut-away perspective illustration of the valve shown in Figure 1 after the replacement of certain component parts of the valve;

Figure 3 is an axial sectional view through the valve structure shown in Figure 2 when taken as indicated by the arrows 3—3 of that figure and as also indicated in Figure 4;

Figure 4 is an enlarged and exploded perspective view showing the valve closure plate, spring biasing means and guide members of the valve shown in Figures 2 and 3;

Figure 5 is a perspective view of an alternative embodiment of a spring biasing means for use in a valve in accordance with this invention; and

Figure 6 is a fragmentary section through the spring biasing means shown in Figure 5.

Referring first to Figure 1, it will be seen that there is indicated generally therein by the legend 8 one embodiment of a compressor valve of a type heretofore known.

The valve 8 comprises a valve body generally indicated at 10 and formed with a plurality of mutually parallel elongated slots or openings 12 for the upward passage of air or gas therethrough. Between the openings 12, there are bars 13 which are integrally formed with a peripheral ring 15 and which are interconnected by a generally central and integrally formed transverse bar 13a (figure 3). For a purpose yet to be explained, the peripheral ring 15 is formed around the outer edge of its top surface with a shoulder 17.

A valve head generally indicated at 16 similarly comprises a peripheral ring 23 and a plurality of integrally formed and mutually parallel bars 18 which are mutually spaced to define mutually parallel elongated slots or openings 19, the bars 18 being interconnected by a generally central and integrally formed transverse bar 18a.

The peripheral ring 23 of the valve head 16 is integrally formed with a depending skirt 24, the lower edge of which is supported on the aforementioned shoulder 17 of the valve body 10, bolts 58 extending upwardly through bores 25 in the peripheral ring 15 of the valve body 10 and screwed into threaded bores 26 in the peripheral ring 23 of the valve head 16, serving to maintain the valve body 10 and the valve head 16 in their assembled juxtaposition so as to define therebetween a valve chamber generally indicated at 27 (Figure 2).

It is usefully to be noted at this juncture that the bars 18 of the valve head 16.extend in alignment or registration with the openings 12 in the valve body. 10. Consequently, the openings 19 of the valve head 16 are out of alignment or registration with the openings 12 in the valve body 10.

Disposed within the valve chamber 27 of the known valve 8 shown in Figure 1 are a plurality of separate and individual valve closure members 14, which have a generally channel-like configuration. It is to be noted that each such closure member is disposed with its upstanding flanges on opposite sides of a respective one of the bars 18 of the valve head 16 and with its web disposed over a respective one of the openings 12 in the valve body 10.

Guide members 20 with inwardly projecting tongues 21 are suitably secured between the valve body 10 and the valve head 16 to provide recesses between such tongues 21 for guiding the ends of the closure members 14 during their upward and downward movements as will readily be understood by reference to Figure 1.

Suitable spring means such as leaf springs 22 are located in the channel closure members 14 to urge them downwardly into abutment with the valve body 10 so to cover the openings 12 therein and so to close the valve 8.

During operation of the known valve 8, the closure members 14 would, as already indicated, be normally urged into their closed positions by the action of the leaf springs 22. On the estabishment of a suitable pressure differential across the valve 8, the closure members 14 would be caused to move upwardly against the action of the leaf springs 22 so allowing the upwardly flow of air or gas through the openings 12 in the valve body 10 into the valve chamber 27 and then out of that chamber through the openings 19 in the valve head 16.

During continued operation in such a manner of the valve 8, the closure members 14 become worn at their ends. Similarly, the guide members 20 are also worn.

In order to service such a valve, it has heretofore been necessary to separate the valve head 16 from the valve body 10 and then to replace the closure members 14, leaf springs 22 and guide members 20. It is further to be noted that closure members 14 of different lengths were required. Consequently, the servicing of a vlave of the type already described has heretofore been relatively complex and expensive.

Reference will now be made to Figures 2, 3 and 4 of the acompanying drawings in which there is indicated generally by the legend 28 a valve generally similar to the valve 8 and obtained by replacement of certain component parts of the valve 8 by other parts yet to be described.

In the valve 28, the separate closure members 14 of the valve 8 are replaced by a single valve closure plate generally indicated at 34 (best shown in Figure 4) and which can be formed, for example, by stamping, from a sheet of metallic, thermoplastic or other suitable material. It will be seen that a plurality of elongated slots or openings 36 are provided in the valve closure plate 34 to define therebetween a plurality of closure bars 38 which, in use, register with the openings 12 in the valve body 10.

It will be seen from Figure 4 that, in the embodiment illustrated, the valve closure plate 34 is defined by two opposed parallel and essentially linear edge portions generally indicated at 39 which are separated by circular arc edge portions 42. The openings 36 are interrupted by a generally central transverse spine 38a.

In the particular closure plate 34 shown in Figures 3 and 4, the linear edge portions 39 are recessed at 41 to facilitate gas flow from one side of the plate to the other when that plate is raised into its open position. Such recessing of the linear edge portions 39 provides along each linear edge portion of the plate 34 three co-linear guide edges 40 which, during operation of the valve 28, are guided by removable guide members generally indicated at 56 and which are clamped by the bolts 58 between the valve body 10 and the valve head 16, such bolts being received in bores 59 in those guide members 56. To ensure that the guide members 56 are maintained in correctly aligned positions, alignment pins (not shown) can be provided on the valve body 10 or the valve head 16 so as to be received in bores 60 provided for such purpose in the guide members 56. The guide members 56 function to prevent rotation of the valve closure plate 34 and a spring biasing means 50 (yet to be described) and to retain those members in proper alignment.

Between the valve closure plate 34 and the valve head 16 and within the valve chamber 27, there is provided an integral one-piece spring biasing means generally indicated at 50. Such spring biasing means replace the individual leaf springs 22 of the valve 8 and can be formed, for example, by stamping, from a sheet of any suitable material such as spring steel. The particular spring biasing means 50 as shown in Figures 2, 3 and 4 is formed with a generally central transverse spine 53 and side members 57 which are connected to the central spine 53 by generally linear bars 62. The side members 57 have outside edges defined by circular arcs. The linear bars 62 have their parallel outside edges recessed as at 63 to provide, for each, three co-linear guide edge surfaces 55.

The spring biasing means is formed so as to have a plurality of slotted openings 52 which register with respective ones of the openings 36 in the valve closure plate 34. The material of the spring closure means 50 between the openings 52 is bent unwardly to form a plurality of resiliently flexible fingers 54 which, in use, engage respective ones of the bars 18 of the valve head 16. Consequently, the central spine 53 and the side members 57 of the spring biasing means press downwardly against the valve closure plate 34 normally to urge that plate into its lowermost closed position.

In the embodiment shown in Figures 2, 3 and 4, the free ends of the fingers 54 are bent downwardly as indicated at 61 to reduce the friction between those fingers and the bars 18 of the valve head 16. It is also to be noted that the fingers 54 provided on each side of the spine 53 terminate at different distances from that spine thereby providing a more uniform distribution of the spring closing force as applied to the valve closure plate 34.

The manner in which the structure of the known valve 8 can be modified to that shown in Figure 2 will now briefly be summarized. To effect such a modification, the bolts 58 are removed to permit separation of the valve head 16 and the valve body 10. The valve closure members 14 and the leaf springs 22 are then removed as are the guide members 20. Bores (not shown) are then drilled in either the valve body 10 or in the valve head 16 and threaded; guide pins (not shown) are then screwed into such bores. The guide members 56 are then placed in position with the aforementioned guide pins entering the bores 60. The valve closure plate 34 and the spring biasing means 50 are then placed in position in the valve chamber 27 and the valve head 16 is secured to the valve body 10 using the bolts 58 which pass through the bores 59 in the guide members 56 so to hold those members in proper mutually parallel alignment.

During use of such a modified valve 28, the valve closure plate 34 is normally held in its closed position with its bars 38 closing the openings 12 in the valve body 10 under the action of the spring biasing means 50. When an adequate pressure differential occurs across the valve 28, the valve closure plate 34 rises from the valve body 10 allowing gas flow upwardly through the openings 12 in the valve body 10, through the openings 36 and 41 on the valve closure plate 34, through the openings in the spring biasing means 50 and out through the openings 19 in the valve head 16.

Servicing of the valve 28 is a simple matter. All that has to be done is to remove the valve head 16 and replace the spring

biasing means 50 and the valve closure plate 34. If the guide members 56 have become worn, they are also removed and replaced. The whole servicing operation can be carried out in a minimum of time by relatively unskilled persons. Additionally, the problems involved in manufacturing and stocking the relatively large number of replacement parts as required for known valves are drastically alleviated.

Reference will now be made to Figure 5 in which there is indicated generally at 66 an alternative embodiment for an integral one-piece spring biasing means for use in a plate-type valve in accordance with this invention. The spring biasing means 66 is similar to the spring biasing means 50 hereinbefore described with reference to Figure 4 of the drawings. For example, it comprises a generally central transverse spine 68 and, on opposite sides of that spine, side members 70 and 72 having circular arc edge surfaces 74.

Elongated slots or openings 76 are formed between the spine 68 and the side members 70 and 72 to define bars 78 which interconnect the spine 68 and side members 70 and 72 and upwardly deformed and resiliently flexible fingers 80a, 80b, 80c, 80d and 80e on each side of the spine 68. It is to be noted that these several fingers terminate, on each side of the spine 68, at three different distances from that spine 68 so providing an even more uniform pressure distribution. For example, the fingers 80c and 80d project a maximum distance from the spine 68 while the fingers 80e project inwardly from the side members to terminate at positions relatively close to the spine 68. The fingers 80a and 80b project outwardly from the spine to terminate at positions intermediate the free ends of the outermost fingers 80c and 80d, on the one hand, and the free ends of the innermost fingers 80e, on the other hand.

It will readily be understood that the spring biasing means 66 has a relatively simple construction and is easily and inexpensively manufactured, for example, by a stamping operation. When such a spring biasing means is manufactured by stamping of a metal plate, it has been found that it is not necessary to take steps to avoid the slight warping of the fingers 80 which sometimes occurs during heat treatment of the stamped plate. Such warping is shown considerably exaggerated in Figure 6 of the accompanying drawings. In some circumstances, such warping of the fingers 80 may even have a beneficial effect on the spring action of those fingers.

While the invention has hereinbefore been specifically described with reference to the particular embodiment thereof as shown in the accompanying drawings, it should be understood that numerous variations and modifications in the illustrated structures are possible within the scope of this invention.

For example, while the invention is especially applicable to valves having linear openings as described, it is equally applicable to valves having annular openings. In such a case, the valve closure member and the spring biasing means would be formed with annular openings which are discontinuous so that the valve closure bars or rings would remain united with each other. Similar structure would, of course, be provided in the valve body and the valve head.

Similarly, this invention is in no way restricted to the use of any particular means for releasably interconnecting the body and head of the valve nor is it restricted to the provision of a valve closure plate or spring biasing means having any particular number of slotted openings or any particular number of fingers thereon.

Other modifications and variations within the scope of the invention will be readily apparent to those conversant with the structure of valves of the type in question.

WHAT WE CLAIM IS:—

1. A plate-type valve which comprises:

a valve body having a plurality of spaced apart openings therethrough for the flow of fluid;

a valve head located above said valve body in spaced apart position relative thereto to define therewith a valve chamber;

a peripheral wall disposed between said valve body and said valve head outwardly to define said valve chamber, at least one discharge opening being provided for the flow of fluid out of said valve chamber;

an integral one-piece valve closure plate disposed within said valve chamber and having at least one opening therethrough for the flow of fluid and imperforate portions located in registration with said openings in said valve body to close those openings when said valve closure plate is disposed in a closed position in sealing proximity to said valve body;

a resilient spring means disposed within said valve chamber between said valve head and said valve closure plate and acting therebetween to urge said plate into said closed position thereof; and

a valve closure plate guiding means constituted by at least one portion of said peripheral wall, which portion guidingly engages a corresponding edge portion of said valve closure plate and which portion of said peripheral wall is removably and separately secured in position between said valve body and said valve head.

2. A plate-type valve as claimed in Claim 1, in which said valve closure plate is peripherally defined by two mutually parallel and opposed linear edges, and which valve comprises two correspondingly opposed said valve closure plate guiding means having opposed and parallel linear faces.

3. A plate-type valve as claimed in Claim 1 or 2 in which said valve closure plate is peripherally defined by said two linear edges and by intermediate circular arc edge portions.

4. A plate-type valve as claimed in Claim 1, 2 or 3 in which said valve closure plate is formed with a plurality of mutually parallel and elongated openings therethrough.

5. A plate-type valve as claimed in any one of Claims 1 to 4 in which said spring means comprises a generally planar spine having terminal end surfaces for guided engagement with said opposed and parallel linear faces of said valve plate guiding means and a plurality of resiliently flexible fingers integrally formed with and extending from said spine angularly with respect to the principal plane of said spine.

6. A plate-type valve as claimed in Claim 5 in which said central spine of said spring means is in surface abutment with said valve closure plate while said fingers generally terminally engage said valve head.

7. A plate-type valve as claimed in Claim 5 or 6 in which said flexible fingers of said spring means extend from said spine along two sides thereof.

8. A plate-type valve as claimed in Claim 5, 6 or 7 in which said spring means additionally comprises side members spaced apart from said spine on opposite sides thereof with said fingers extending from both said side members and said spine.

9. A plate-type valve as claimed in Claim 8 in which said side members are integrally formed with said spine and with generally planar bars extending therebetween.

10. A plate-type valve as claimed in Claim 9 in which said planar bars extending between said side members and said spine essentially at said outer ends of said side members are recessed along their outer edges between said side members and spine.

11. A plate-type as claimed in any one of Claims 6 to 10 in which said side members are essentially coplanar with said spine.

12. A plate-type valve as claimed in any one of Claims 6 to 11 in which each said side member has an outer edge defining a circular arc.

13. A plate-type valve as claimed in any one of Claims 1 to 12 which additionally comprises a pair of said valve closure plate guiding means which are adapted to be mounted on the valve body to provide guide surfaces for said valve closure plate and said spring.

14. A plate-type valve substantially as hereinbefore described with reference to, and as shown in, Figures 2—6 of the accompaning drawings.

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1572957 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

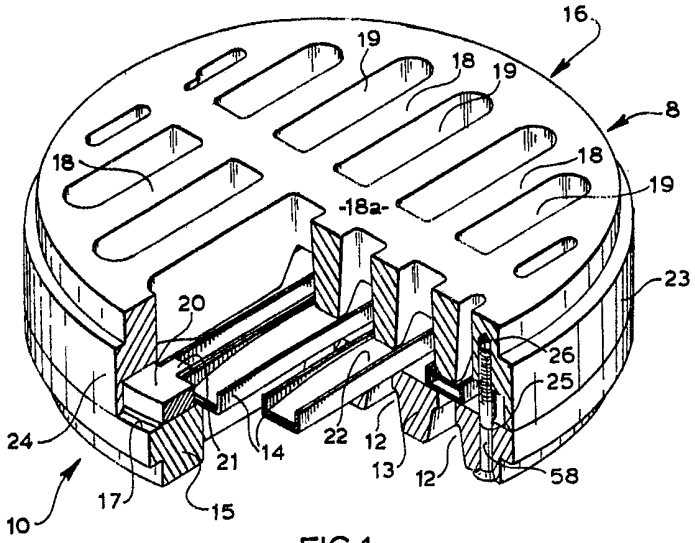

FIG.1
PRIOR ART

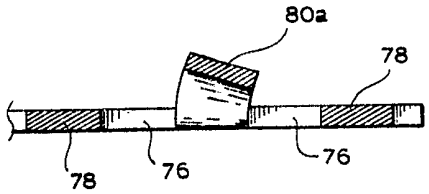

FIG.6

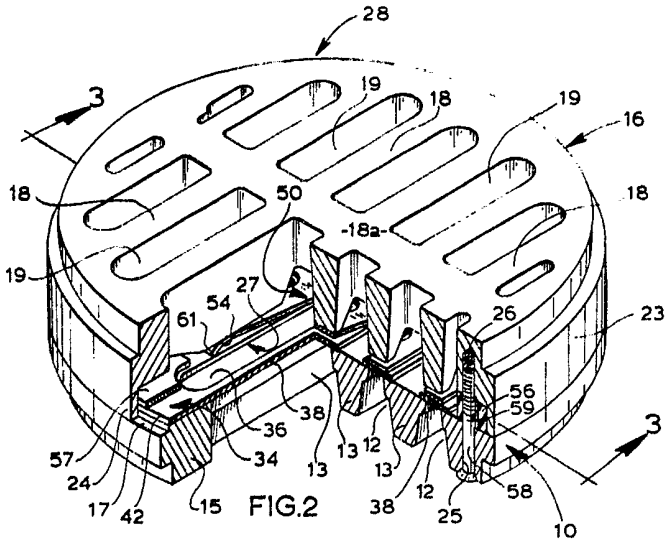
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FIG.2

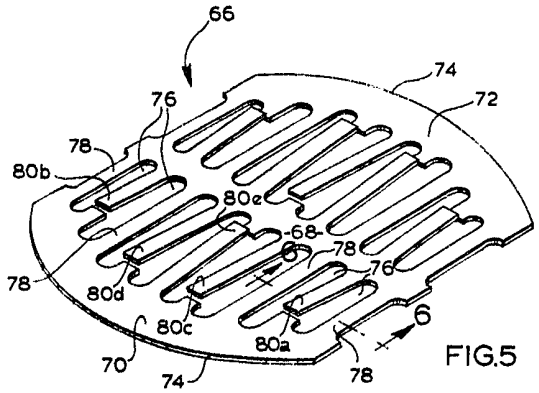
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FIG.5

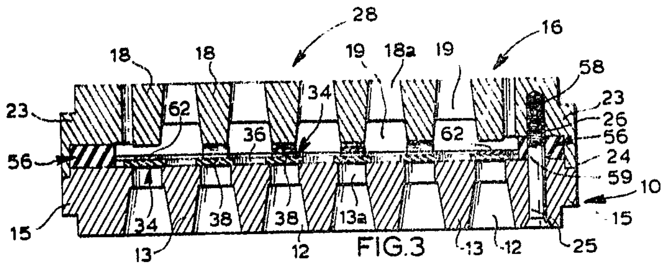
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FIG.3

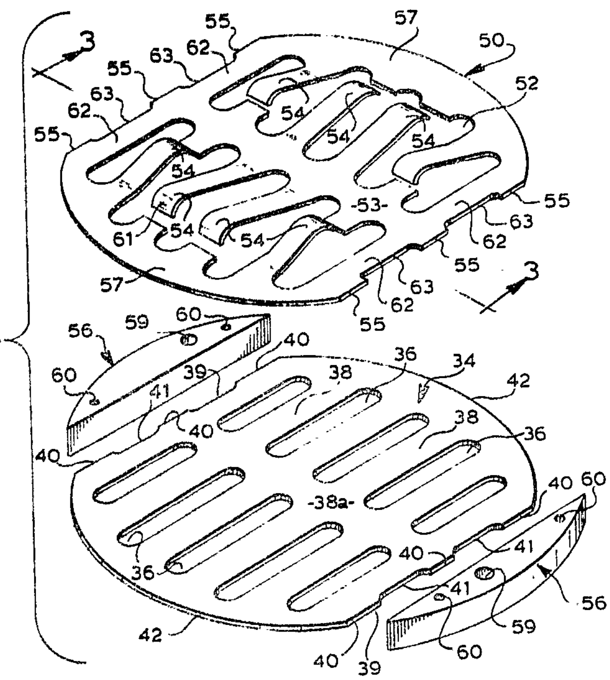
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FIG.4