

VALVE PLATE FOR SEALING A VALVE OPENING OF A VACUUM VALVE

The invention relates to a valve plate which is intended for sealing a valve opening of a vacuum valve and is of at least essentially rectangular shape with relatively long longitudinal sides and relatively short narrow sides, wherein a sealing ring made of an elastomer material is fitted on a front side of the valve plate for the purpose of sealing the valve plate in relation to a sealing seat which encloses the valve opening and, on a rear side, the valve plate has at least one recess with an undercut boundary wall which forms a sloping surface which, for the purpose of fastening the valve plate on a carrier, can be braced with a sloping surface of the carrier.

A valve plate of this type can be found in US 8,511,642 B2. Two such valve plates are fitted on opposite sides of a carrier in order to form a closure unit of a vacuum valve. Clamping pieces are provided in order to brace the sloping surfaces of the valve plates with sloping surfaces of the carrier. These clamping pieces are screwed on a narrow side of the carrier, wherein a respective clamping piece likewise has a sloping surface which interacts with a further sloping surface of the respective valve plate. Interaction of the sloping surfaces of the valve plates with the sloping surfaces of the carrier and with the sloping surfaces of the clamping pieces causes the valve plates to be pulled against the carrier and connected rigidly thereto. Furthermore, a respective valve plate can be pushed on the carrier via a kind of dovetail guide, as a result of which the valve plate is held in captive fashion in relation to the carrier during installation and the valve plate is also positioned laterally (= position in relation to the direction of the longitudinal sides of the valve plate). Although the valve plates are held, and positioned, in a reliable manner, this design, *inter alia* in view of the number of separate clamping pieces, is associated with relatively high outlay in terms of production and installation.

The object of the invention is to provide an advantageous valve plate of the type mentioned in the introduction which can be installed on a carrier, and removed from the same, in a straightforward and reliable manner. This is achieved according to the invention by a valve plate having the features of Claim 1.

The invention makes provision for the rear side of the valve plate to have fitted on it at least one lug, which protrudes beyond the rear side of the valve plate and has a through-passage bore through which to guide a clamping screw, which can be screwed into a threaded bore of the carrier, for the purpose of bracing the at least one sloping surface of the valve plate with the at least one sloping surface of the carrier. The design here is such that in a side view of the valve plate, as seen in a viewing direction parallel to the longitudinal sides of the valve plate, the straight-line extension of the longitudinal center axis of the through-passage bore, which runs through the lug, runs past the sloping the surface at a distance from the rear side of the valve plate.

When the valve plate is placed, by way of its at least one sloping surface, on the at least one sloping surface of the carrier and a clamping screw, which is guided through the through-passage bore of the at least one lug, is screwed into a threaded bore of the carrier and clamped, this design gives rise to a tilting moment, as a result of which a portion of the rear side of the valve plate which, as seen in relation to the direction parallel to the narrow sides of the valve plate, is closer to the at least one lug than to the sloping surface of the valve plate is pushed against the carrier. This tilting moment, in conjunction with the sloping surfaces, therefore causes the valve plate to be pushed against the carrier in a play-free manner. This allows for very straightforward installation and removal without a large number of losable parts.

The at least one recess, which has a sloping surface, preferably extends from an edge of the valve plate which forms one of the longitudinal sides of the valve plate, wherein, on its edge located opposite this edge of the valve plate, the recess has the boundary wall which forms the sloping surface.

The valve plate advantageously has a first and a second recess, which, as seen in relation to the direction of the longitudinal sides of the valve plate, are spaced apart from one another.

The valve plate preferably has fitted on it first and second lugs, which, as seen in relation to the direction of the longitudinal sides of the valve plate, are spaced apart from one another, wherein it is preferably the case that the first recess and the first lug are arranged in the same first

region of the longitudinal extent of the valve plate, and the second recess and second lug are arranged in the same second region of the longitudinal extent of the valve plate.

The valve plate preferably has a slot which extends from the recess or one of the recesses and runs parallel to the narrow sides of the valve plate, to be precise in the direction of that longitudinal side of the valve plate which is located opposite that longitudinal side of the valve plate from which the recess extends. This slot serves for interacting with a centering protuberance, which is arranged on the carrier and, when the valve plate is placed on the carrier, moves into the slot. The positioning of the valve plate as seen in relation to the direction of its longitudinal extent is fixed as a result.

A closure unit for a vacuum valve according to the invention has a carrier and at least one valve plate according to the invention, which is fastened on the carrier, wherein the sloping surface of the at least one recess of the valve plate and the at least one sloping surface of the carrier are braced with one another by means of at least one clamping screw, which is screwed into a threaded bore of the carrier. This threaded bore is preferably made in a narrow side of the carrier, which is at right angles to a side surface of the carrier against which the rear side of the valve plate is pushed.

The at least one sloping surface of the carrier is preferably arranged on a strip which protrudes beyond that side surface of the carrier against which the rear side of the valve plate is pushed.

One possible embodiment of the invention makes provision for a respective valve plate to be arranged on opposite sides of the carrier and to be pushed against the carrier.

A vacuum valve of the invention has a closure unit which is fitted on a valve stem and has at least one valve plate according to the invention.

Further advantages and details of the invention will be explained hereinbelow with reference to the accompanying drawing, in which:

Figs 1 and 2 show a front view and a rear view of an exemplary embodiment of a valve plate according to the invention;

Fig. 3 shows a plan view;

Fig. 4 shows a side view;

Fig. 5 shows a cross section taken along line AA from Fig. 3;

Fig. 6 shows a front view (the rear view is identical) of a carrier for holding two valve plates according to the invention;

Figs 7 and 8 show a top view and a bottom view of the carrier;

Fig. 9 shows a side view of the carrier;

Fig. 10 shows a cross section taken along line BB from Fig. 6;

Figs 11 and 12 show a top view and a bottom view of a closure unit comprising the carrier and the valve plates, which are fitted on the carrier;

Fig. 13 shows a side view;

Fig. 14 shows a section taken along line CC from Fig. 11;

Fig. 15 shows a section taken along line DD from Fig. 11;

Fig. 16 shows a section taken along line EE from Fig. 11;

Fig. 17 shows an oblique view, with one of the valve plates removed from the carrier;

Fig. 18 shows an oblique view analogous to Fig. 17, but from a different viewing direction;

Fig. 19 shows a vacuum valve having a valve plate according to the invention (simplified); and

Fig. 20 shows a cross section through the vacuum valve (simplified).

The figures show an exemplary embodiment of a valve plate according to the invention, and also a closure unit having two such valve plates, and also a vacuum valve having such a closure unit.

The valve plate 1 has a sealing ring 3 made of an elastomer material, the sealing ring being fitted on a front side 2 of the valve plate and being located in a plane 13.

The front side 2 and the rear side 4, which is located opposite the front side, form the large sides of the valve plate 1. In a side view of the front side of the valve plate (cf. Fig. 1), the valve plate is of at least essentially rectangular shape with relatively long longitudinal sides 5 and relatively short narrow sides 6. An “essentially” rectangular shape comprises, in particular, the valve plate being rectangular with rounded corners.

The longitudinal extent of the valve plate 1, this longitudinal extent running parallel to the longitudinal sides 5, is significantly greater than the extent of the valve plate parallel to the narrow sides 6, preferably more than three times the extent, and particularly preferably more than five times the extent.

The thickness of the valve plate is preferably smaller than the extent parallel to the narrow sides, preferably less than half the extent.

On the rear side 4 of the valve plate, two recesses 7 are spaced apart from one another, as seen in relation to the longitudinal extent of the valve plate 1. In the exemplary embodiment, a respective one of the recess 7 extends from an edge of the valve plate 1 which forms one of the longitudinal sides 5 of the valve plate 1. On the side located opposite this edge which forms the longitudinal side 5, the recess 7 is bounded by an undercut boundary wall, i.e. that extent of the recess 7 which is measured parallel to the narrow side 6 of the valve plate 1 increases in the direction of the base of the recess. This boundary wall therefore forms a sloping surface 8.

The angle 9 which the sloping surface 8 encloses with the plane 13, and in which is located the sealing ring 3 (or its end abutment surface for butting against the valve seat), preferably ranges from 20° to 45°, for example is approximately 30°.

In a view of the rear side 4 of the valve plate 1 (Fig. 2), the recess edge 10 at which the sloping surface 8 terminates on the side remote from the base of the recess runs parallel to the longitudinal sides 5 of the valve plate 1. Between the edge 10 of the recess 7 and that edge of the valve plate which forms one of the longitudinal sides of the valve plate and from which the respective recess 7 extends, the recess is bounded by edges 11, 12, which run parallel to the

narrow side 6 of the valve plate. The boundary walls of the recess 7 which form these edges 11, 12 are preferably at right angles to the plane 13 in which the sealing ring 3 is located.

The rear side 4 of the valve plate 1 has fitted on it two lugs 14, which project from the rear side 4 of the valve plate 1. These lugs 14 each have a through-passage bore 15 through which to guide a clamping screw 16, which can be screwed into a threaded bore of the carrier, which will be explained hereinbelow. The lugs 14 are spaced apart from one another in the direction of the longitudinal extent of the valve plate 1. In the exemplary embodiment, the first recess 7 and the first lug 14 are located in the same first region of the longitudinal extent of the valve plate, and the second recess 7 and the second lug 14 are located in the same second region of the longitudinal extent of the valve plate.

In a side view of the valve plate, as seen in a viewing direction parallel to the longitudinal sides 5 of the valve plate – such a view is shown in Fig. 4 – or as seen in a vertical cross section through the valve plate – such a view is shown in Fig. 5 – the straight-line extension of the longitudinal center axis 17 of the through-passage bore 15 of this lug 14 runs past the sloping surface 8 at a distance a from the rear side 4 of the valve plate.

The longitudinal center axis 17 of the through-passage bore 15 is preferably located parallel to the plane 13, in particular parallel to the narrow sides 6 of the valve plate 1.

As seen in a side view parallel to the longitudinal sides 5 of the valve plate (cf. Fig. 4), the lugs 14 preferably project at right angles from the rear side 4 of the valve plate.

A carrier 20, which can have a respective valve plate 1 according to the invention secured on opposite sides, is illustrated in Figs 6 to 10. The carrier 20 can be connected to a valve stem 40 in a central region via a connecting screw, wherein the valve stem 40 can be inserted into an aperture 22 of the carrier. The connecting screw can be screwed into a threaded bore of the valve stem 40 through the through-passage bore 30 of the carrier.

The carrier extends, in opposite directions, from the central region, in each case to a respective head portion 23. Connection to the valve plates 1 takes place in the head portions 23. A respective one of the head portions 23 has opposite side surfaces for butting against a respective valve plate 1. These side surfaces each have parallel surface-area portions 24a, 24b, which are located in a common plane and between which a recessed portion 25 is located. When the respective valve plate is in the installed state, the surface-area portions 24a, 24b are located parallel to the plane 13.

A respective protruding strip 26 projects from the respective head portion 23 on opposite sides. This strip has a sloping surface 27 for interacting with a respective sloping surface 8 of the respective valve plate 1. The surface-area portions 24a adjoin the sloping surfaces 27. The angle between the sloping surface 27 and the adjacent surface-area portion 24a corresponds to the angle 9 which the sloping surface 8 encloses with the plane 13.

An upper side of the carrier 20 is provided with threaded bores 28, into which to screw the clamping screw 16 (“top/upper” refers to that position of the carrier in which the valve plates are installed on the carrier). In the exemplary embodiment, this upper side adjoins the surface-area portion 24b and is at right angles to the surface-area portions 24a, 24b.

For the purpose of fastening a respective valve plate 1 on the carrier 20, the valve plate 1 is placed, by way of its sloping surfaces 8, on the sloping surfaces 27 of the strips 26 of the head portions 23 of the carrier and the clamping screws 16 are screwed into the threaded bores 28. Since the longitudinal center axes 17 of the through-passage bores 15 run past the sloping surfaces 8 of the valve plate 1 at a distance a from the valve plate 1, the abutment of the heads 16b of the clamping screw 16 against the lugs 14 gives rise to a tilting moment, as a result of which the rear side 4 of the valve plate is pushed against the surface-area portion 24b of the carrier 20. At the same time, the interacting sloping surfaces 8, 27 pull the rear side 4 of the valve plate onto the surface-area portion 24a. In the state in which the valve plate 1 is connected to the carrier 20, there is preferably full-surface-area abutment of the valve plate against the surface-area portions 24a, 24b, cf., in particular, Fig. 15.

A portion 16c of the respective clamping screw 16, this portion being located in the region of the through-passage bore 15, has such a large amount of play in relation to the through-passage bore 15 that, in the state in which the valve plate and the carrier are connected, this portion of the clamping screw 16 is spaced apart from the wall of the through-passage bore.

Even in the state in which a respective valve plate 1 has been removed from the carrier 20, the clamping screws 16 are held in captive fashion on the lugs. For this purpose, the clamping screws 16, in an end portion 16a, have a thread and, in the region between the end portion 16a and the head 16b, have a portion 16c with no thread, this portion having a smaller external diameter than the thread in the end portion 16a. The through-passage bores 15 of the lugs 14 have an internal thread 15a, through which the end portion 16a of the clamping screws 16 is screwed, whereupon the portion 16c of the clamping screw 16 ends up located in the region of the internal thread 15a, and the clamping screw 16a can be displaced, via the portion 16c, in relation to the region of the internal thread 15a.

In an analogous manner, the connecting screw 21 can be held in captive fashion on the carrier, as can be seen from Fig. 14.

The threaded bores 28, at the start, have a portion 28a with no thread; it is only in a lower-down portion 28b that they have an internal thread (cf. Fig. 15). The portion 28a has a diameter which is greater than the internal diameter of the thread of the portion 28b, and therefore the threaded end portion 16a of the clamping screw 16 can be pushed in through the portion 28a until it reaches the threaded portion 28b of the threaded bore 28. This makes it possible, during installation, for the clamping screws 16 to be introduced, by way of their end portions 16a, into the initial portions 28a of the threaded bores before being screwed into the threads in the portions 28b of the threaded bores. It is therefore the case that, even prior to the clamping screws being screwed into the threads of the threaded bores 28, the valve plate 1 is held on a provisional basis on the carrier 20, and this makes installation easier.

As can be seen from Fig. 5 and Fig. 15, the internal threads 15a can only extend over part of the length of the through-passage bores 15, and therefore the internal threads 15a are adjoined

by a portion 15b with no internal thread and with an enlarged diameter. Together with the portion 28a of the threaded bores 28, this portion 15b can accommodate the end portion 16a of the respective clamping screw 16 prior to the clamping screw being screwed into the portion which has the thread 28b.

In order for the valve plate 1 to be positioned laterally, that is to say in relation to the direction of its longitudinal sides 5, the exemplary embodiment provides a slot 18 which extends from the edge 10 of one of the recesses 7 and runs in the direction of the opposite longitudinal side 5 of the valve plate 1. A centering protuberance 29 of the carrier 20 interacts with this slot 18, the centering protuberance being arranged on one of the head portions 23, in the exemplary embodiment in the region of the recess portion 25. When the valve plate 1 is placed on the carrier 20, the centering protuberance 29 moves into the slot 18 and fixes the lateral positioning of the valve plate 1.

The lugs 14 are at different distances from the narrow sides 6 of the valve plate, cf., for example, Figs 2 and 3. The threaded bores 28 are arranged correspondingly. The lugs of the valve plates 1 fitted on opposite sides of the carrier are therefore offset with respect to one another in each case as seen in relation to the longitudinal direction of the valve plate 1. This means that the width of the carrier 20 can be kept small.

It is possible here for the two valve plates 1, as is preferred, to be identical. The valve plates secured on the opposite sides of the carrier 20 have been pivoted in relation to one another through 180° about a center axis located parallel to the narrow sides 6 of the valve plate.

In the region between the two end-side head portions 23, the carrier 20, in the exemplary embodiment, is spaced apart from the rear side of the valve plate 1. This allows a certain amount of torsion (= twisting) of the carrier 20 about its longitudinal axis. This can therefore take place between the respective head portion 23 and the central region of attachment to the valve stem. As a result, the position of the valve plate 1 can be adapted, in respect of this axis, in relation to the valve seat of the vacuum valve, which means that more uniform pressing of the sealing ring 3 can be achieved when the vacuum valve is in the closed state.

However, it is also conceivable, and possible, to have exemplary embodiments which dispense with such a possibility for torsion of the carrier 20. It would also be possible here for such a strip with a sloping surface to be present in a central region of the longitudinal extent of the carrier and for the valve plate to have a corresponding recess with a sloping surface. It would also be possible, for example, for a single strip with a sloping surface to extend over the entire length of the carrier 20, or over much of the length of the carrier, and for the rear side of the valve plate to have a single recess 7 with a sloping surface 8 of a corresponding extent.

In order for the closure unit to be lifted out of the vacuum valve for a service, the carrier has, on the upper side 31, threaded service bores 32, into which screws of a hoisting device can be screwed.

It is also possible for the valve plates 1 to have such threaded service bores 19 on their upper sides.

A vacuum valve having such a closure unit is illustrated in a simplified state in Figs 19 and 20. The closure unit has been fitted on a valve stem 40, which can be adjusted by means of a valve drive 46. On the one hand, the valve stem 40 can be displaced parallel to its longitudinal extent so that, when the vacuum valve is in the open state, the valve plates are moved out of the region of a through-passage, through the vacuum valve, which extends between first and second valve openings 41, 42 of the valve housing 43.

In order for the valve to be closed, the valve plates 1 are moved, by adjustment of the valve stem 13 in its longitudinal direction, into a position in which they are located between the valve openings 41, 42, this position being illustrated in Fig. 20. In the exemplary embodiment, use is made, for this purpose, of a piston/cylinder unit 46a. The sealing rings 3 of the valve plates 1 here, however, are still raised up from the sealing surfaces which enclose the respective valve opening 41, 42 on the inner side of the valve housing 43. These sealing surfaces form valve seats 44, 45 of the vacuum valve.

In the exemplary embodiment, the valve stem 40 can be displaced, by the valve drive 46, at right angles to its longitudinal extent in order, starting from this position of the valve plates 1, to press one of the valve plates 1 onto one of these sealing surfaces, so as to seal the corresponding valve opening 41, 42. An illustration is given of piston/cylinder units 46b, 46c for this purpose. For the sake of simplicity, there is no illustration given of a corresponding means for guiding the piston/cylinder unit 46a in relation to the valve housing. Instead of the valve stem being displaced at right angles to its longitudinal extent, the design could also be such that the valve stem 40 is pivoted, by the valve drive 46, about a pivot axis which is located at right angles to its longitudinal extent.

A vacuum valve having a valve plate according to the invention can be designed in different ways. A valve plate according to the invention can also be used for vacuum valves which have just a single valve plate, fastened on a carrier, for the purpose of sealing a valve opening.

Key
to Reference Signs:

1	Valve plate
2	Front side
3	Sealing ring
4	Rear side
5	Longitudinal side
6	Narrow side
7	Recess
8	Sloping surface
9	Angle
10	Edge
11	Edge
12	Edge
13	Plane
14	Lug
15	Through-passage bore
15a	Internal thread
15b	Portion
16	Clamping screw
16a	End portion
16b	Head
16c	Portion
17	Longitudinal center axis
18	Slot
19	Threaded service bore
20	Carrier
21	Connecting screw
22	Aperture
23	Head portion

24a	Surface-area portion
24b	Surface-area portion
25	Recessed portion
26	Strip
27	Sloping surface
28	Threaded bore
28a	Portion
28b	Portion
29	Centering protuberance
30	Through-passage bore
31	Upper side
32	Threaded service bore
40	Valve stem
41	First valve opening
42	Second valve opening
43	Valve housing
44	Valve seat
45	Valve seat
46	Valve drive

CLAIMS

1. Valve plate which is intended for sealing a valve opening (31, 32) of a vacuum valve and is of at least essentially rectangular shape with relatively long longitudinal sides (5) and relatively short narrow sides (6), wherein a sealing ring (3) made of an elastomer material is fitted on a front side (2) of the valve plate for the purpose of sealing the valve plate in relation to a valve seat (44, 45) which encloses the valve opening (31, 32) and, on a rear side (4), the valve plate has at least one recess (7) with an undercut boundary wall which forms a sloping surface (8) which, for the purpose of fastening the valve plate on a carrier (20), can be braced with a sloping surface (27) of the carrier (20), characterized in that the valve plate has fitted on it at least one lug (14), which protrudes beyond the rear side (4) of the valve plate and has a through-passage bore (15) through which to guide a clamping screw (16), which can be screwed into a threaded bore (28) of the carrier (20), for the purpose of bracing the at least one sloping surface (8) of the valve plate with the at least one sloping surface (27) of the carrier (20), wherein in a side view of the valve plate, as seen in a viewing direction parallel to the longitudinal sides (5) of the valve plate, the straight-line extension of the longitudinal center axis (17) of the through-passage bore (15), which runs through the lug (14), runs past the sloping surface (8) at a distance (a) from the rear side (4) of the valve plate.
2. Valve plate according to Claim 1, characterized in that the at least one recess (7) extends from an edge of the valve plate which forms one of the longitudinal sides (5) of the valve plate and, on the side located opposite this edge of the valve plate, has the boundary wall which forms the sloping surface (8).
3. Valve plate according to Claim 2, characterized in that, as seen in a view of the rear side of the valve plate, between that edge of the valve plate from which the recess (7) extends and the boundary wall which forms the sloping surface (8), the at least one

recess (7) is bounded on opposite sides by edges (11, 12) which run at right angles to the longitudinal sides (5) of the valve plate.

4. Valve plate according to one of Claims 1 to 3, characterized in that the at least one lug (14) projects at right angles from the rear side (4) of the valve plate.
5. Valve plate according to one of Claims 1 to 4, characterized in that the longitudinal center axis (17) of the through-passage bore (15) through the lug (14) is located parallel to the plane (13) in which the sealing ring (3) of the valve plate (1) is located.
6. Valve plate according to one of Claims 1 to 5, characterized in that the valve plate has a first and a second recess (7), which are spaced apart from one another in the direction of the longitudinal extent of the valve plate.
7. Valve plate according to one of Claims 1 to 6, characterized in that the rear side (4) of the valve plate (1) has fitted on it a first and a second lug (14), which are spaced apart from one another in the direction of the longitudinal extent of the valve plate (1).
8. Valve plate according to Claims 6 and 7, characterized in that the first recess (7) and first lug (14) are arranged in the same first region of the longitudinal extent of the valve plate, and the second recess (7) and second lug (14) are arranged in the same second region of the longitudinal extent of the valve plate.
9. Valve plate according to one of Claims 1 to 8, characterized by the presence of a slot (18) which extends from the recess (7) and is intended for interacting with a centering protuberance (29), which is arranged on the carrier (20) and, when the valve plate is placed on the carrier (20), can be moved into the slot (18), wherein the slot (18) extends from the recess (7), parallel to the narrow sides (6) of the valve plate, in the direction of the opposite longitudinal side (5) of the valve plate (1).

10. Closure unit for a vacuum valve, having a carrier (20) and at least one valve plate (1) according to one of Claims 1 to 9, which is fastened on the carrier (20), wherein the sloping surface (8) of the at least one recess (7) of the valve plate (1) and the at least one sloping surface (27) of the carrier (20) are braced with one another by means of at least one clamping screw (16), which extends through the through-passage bore (15) of the lug (14) and is screwed into a threaded bore (28) of the carrier (20).
11. Closure unit according to Claim 10, characterized in that the valve plate (1) butts, by way of its rear side (4), against a side surface of the carrier (20) and the threaded bore (28) is made in an upper side (31) of the carrier (20), the upper side being at right angles to the side surface.
12. Closure unit according to Claim 11, characterized in that the at least one sloping surface (27) of the carrier (20) is arranged on a strip (26) which protrudes beyond the side surface against which the valve plate (1) butts by way of its rear side (4).
13. Closure unit according to Claim 11 or 12, characterized in that that side surface of the carrier (20) against which the valve plate (1) butts by way of its rear side (4) has a first surface-area portion (24a), which adjoins the sloping surface (27), and a second surface-area portion (24b), which adjoins the narrow side which has the threaded bore (28), wherein a recessed portion (25) is located between the first and second surface-area portions (24a, 24b).
14. Closure unit according to one of Claims 10 to 13, characterized in that a respective valve plate (1) is fitted on opposite sides of the carrier (20), the valve plate being identical.