

[54] **PLATE VALVE ASSEMBLY**

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[22] Filed: **Feb. 18, 1972**

[21] Appl. No.: **227,398**

[30] **Foreign Application Priority Data**
Feb. 19, 1971 Australia..... 1456/71

[52] U.S. Cl..... **137/514, 137/516.19**

[51] Int. Cl..... **F16k 15/14**

[58] Field of Search..... 137/514, 516.11-516.21

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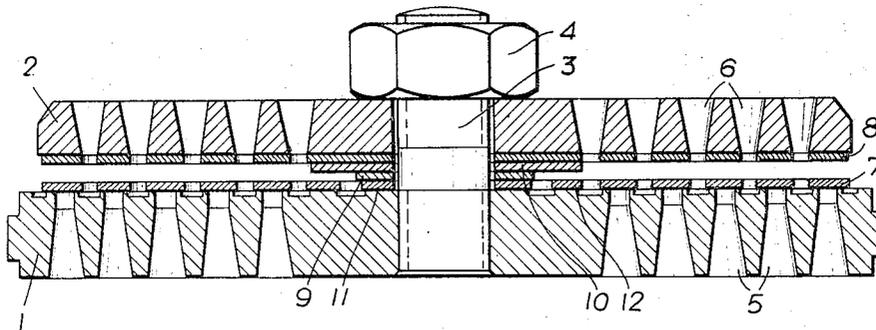
Primary Examiner—Robert G. Nilson
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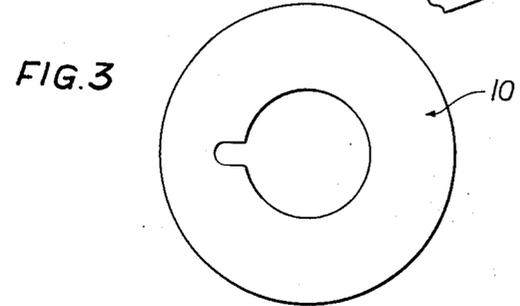
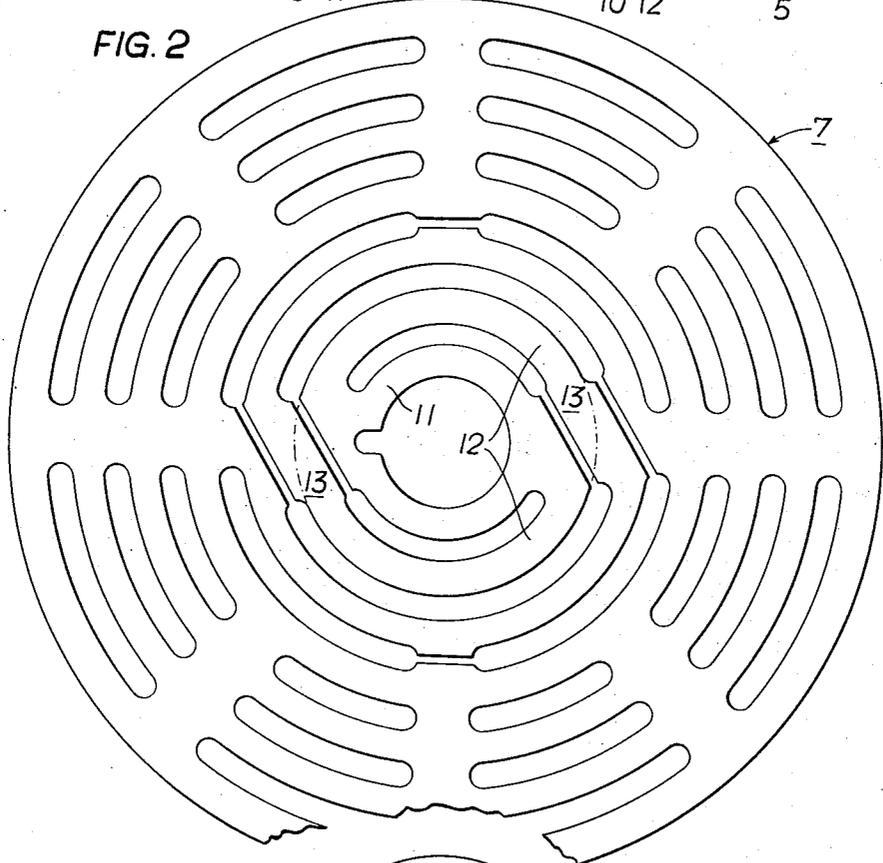
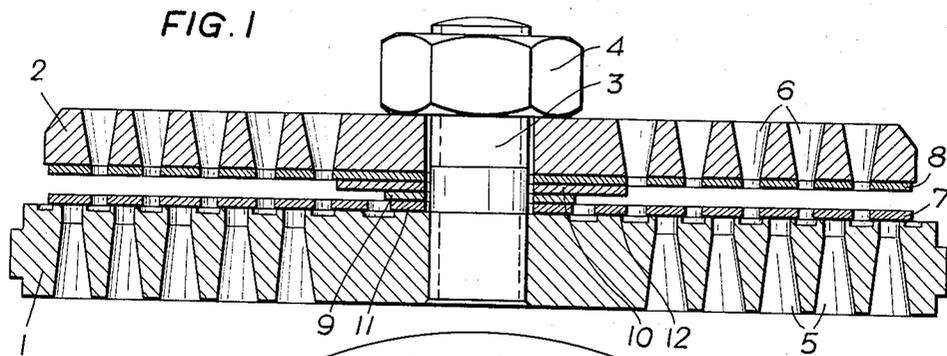
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[57] **ABSTRACT**

A plate valve assembly for a piston compressor which comprises a spaced valve seat and catcher, a valve plate between the valve seat and catcher, a guiding system for the valve plate consisting of at least one flexible link having one extremity integral with the valve plate and at least one abutment overlying the valve plate for limiting deflection of said link in the direction of the catcher.

8 Claims, 13 Drawing Figures





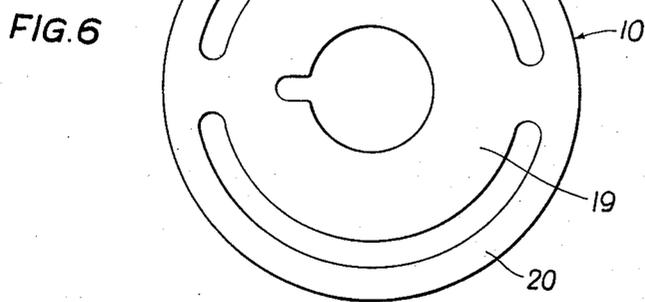
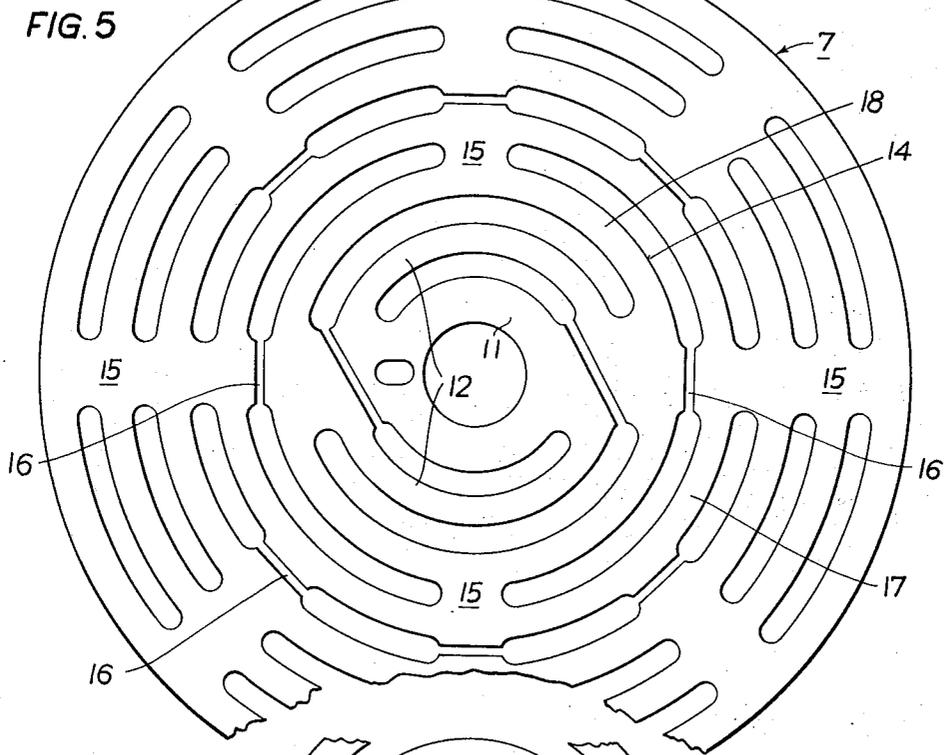
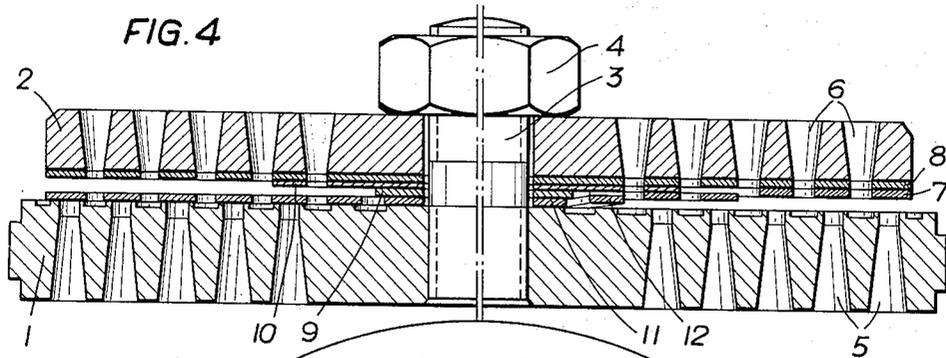


FIG. 7

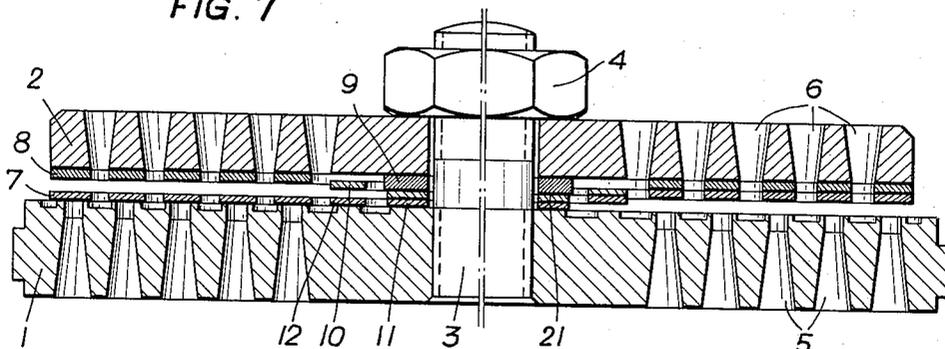
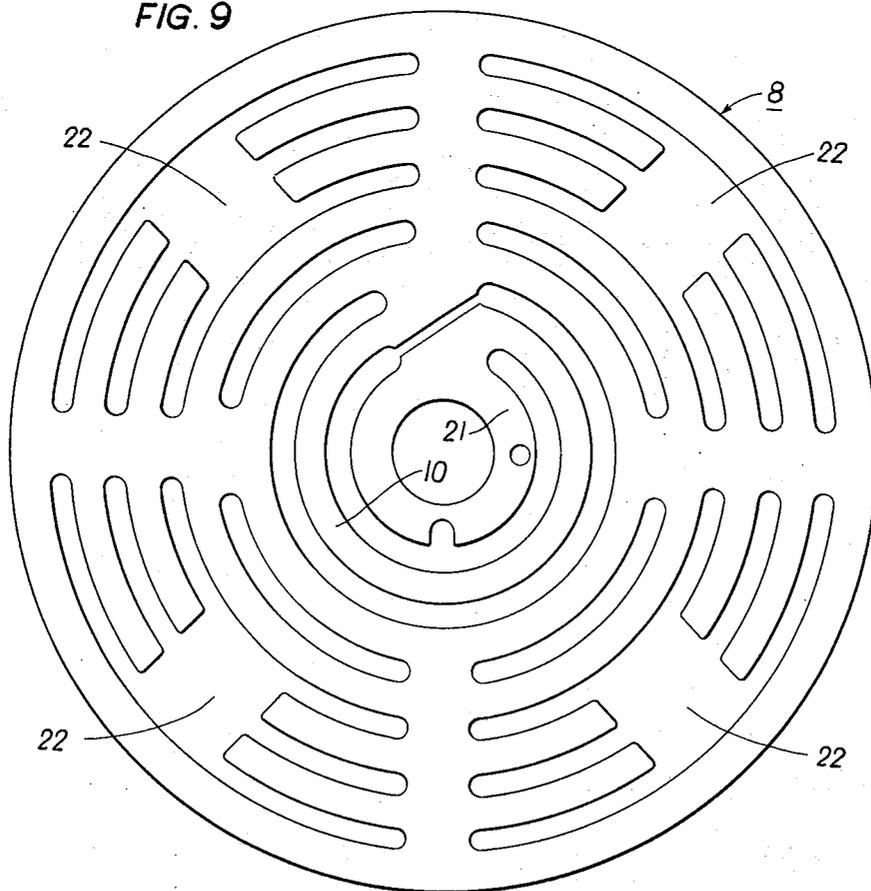


FIG. 8



FIG. 9



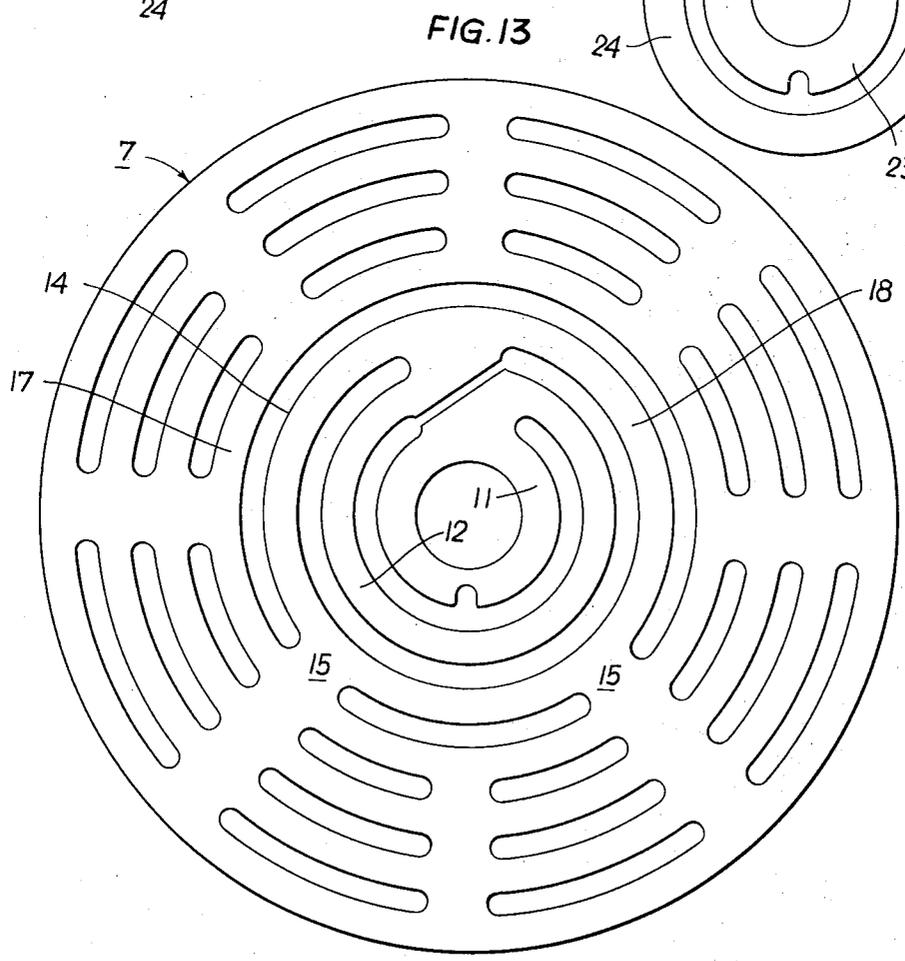
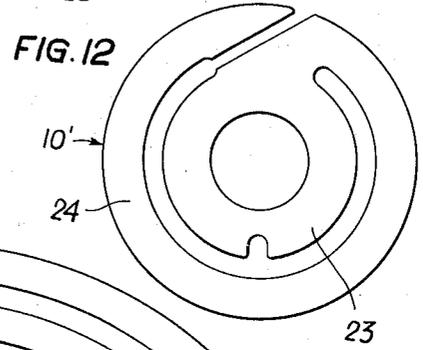
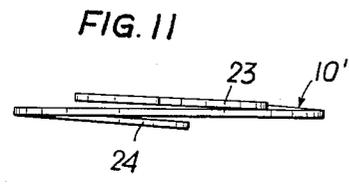
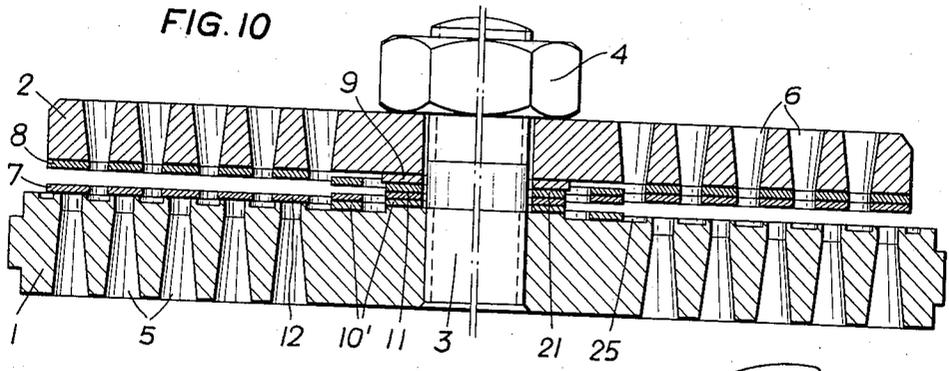


PLATE VALVE ASSEMBLY

This invention relates to plate valve assemblies for piston compressors, comprising a valve seat and catcher, and a valve plate between the valve seat and catcher wherein the valve plate is equipped with a frictionless guiding system consisting of at least one flexible link which has one extremity integral with the valve plate and has its other extremity anchored in axially spaced relation from an abutment surface of the valve plate facing the catcher.

Guiding link systems for the valve plate, that is to say systems comprising one or more flexible links are well known. In one known form, the link arms formed integrally with the valve plate have their extremities coupled to co-ordinated links of a link plate, fastened in the valve assembly. This embodiment allows large valve plate strokes, with considerable overall length of the links and consequent lesser stress on the guiding link system. An embodiment is also known wherein the flexible links of the valve plate itself are anchored between the valve seat and the catcher, commonly being clamped, with the aid of a boss, by means of the central screw of the valve assembly. This eliminates a special link plate, but the space available for the links is restricted, so that relatively short link arms must cope with the entire stroke. The link arms undergo relatively high stresses therefore, especially in the case of longer strokes, so that link breakages can occur which render the valve unusable and moreover endanger the piston compressor itself, since fragments could drop into the cylinder. The link guiding system accordingly requires special care when designing the plate valve assembly.

An attempt to improve the link guiding system has been disclosed in the German display specification No. 1,425,622. This arrangement is based on the concept that rigid clamping of the link arm extremities results in an uneven distribution of bending stress in the link arms and in torsional stress on the same, which was considered to be the primary reason for the risk of link breakage. To remedy this, provision is made in this arrangement for clamping the link extremities in punctiform contact or in a linear contact extending transversely to the link arm, and for the links to be provided with different degrees of permanent curvature corresponding to possible dynamic pressure differences in different areas of the flow cross-section in the valve. This arrangement cannot however prevent twisting of the link arms. Linear contact clamping acting transversely to the link arm prevents unconstrained turning of the link arm in precisely the same way as rigid clamping. Although unconstrained turning may well be available with punctiform clamping of the link arms, this would however result in insufficiently precise and reliable anchoring of the valve plate. Moreover, a sliding displacement and rubbing of the inner link arm extremities on the central guide may not be prevented in such a case. The measures proposed thus tend to increase the cost of the valve and impair operational reliability by imprecise and not entirely frictionless guiding of the valve plate. In the same way, a division of the valve plate hub by means of radial slots between the link extremities, which is known per se becomes ineffective with firm clamping of the hub between plane rings, so that there is no difference from a solid hub.

The differential curvature of the link arms, which had also been proposed for the purpose of equalising non-uniform incident flow, cannot be applied in practice. Since the flow conditions are different in each compressor, the link curvature would have to be determined and applied individually for each particular compressor. Moreover, the valve would have to be incorporated in the compressor in a particular position. Beyond this, a non-uniform curvature making allowance for the flow conditions in the direction of valve opening would deleteriously affect the displacement conditions for the valve plate upon closing the valve.

It is also known for the valve plate links to be anchored directly on the catcher by means of a hub, so that when the valve is completely opened, the valve plate and its links lie flat in the same plane on the abutment surface of the catcher. Although the links are thus supported on the catcher when the valve is open, they are however bent outwardly relatively far from the plane of the valve plate, when the valve is closed. Moreover the flat contact of the links on the catcher promotes disadvantageous late-closing actions of the valve, because the freeing of the valve plate from the catcher is thereby delayed, especially in the case of lubricated valves.

An object of the present invention is to provide an improvement in known plate valves having a link guiding system. To this end, the invention is based on the finding that the risk of breakage of the links in the known embodiments is presumably attributable to the fact that the links are deflected during the stroke displacement and follow the entire valve plate stroke with a part of their length, so that their residual and relatively short link portion is overstressed. The deflection also occurs in the case of long links which are relatively soft and are exposed to direct incident flow of the working fluid. This is the case in particular when parts of the links cover through-flow passages of the valve seat in a manner known per se, to prevent an excessive loss of flow cross-section.

According to the invention, at least one abutment is incorporated in the area of displacement of the link or links of the valve plate, which abutment projects over the surface of the valve plate facing the catcher and limits the link deflection in the direction of the catcher. This measure, which may be applied with valve plate links of any configuration and irrespective of their number, minimizes deleterious deflection of the links and connex complementary stresses. Even in the case of long links, their entire length is exploited for overbridging the plate stroke, so that the links are exposed to correspondingly low stress acting uniformly along their entire length. The risk of link breakages is thus largely eliminated, and provides resilient impact damping for the valve plate, since the links impinge earlier on their stop than the valve plate itself, so that the stress on the valve plate is reduced. Moreover, the freeing of the valve plate from its upper stroke delimiter during closing displacement, is facilitated by the abutment.

The abutment may consist of a ring clamped between the valve seat and catcher, the outer periphery of the ring being situated in the area of displacement of the links. In the case of a valve plate where the links are clamped on the valve axis with a central hub by means of a central screw and "stroke spacers," a divided spacer is advantageously employed, the one part being

formed as a ring which has a slightly larger diameter than the other part and thus forms the abutment. The thickness of such an abutment ring amounts to between say one half and one fifth of the total plate stroke. This embodiment may also be incorporated subsequently in any valve comprising a link guiding system, i.e., by simple installation of the abutment ring. The catcher itself may also have projections acting as abutment faces for the links.

In a further development of the invention, the abutment for each link may be formed as a helical surface on which the link comes into contact over at least a part of its length when the valve plate is lifted off the valve seat. The abutment may consist of a spring plate, damping plate or buffer plate, which the portion situated over the links of the valve plate is endowed with a permanent curvature towards the valve plate and which is preferably clamped between the valve seat and catcher, together with the valve plate. This provides a resilient stop for the links of the valve plate, which ensures extensive support for the valve plate links and thereby minimizes deleterious stressing of the same.

The abutment may also consist of a solid nave ring clamped between the valve seat and catcher, to which is adjacent at least one slotted ring conforming in shape to the links of the valve plate. This ring may also have a permanent curvature for example of helical form, so that it also serves the purpose of resilient interception of the valve plate links.

The abutment for the links of the valve plate will, preferably be arranged between the valve plate and the catcher, so that it prevents excessive deflection of the plate links during opening movement of the valve plate. Within the scope of the invention, and complementary to the abutment situated in front of the catcher, a further abutment projecting over the valve seat may be incorporated between the latter and the valve plate, which delimits the link deflection in the direction of the valve seat and which is partially imbedded in a recess of the valve seat. This embodiment is appropriate if the links of the valve plate are anchored between and with spacing from both stroke delimiting surfaces, e.g., with a central hub. The links may however also have their inwardly situated extremities anchored directly on the valve seat in a manner known per se, the valve seat concomitantly limiting the link deflection in the one direction.

The invention will now be described by way of example with reference to the accompanying drawings in which:-

FIGS. 1 to 6 show two forms of plate valve assembly according to the invention,

FIGS. 1 and 4 each being an axial central section through the respective assemblies,

FIGS. 2 and 5 each being a plan view of the respective valve plate, and

FIGS. 3 and 6 each showing respective abutment rings in plan view,

FIG. 7 shows another form of plate valve assembly according to the invention in axial cross section,

FIGS. 8 and 9 show a damping plate for the assembly of FIG. 7 in sideview and plan view respectively,

FIG. 10 shows another modified form of plate valve assembly according to the invention in axial cross section,

FIGS. 11 and 12 show an abutment ring in sideview and plan view, and

FIG. 13 show a further form of valve plate in plan view.

In all the illustrated embodiments, the valve assembly consists of a valve seat 1 and a catcher 2 which is connected to the valve seat 1 by means of a central bolt 3 and a nut 4. Throughflow passages 5 and 6 are formed in the valve seat 1, and in the catcher 2 respectively. Between the valve seat 1 and the catcher 2 are situated in each case a valve plate 7 and a damping or buffer plate 8. Moreover, plate springs or coil springs may be incorporated in a manner known per se for the valve plate 7 and if appropriate also for the damping plate 8. Several damping or buffer plates may be employed if required. Encircling the central bolt 3 are situated stroke spacers 9, and abutment rings 10 are incorporated in several of the embodiments. In its centre, the valve plate 7 has a hub 11 which is clamped in the assembly by means of the central bolt 3 and from which extend flexible links 12 integral with the sealing portion of the valve plate 7 and serving to guide the plate frictionlessly during the stroke displacement. Embodiments are possible which comprise a single link 12, or several links, in particular two, three or four links.

In the embodiment according to FIGS. 1 to 3, an abutment ring 10 overlies the stroke spacer 9 arranged over the hub 11. Between the abutment ring 10 and the catcher 2 is clamped the damping plate 8 which also has a hub and flexible links, but which may alternately be formed with a rigid central portion. The outer rim of the abutment ring 10 projects beyond the periphery of the stroke spacer 9 and is situated above the innermost links 12 formed by the plate ring adjacent to the hub 11. When the valve is closed, the abutment ring 10 is spaced from the links 12 by a distance determined by the thickness of the stroke spacer 9. When the valve plate 7 lifts off the valve seat 1, the links 12 first impinge against the abutment ring 10 with the abutment portions marked 13 in FIG. 2, before the valve plate itself strikes the damping plate 8, together with which it strikes the catcher 2. The abutment ring 10 spaced below the catcher 2 thereby limits the stroke of the links 12 which is thus smaller in the area of the abutment ring 10 and of the abutment portions 13 than the stroke of the remainder of the valve plate 7. This prevents the links 12 from being deflected and coming into contact with the abutment surface of the catcher 2 of the damping plate 8 with a part of their length, say with the part situated radially outwards from the abutment portions 13, in which event the remaining part of the links 12 would have to overbridge the entire plate stroke and would thereby be exposed to high bending stresses.

In the embodiment according to FIGS. 4 to 6, a stroke spacer 9, an abutment ring 10 and a damping or buffer plate 8, are arranged around the central bolt 3 and over the hub 11. The valve plate 7 shown in FIG. 5 has a specially arranged link guiding system. To the hub 11 are joined two approximately semi-circular links 12 which are attached to an uninterrupted plate ring 14, the radial webs 15 interconnecting the plate rings being divided in this area by a slot 16 extending in the peripheral direction. The ring 14 is thus connected only by two diametrically opposed webs 15 to the next outwardly adjacent plate ring 17 which, for its part, is largely separated from the remaining uninterrupted plate rings by further slots 16 and is also joined to these only by means of diametrically opposed radial

webs 15. The annular parts marked 18 of the rings 14 and 17 are thus extensively flexible and form a part of the link guiding system. Since they are formed without interruptions, they may advantageously be used to cover throughflow passages 5 in the valve seat 1, without having to eliminate the conventional annular incision above the throughflow passages 5 or having to mill the latter.

In this embodiment, the abutment ring 10 has a hub 19 covering the links 12 and, joined to said hub by means of two webs, an external ring 20 situated above the ring 14 of the valve plate 7 and forming a terminal abutment for the plate. In this manner, the abutment ring 10 prevents the semi-circular links 12 from overbridging the entire stroke of the valve plate 10 and thus from incurring an excessive bending stress. Moreover, the abutment ring 10 resiliently intercepts the valve plate 7 during its opening displacement through its flexible ring portions 18, so that an advantageous damping action on the opening surge is obtained. Conversely, during a closing displacement of the valve plate 7, the abutment ring 10 and the resiliently deformed ring portions 18 facilitate the freeing of the valve plate 7 from the damping plate 8 from the catcher 2, so that delayed closures with consequent additional strains on the valve plate 7 are minimized.

In the example according to FIGS. 7 to 9, the inner portion of the damping plate 8 forms the abutment for the links 12 of the valve plate 7. The damping plate 8 has a hub 21 to which is joined a single link which forms the abutment ring 10 for an identically shaped link of the valve plate 7. As apparent from FIG. 8, the hub 21 is permanently bent out of the plane of the damping plate 8 towards the valve seat 1 and is clamped fast in the valve assembly (FIG. 7), conjointly and in direct contact with the hub 11. The link 12 of the valve plate 7 then comes into contact with the abutment ring 10 formed by the link of the damping plate 8 during the opening of the valve, thereby essentially securing the same advantages as in the previous embodiments, in particular prevention of a deleterious deflection of the links.

FIG. 10 shows an embodiment of the plate valve assembly according to the invention, wherein abutments for the links 12 are incorporated in both directions of displacement of the valve plate 7. The abutment ring 10 acting in the direction of opening is formed by the inner portion of the damping plate 8 as in the embodiment according to FIGS. 7 to 9. Between the valve plate 7 and the valve seat 1 is situated another abutment ring 10' which is shown in FIGS. 11 and 12. The abutment ring 10' has a hub 23 clamped fast immediately below the valve plate 7. From the hub 23 extends a split ring 24 which is permanently bent downwardly from the plane of the hub 23, for example in the shape of a helix. According to FIG. 10, the ring 24 extends into a recess 25 of the valve seat 1, in which it is partially imbedded. The abutment ring 10' thus prevents a downward deflection of the link or links 12 of the valve plate 7 in the direction towards the valve seat 1, so that the valve plate links are protected against overloads in both directions of displacement.

The valve plate 7 shown in FIG. 13 fundamentally corresponds to the embodiment shown in FIG. 5, with the difference that a single link 12 only, is used. The link 12 extends from the hub 11 and is joined to the innermost uninterrupted plate ring 14 which is connected

by two webs 15 only to the next uninterrupted plate ring 17. These two webs 15 are situated on plate diameters which, in the case illustrated, subtend a right angle between them, so as to leave a free ring portion 18 extending uninterruptedly along approximately three-quarters of the circumference, at the middle of which the link 12 is joined to the ring 14. A single web only may be arranged between the rings 14 and 17 instead of the two webs 15. In view of its extensive independence of the adjacent uninterrupted ring 17, the ring portion 18 is flexible and consequently forms a part of the link guiding system. If the link 12 is intercepted, for example by an abutment ring 10' according to FIGS. 11 and 12, either in the opening direction or/and in the closing direction of the valve plate 7, say at a distance of between one third to one sixth of the stroke from the abutment surface, the ring portion 18 is resiliently bent out of the valve plate 7, and thus takes over the function of the link at the same time performing a damping action on the impact of the valve plate, since it is more rigid than the link 12. As in the previous embodiments, this also prevents overstressing of the link 12 of the valve plate.

I claim:

1. A plate valve assembly for a piston compressor comprising a spaced valve seat and catcher, a valve plate disposed between the valve seat and the catcher, the valve plate being so designed as to define a guiding system comprising at least one integral flexible link and another portion of the valve plate spaced axially from the catcher, at least one abutment element overlying the valve plate in the area of said link for limiting deflection of said link in the direction of the catcher, said abutment having an outer periphery lying in the area of deflection of said link.

2. A plate valve assembly according to claim 1, wherein the abutment comprises a ring means clamped between the valve seat and the catcher, the ring having said outer periphery lying in the area of deflection of the link.

3. A plate valve according to claim 1, further comprising a buffer plate disposed between the catcher and the valve plate, the abutment being formed as a projection integral with the buffer plate, the projection forming abutment surfaces for the link.

4. A plate valve assembly according to claim 1, wherein the abutment is formed as a helical surface with which the link comes into contact at least over a part of its length when the valve plate is lifted off the valve seat.

5. A plate valve assembly according to claim 4, wherein the abutment is formed as a portion of a spring plate, lying above the link of the valve plate and clamped above the valve plate between the valve seat and the catcher, said spring plate being permanently bent towards the valve plate.

6. A plate valve assembly according to claim 4, wherein the abutment is formed as an uninterrupted nave ring clamped between the valve seat and catcher to which nave ring is attached at least one divided ring conforming in shape to the shape of the or each link of the valve plate.

7. A plate valve assembly according to claim 1, including a further abutment for limiting deflection of the link in the direction of the valve seat, said further abutment lying between the valve plate and the valve seat.

8. A plate valve assembly according to claim 7, wherein said further abutment partially engages in a recess of the valve seat.

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