Sept. 7, 1937. A. V. SAHAROFF 2,092,088

VALVE

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Fig. 1.

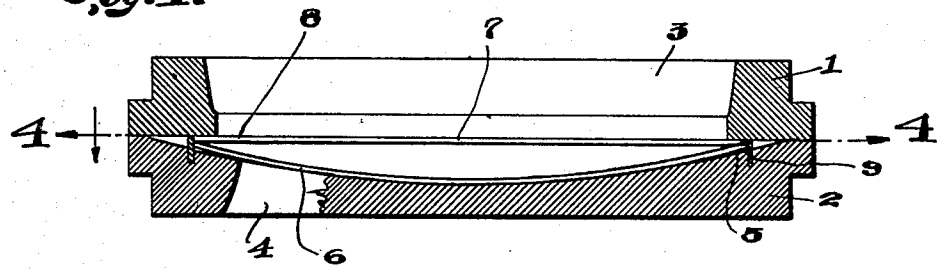


Fig. 2.

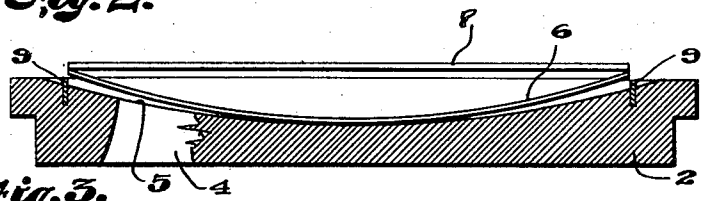


Fig. 3.

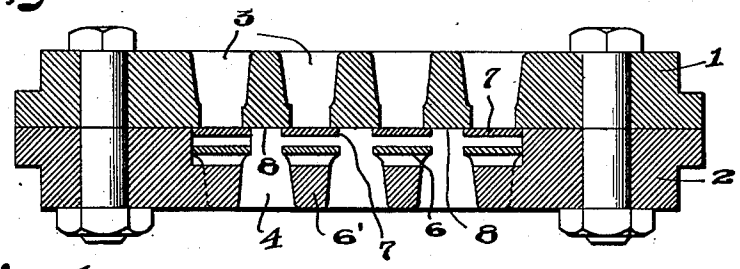
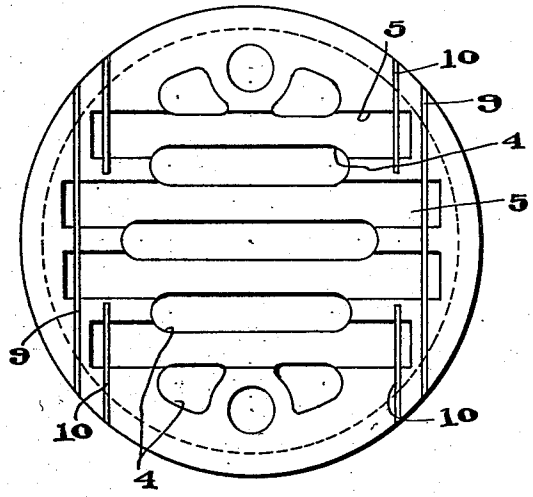


Fig. 4.



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VALVE

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Fig. 5.

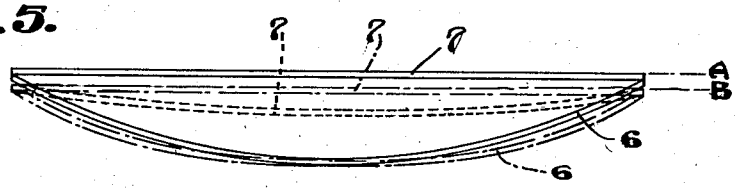


Fig. 6.

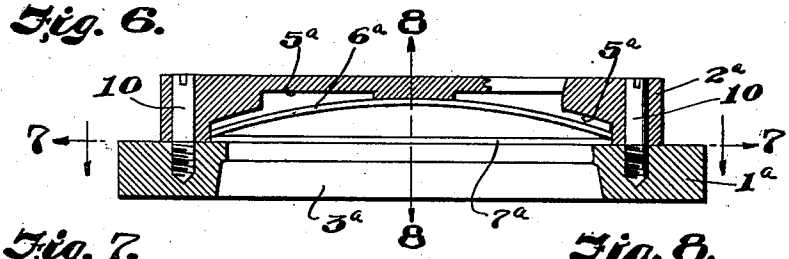


Fig. 7.

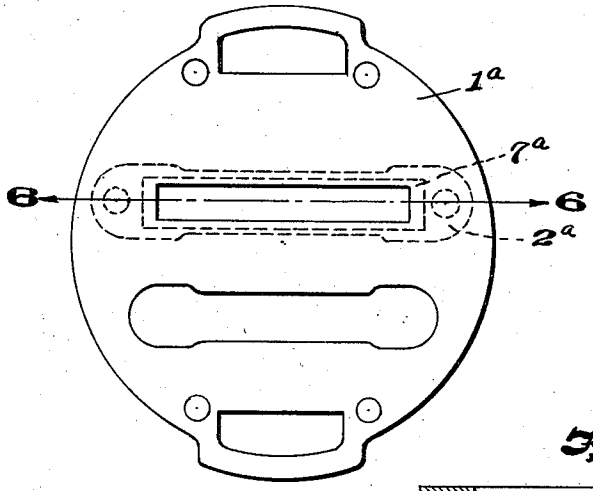


Fig. 8.

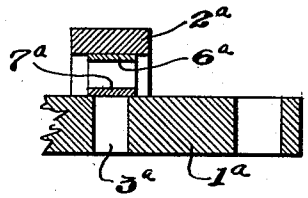


Fig. 9.

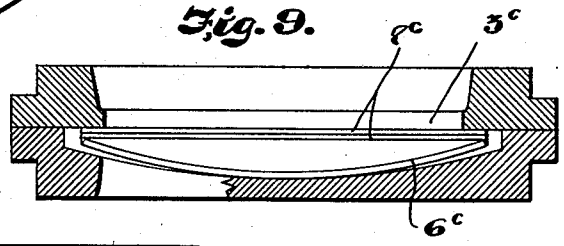
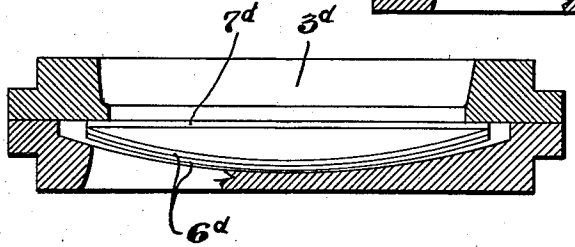


Fig. 10.



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2,092,088

UNITED STATES PATENT OFFICE

2,092,088

VALVE

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Application October 9, 1935, Serial No. 44,178

10 Claims. (Cl. 277—60)

This invention relates to automatic plate valves adapted for use in air or gas compressors and the like, and specifically to automatic plate valves that function by bending and are free from localized bending with its resulting crystallization of the metal, and fracture.

An object of the present invention is to provide automatic plate or strip valve of the "feather" type embodying a thin elastic valve-forming strip free to permit uniform bending in which part of the valve opening is effected in the manner of or by direct lift of the valve-forming strip and part by flexure of the valve-forming strip itself, thereby permitting the securing of a greater total opening through the valve lift with less initial spring loading of the valve strip than is possible with a valve of the approved "feather" type or with a valve of the straight plate or strip type.

With these and other objects in view as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first disclosed in connection with the accompanying drawings, showing a valve of the preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a cross-section through an assembled valve of the present invention.

Figure 2 is a cross-section through the guard or cover plate of the valve showing a pair of valve strips in position.

Figure 3 is a cross-section through the assembled valve and taken at right angles to the section shown in Figure 1.

Figure 4 is a plan view of the guard section or abutment block taken on the line 4—4 of Figure 1.

Figure 5 is a detail view in edge elevation of the valve strips illustrating the manner in which the valve operates for opening.

Figure 6 is a cross section through an assembled valve of a modified form.

Figure 7 is a plan view of the valve plate taken on the line 7—7 of Figure 6 and showing the guard or abutment block and valve strips in dotted lines.

Figure 8 is a detail cross section taken on the line 8—8 of Figure 6.

Figure 9 is a cross section through a still further modified form of the invention showing a plurality of elastic valve-forming strips used in combination with a single spring backing strip.

Figure 10 is a cross section through a modified form of the invention showing a plurality of spring backing strips employed with a single elastic valve-forming strip.

Referring more particularly to Figures 1 to 5 inclusive of the drawings wherein the preferred form of the present invention is shown as embodying a valve comprising a plurality of valve openings and thin elastic valve-forming strips for controlling the openings, the improved valve comprises the valve seat 1 and the guard or abutment member 2. The valve seat 1 and the abutment member 2 are provided with parallel openings or ports 3 and 4 respectively which are disposed in staggered relation as clearly shown in Figure 3 of the drawings. The guard or abutment member 2 has concave recesses 5 milled in the ribs 6' which are spaced between the openings or ports 4. The curved milled surfaces 5 serve as abutment surfaces for the spring backing strips 6, the ends of which engage the inner side of the flat thin elastic-valve-forming strips 7 at their ends only. The thin elastic valve-forming strips 7 normally rest against the seats 8 of the valve seat member 1.

In Figures 1 to 4 inclusive of the drawings, the abutment surfaces 5 are shown as milled upon a single uniform radius for the purpose and in the manner as disclosed in my prior Patent Number 1,916,685, however it is to be understood that these abutment surfaces may be formed in any manner, either upon a single radius, in a catenary curve, or in any other shape, form or manner desired, without departing from the spirit of the present invention.

As shown in my prior patent above mentioned, Figures 1 to 4 inclusive of the drawings show the active length of the abutment surfaces 5 regulated or formed by the shoulder forming strips 9 and 10 which are of any suitable material and are inserted in the guard or abutment member 2. The strips 9 and 10 extend transversely across the ends of the milled surfaces 5 the proper distance inwardly from the ends of the milled surfaces to form a stop or stops for the ends of the strips 6 and 7. The present invention is not to be limited to this specific feature of construction as the abutment surfaces may be formed in any practical manner with or without the stop strips 9 and 10.

The resilient or spring backing strips 6 are curved on radii calculated to give them sufficient tension to hold the elastic valve-forming strips 7 against their seats on the flat surface

8 of the valve seat member 1 for closing the valve openings or ports 3.

As clearly shown in Figure 1 of the drawings, the end portions of the resilient or spring backing strips 6 are, when the valve openings are closed, free from engagement with the abutment surfaces 5. When pressure is applied to the valve-forming strips 7 through the openings 3 and the valve starts to open, the valve-forming strips 7 first move substantially unflexed or unbent away from the seats 8 a predetermined distance, limited by the space between the backing strips 6 and the abutment surface 5. When the backing strips 6 engage the abutment surfaces 5 bending of the strip 6 is stopped and the valve-forming strips are then in the position indicated in dot-and-dash lines in Figure 5 of the drawings. After the valve strips 7 have moved by direct lift, and substantially unflexed for the predetermined distance above referred to, they begin to flex or bend uniformly as shown in the dotted lines in Figure 5 of the drawings, thereby further increasing the size or area of the valve opening. From the above, it will be apparent that the valve-forming strips 7 which are free to permit uniform bending, move by direct lift to effect the first part of the valve opening and subsequently flex or bend to provide the remaining portion of the valve opening, thereby permitting the securing of a greater total valve opening through the valve lift with less initial spring loading on the valve-forming strips themselves than would be possible with valves of the regular approved "feather" type and permit the securing of a greater total valve opening with a smaller size valve, less direct movement and with a finer degree of accuracy than is permitted by valves of the plate or strip type where no provision is made for flexure of the valve-forming strips or plates.

While in the foregoing description, the flexible valve-forming strip 7 has been described as moving in unflexed condition off its seat, during its direct lifting movement, it is to be understood that the valve-forming strip 7 may be of such thickness or strength that it will flex to a certain degree during its direct lift thereby providing a valve-opening movement which comprises first a combination of direct lift and flexing of the valve strip and subsequently flexing of the strip to provide the desired valve opening. Also it is to be understood that by the various proportioning of the strengths and thicknesses of the strips 6 and 7 the degree of the flexing of the strip 7 during the direct lift may be in any proportion of the complete opening of the valve, desired, and to meet the particular conditions.

In Figures 6 to 8 inclusive of the drawings, a modified form of the invention is shown wherein a single valve-forming strip 7*a* is employed in lieu of a plurality of strips as shown in Figures 1 to 4 inclusive. The valve seat 1*a* consequently has a single valve opening 3*a* which is controlled by the strip 7*a*. The guard or abutment member 2*a* is relatively narrow, being only of sufficient width to properly guard the valve strip and it is shown attached to the seat 1*a* by means of suitable bolts 10. While a particular construction of guard or abutment member 2*a* is shown in these drawings it is to be understood that the invention is not limited in any manner to this particular construction and that the guard or abutment member 2*a* may be constructed in any practical manner. In this modified form, like in the preferred form, a resilient or spring backing strip 6*a* is provided, the ends of which engage the valve-forming strip 7*a* at its ends, there being no other contact or engagement between the two strips. In Figures 6 to 8 the abutment surface 5*a* is shown as part flat or straight and part curved and it is to be understood that in the construction of valves in accordance with this invention the abutment surfaces may have the degree of curvature required to meet the valve conditions required by the particular compressor with which the valve is associated. The greater the radii of the curvature of the abutment surface or the nearer it approaches a flat surface the greater will be the percentage of the valve opening by direct lift of the valve strip 7*a*, the tension of the backing strip 6*a* being equal. Thus it may be seen, that without departing from the spirit of the present invention, the combination of the direct lift and flexing or bending of the valve strips can be made in any proportion. That is, the direct lift may be anywhere from 1 to 99 per cent of the movement of the valve-forming strips, and the flexing may be anywhere from 99 to 1 per cent.

Figure 5 shows diagrammatically the action of the valve-forming strip and the spring backing strip where the valve-forming strip 7 moves in unflexed movement during its lift. The solid line portions show the strips 6 and 7 in their normal positions when the valve is closed. When pressure is applied to the strip 7, the strip 6 yields and the strip 7 moves in direct lift from the solid line position into the dot-and-dash line position. That is, it moves through a distance indicated by the dot-and-dash lines A and B. When the valve-forming strip 7 reaches the dot-and-dash line position the backing strip 6 will cease to yield owing to its contact with the abutment surface 5 and the valve-forming strip 7 will flex into the position shown in dotted lines.

It is to be further understood that the valve forming strips and the spring backing strips may be made up in any combination to provide various desired actions of the valves. In Figure 9 of the drawings, two elastic valve-forming strips 7*c* are provided which control the valve opening 3*c* while only one resilient or spring backing strip 6*c* is employed. Such a construction will stiffen the valve-forming strip action and consequently make the flexing of the strips more difficult, requiring a greater pressure to flex the strips than would be required by a single strip of the same thickness and strength as each of the strips 7*c*.

In Figure 10 of the drawings, a single elastic valve-forming strip 7*d* is shown for controlling the valve port 3*d*. However, two resilient or spring backing strips 6*d* are shown which will provide a valve in which the direct lifting will be stiffened, requiring a stronger heavier valve-forming strip 7*d* in instances where it is practical for this strip to move in unflexed direct lift and in instances where the strip 7*d* is not of such strength as to remain unflexed during its direct lift, its flexing action during the direct lift will be proportionately greater than the flexing action would be if a single backing strip 6*d* were employed.

The automatic plate valve described and shown in the drawings has distinct advantages over approved "feather" type valves such as shown by United States Letters Patent, Reissue Number 13,991; Number 1,341,145; Number 1,916,685; and others, and over the direct lift type of plate or strip valve such as shown in United States Patents Num-

bers 1,534,260; 1,528,172; 1,287,530; 1,400,373; 1,688,185; 1,492,599; and others, in that the valve of the first or "feather" group does not permit of direct lift of the valve-forming strips, whereas the valves of the second or direct lift group do not permit or provide for flexure of the valve-forming strip, the effectiveness in operation depends on an inter-relationship between the length of the valve-forming strips, the thickness of the strip, the maximum deflection permitted by the curve of the abutment surface and to some extent, by the width of the valve-forming strip. As the pressure under which the valve-forming strips of such valves must work is relatively heavy, the valve-forming strip thickness can not be reduced below a certain predetermined minimum, which might require a valve-forming strip so heavy as to involve a very considerable and objectionable amount of initial loading effected by the stiffness of the strip itself. As the strip is made thinner to avoid this objectionable amount of initial loading required it will break in service due to transverse bending imposed by fluid pressure.

If the compressor construction and the work performed thereby require a relatively short valve forming strip for relatively high pressure, the valve of the present invention will allow for a considerable direct lift of the strip before the ends of the backing actually contact the abutment surface, after which the valve-forming strip begins to flex or bend to provide for the increase of the valve opening. For light pressures, where a thinner valve forming strip may be used the amount of direct lift may be reduced and the flexing or bending of the valve-forming strip itself be utilized to provide the free or open area through the valve.

In the type of plate or strip valve where no provision is made for flexing of the valve-forming plates or strips, long life and satisfactory performance can only be secured by holding the valve lift in relatively narrow limits, which requires relatively large valves to provide sufficient valve opening to meet many operating conditions and practically precludes the use of such valves in high speed high pressure compressors of small size or results in an expensive cumbersome valve structure of inappropriate size with respect to the compressor cylinder with which it is used.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In a valve, a valve seat having a port therein, a thin elastic valve-forming strip of uniform width and tension throughout its length closing said port and free to permit uniform bending throughout its entire length, a fixed abutment block, means between said valve-forming strip and abutment block to normally hold said valve-forming strip in port closing position, said means adapted to permit limited direct lift of said valve-forming strip, said valve-forming strip adapted to flex after arresting of its direct lift movement to further increase the valve opening.

2. In a valve, a valve seat having a port therein, a thin elastic valve-forming strip of uniform width and tension throughout its length for closing said port and free to permit uniform bending throughout its entire length, a fixed abutment block, spring means between said valve forming strip and abutment block, said spring means tensioned to permit limited direct lift of said valve-forming strip off its seat, said valve-forming strip adapted to flex after reaching the limit of its direct lifting to further increase the valve opening.

3. In a valve, a valve seat having a port therein, a thin elastic valve-forming strip of uniform width and tension throughout its length closing said port and free to permit uniform bending throughout its entire length, a fixed abutment block, resilient backing means between said valve-forming strip and abutment block and tensioned to normally hold said valve-forming strip in port-closing position, said backing means adapted upon pressure being applied to said valve-forming strip to permit limited direct lift of the valve-forming strip, said valve-forming strip adapted to flex to further increase the valve opening after termination of its direct lift valve opening movement.

4. In a valve, a valve seat having a port therein, a thin elastic valve-forming strip of uniform width and tension throughout its length for closing said port and free to permit uniform bending throughout its entire length, a fixed abutment block, resilient means between said valve-forming strip and abutment block, said resilient means tensioned to permit limited direct lift of said valve-forming strip off its seat, said valve-forming strip being of such elasticity that it will flex to a predetermined degree during said direct lift movement and continue to further flex after reaching the limit of its direct lift movement.

5. In a valve, a valve seat having a port therein, a thin elastic valve-forming strip of uniform width and tension throughout its length for closing said port and free to permit uniform bending, a fixed abutment block, a resilient backing strip between said valve-forming strip and abutment block and curved to normally hold said valve-forming strip in port closing position, said backing strip tensioned to flex under pressure applied to said valve-forming strip to permit limited direct lift of the valve-forming strip, said backing strip having engagement with said valve-forming strip only at its ends to permit uniform bending of the valve-forming strip throughout its entire length after it reaches the end of its direct lift movement to further increase the area of the valve opening.

6. In combination, a valve seat having a port, a thin elastic valve-forming strip free to permit uniform bending, an abutment block having a curved abutment surface, a curved resilient backing strip between said valve-forming strip and said abutment surface, said backing strip tensioned to hold said valve-forming strip flat against said seat, said curved abutment surface being milled on radii greater than the radii of the curvature of said resilient backing strip whereby said elastic valve-forming strip will have a direct unflexed lift off said seat for a predetermined distance before beginning to flex.

7. In combination, a valve seat having a port, a thin elastic valve-forming strip free to permit uniform bending, an abutment block having a curved abutment surface, a curved resilient backing strip between said valve-forming strip and said abutment surface, said backing strip tensioned to hold said valve-forming strip flat against said seat, said curved abutment surface being milled on radii greater than the radii of the curvature of said resilient backing strip and said backing strip being tensioned to flex under pressure applied to the valve-forming strip

whereby said valve-forming strip will have a direct unflexed lift off its seat for a predetermined distance, said valve-forming strip adapted to flex to further increase the valve opening after termination of its direct lift valve-opening movement.

8. In combination, a valve seat having a plurality of ports, a plurality of thin elastic valve-forming strips each of uniform width and tension throughout its length free to permit uniform bending throughout their entire lengths and for controlling said ports, a fixed abutment block having abutment surfaces thereon, curved resilient backing strips between said valve-forming strips and said abutment surfaces and tensioned to hold said valve-forming strips flat against said seat, said abutment surfaces being formed with respect to the curvature of said resilient backing strips to permit the resilient backing strips to bend a limited distance to permit unflexed direct lift of the valve-forming strips for a predetermined distance, said valve-forming strips adapted to flex after termination of their direct lift movement to further increase the valve opening.

9. In a valve, a valve seat having a plurality of ports therein, a plurality of thin elastic valve-forming strips of uniform width and tension throughout their lengths and all lying in the same plane and free to permit uniform bending throughout their entire lengths, a fixed abutment block having abutment surfaces thereon, curved resilient backing strips between said valve forming strips and said abutment surfaces and tensioned to hold said valve-forming strips flat against said seat, said abutment surfaces being formed with respect to the curvature of said resilient backing strips to permit the backing strips to bend a limited distance whereby said valve forming strips may move in unflexed direct lift for a predetermined distance, said valve-forming strips flexing throughout their entire lengths after termination of their direct lift movement to further increase the valve opening.

10. In a valve, a valve seat having a plurality of ports therein, a plurality of thin elastic valve-forming strips of uniform width and tension throughout their lengths and all lying in the same plane and free to permit uniform bending throughout their entire lengths, a fixed abutment block having abutment surfaces thereon, curved resilient backing strips between said valve forming strips and said abutment surfaces and tensioned to hold said valve-forming strips flat against said seat, said abutment surfaces being formed with respect to the curvature of said resilient backing strips to permit the backing strips to bend a limited distance whereby said valve forming strips may move in unflexed direct lift for a predetermined distance, said valve-forming strips flexing throughout their entire lengths after termination of their direct lift movement to further increase the valve opening, said curved resilient backing strips having substantially line contact to their ends only with said valve-forming strips.

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