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(54) SLIDE GATE AND VALVE PLATE FOR SLIDE GATE

SCHIEBERVERSCHLUSS UND VENTILPLATTE FÜR EINEN SCHIEBERVERSCHLUSS

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Description

[Technical Field]

[0001] The present invention relates to a slide gate positioned between a ladle and a tundish to control a flow rate of molten steel, and more particularly, to a valve plate for a slide gate, which is capable of minimizing generation of stress and cracks.

[Background Art]

[0002] In continuous casting, molten steel refined in a ladle is transported to a tundish and in this case, a slide gate serving as a valve is mounted between the ladle and tundish in order to control a flow rate of the molten steel. The slide gate is constituted by an upper valve plate and a lower valve plate each having an orifice.

[0003] The slide gate is in an opened state when two orifices are at the same position and in a closed state when the lower valve plate adopts a closed state, i.e. when the lower valve plate slides and the orifice of the upper valve plate is clogged by the lower valve plate. In addition, an opening degree of the orifice of the upper valve plate is controlled according to a movement degree of the lower valve plate to control the flow rate of the molten steel.

[0004] A peripheral temperature of the orifice of the valve plate reaches 1600°C, while an outer temperature of the valve plate is approximately 400°C. Accordingly, a temperature gradient occurs toward a periphery of the valve plate of the orifice and a crack may be generated in the valve plate due to a difference in thermal expansion.

[0005] A method is used, which clamps an exterior of the valve plate by using a tool such as a stopper, or the like in order to suppress the generation of the crack. However, stress generated according to a shape of the valve plate varies when the same clamping force is applied, and as a result, shape enhancement of the valve plate is required for minimizing the generation of the stress.

[DISCLOSURE]

[Technical Problem]

[0006] The present invention has been made in an effort to provide a slide gate and a valve plate for the slide gate, which are capable of minimizing generation of stress and cracks generated on the valve plate by optimizing a shape of the valve plate.

[Technical Solution]

[0007] An exemplary embodiment of the present invention provides a valve plate for a slide gate, wherein: the valve plate has a heptagonal shape including a first long side and a second long side extending parallel to each other on opposite sides of the valve plate, a first short side and a second short side slantingly contacting one end of the first long side and one end of the second long side, respectively, a third short side connecting the first short side and the second short side, and a fourth short side and a fifth short side slantingly contacting the other ends of the first long side and the second long side, respectively. The valve plate for the slide gate is symmetrical with reference to a central line parallel to the first long side and the second long side while maintaining the same distance from the first long side and the second long side and an orifice may be formed on the central line.

[0008] A respective virtual right-angled triangle having each of the fourth short side and the fifth short side as an oblique side is configured on the valve plate, and the right-angled triangle may have a bottom side having a length k1 and a height having a length of k2. The fourth short side and the fifth short side is formed to satisfy the following condition:

$$1.5 \leq k1/k2 \leq 2.75$$

[0009] The first long side and the second long side may have the same length, and the lengths of the first long side and the second long side may be greater than the length of each of the first to fifth short sides. The first short side and the second short side may have the same length, and the length of the third short side may be less than the length of each of the first and second short sides. Corners contacting the fourth short side and the fifth short side may be rounded.

[0010] The orifice may be positioned between the first long side and the second long side, and each of the first long side and the second long side may be divided into a first part having a length of $\delta 1$ and a second part having a length of $\delta 2$ by a virtual vertical line which is orthogonal to the central line and meets a center of a shape of the orifice. The first

long side and the second long side may be formed to satisfy the following condition:

$$2 \leq \delta 1/\delta 2 \leq 3.5$$

[0011] Another exemplary embodiment of the present invention provides a slide gate including a valve plate having the aforementioned configuration as an upper valve plate and a lower valve plate, wherein the lower valve plate moves by a stroke length of S along a length direction thereof to open and close an orifice of the upper valve plate.

[0012] A total length D1 of the valve plate may be in a range of twice to three times greater than the stroke length S and a total width D2 of the valve plate may be in a range of once to 1.5 times greater than the stroke length S.

[Advantageous Effects]

[0013] According to exemplary embodiments of the present invention, a valve plate for a slide gate has a heptagonal shape and slopes and lengths of a first short side, a second short side, a fourth short side, and a fifth short side to which clamping force is applied are optimized to reduce maximum stress generated on the valve plate. As a result, crack generation in the valve plate is suppressed to improve a use life-span of the valve plate.

[Description of the Drawings]

[0014]

FIG. 1 is a perspective view illustrating a valve plate for a slide gate according to an exemplary embodiment of the present invention.

FIGS. 2 and 3 are cut-away perspective views of the slide gate including the valve plate illustrated in FIG. 1.

FIG. 4 is a graph showing a numerical analysis result of a maximum stress size depending on a change of $\delta 1/\delta 2$.

FIG. 5 is a graph showing a numerical analysis result of a maximum stress size depending on a change of k1/k2.

[Mode for Invention]

[0015] The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary non-limiting embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention.

[0016] FIG. 1 is a perspective view illustrating a valve plate for a slide gate according to an exemplary embodiment of the present invention.

[0017] Referring to FIG. 1, the valve plate 100 according to the exemplary embodiment as a heptagonal plate having a predetermined thickness includes a circular orifice 19 for discharging molten steel.

[0018] In detail, the valve plate 100 includes a first long side 11 and a second long side 12 extending parallel to each other on opposite sides of the valve plate, a first short side 21 and a second short side 22 slantingly contacting one end of the first long side 11 and one end of the second long side 12, respectively, a third short side 23 orthogonal to the first long side 11 and connecting the first short side 21 and the second short side 22, and a fourth short side 24 and a fifth short side 25 slantingly contacting the other ends of the first long side 11 and the second long side 12, respectively.

[0019] The first long side 11 and the second long side 12 have the same length and the lengths of the first long side 11 and the second long side 12 are greater than respective lengths of the first to fifth short sides 21 to 25.

[0020] Based on FIG. 1, the first short side 21 and the second short side 22 slantingly contact left ends of the first long side 11 and the second long side 12, respectively and the third short side 23 connects the first short side 21 and the second short side 22. The first short side 21 and the second short side 22 have the same length and the length of the third short side 23 may be less than the respective lengths of the first short side 21 and the second short side 22.

[0021] Based on FIG. 1, the fourth short side 24 and the fifth short side 25 slantingly contact right ends of the first long side 11 and the second long side 12, respectively and the fourth short side 24 and the fifth short side 25 have the same length. Corners contacting the fourth short side 24 and the fifth short side 25 are not formed to be pointed, but may be rounded at a predetermined curvature.

[0022] The valve plate 100 has a heptagonal shape in which a diamond shape contacts one side of a central square and a triangular shape contacts the other side of the central square part. In this case, all corners where the first long side 11 and the second long side 12 and the first to fifth short sides 21 to 25 contact each other are rounded to suppress stress concentration on the corners.

[0023] A virtual central line C-C which is parallel to the first long side 11 and the second long side 12 while maintaining the same distance from the first long side 11 and the second long side 12 may be configured on the valve plate 100. The valve plate 100 is symmetric based on the central line C-C (vertically symmetric based on FIG. 1) and the orifice 19 is positioned on the central line C-C. In particular, the center of a shape of the orifice 19 is positioned on the central line C-C. The orifice 19 does not deviate between the first long side 11 and the second long side 12.

[0024] A virtual vertical line D-D which meets the center of the shape of the orifice 19 and is orthogonal to the central line C-C may be configured on the valve plate 100. The first long side 11 and the second long side 12 are divided into first parts 11a and 12a and second parts 11b and 12b based on the vertical line D-D and the first parts 11a and 12a and the second parts 11b and 12b have lengths of $\delta 1$ and $\delta 2$, respectively. The first parts 11a and 12a contact the first short side 21 and the second short side 22 and the second parts 11b and 12b contact the fourth short side 24 and the fifth short side 25.

[0025] The length $\delta 1$ of the first parts 11a and 12a is greater than the length $\delta 2$ of the second parts 11b and 12b. That is, the orifice 19 is positioned closer to the fourth short side 24 and the fifth short side 25 than the first short side 21 and the second short side 22. The first short side 21 has a slope of an acute angle with respect to the first long side 11 and the second short side 22 has the same slope of the acute angle with respect to the second long side 12. In FIG. 1, the slopes of the first short side 21 and the second short side 22 are represented as θ.

[0026] Further, a virtual right-angled triangle may be configured on the valve plate 100, in which each of the fourth short side 24 and the fifth short side 25 has an oblique side. A bottom side k1 of the right-angled triangle is parallel to the central line C-C and a part of the bottom side overlaps with the central line C-C. A height k2 of the right-angled triangle is parallel to the vertical line D-D. The slopes of the fourth short side 24 and the fifth short side 25 are determined by k1 and k2 values.

[0027] The first short side 21, the second short side 22, the fourth short side 24, and the fifth short side 25 at the center of the valve plate 100 are parts that contacts a stopper of a clamping device (not illustrated) to receive clamping force from the clamping device. In addition, a surface pressure depending on a weight of the molten steel is applied onto an entire surface of the valve plate 100.

[0028] FIGS. 2 and 3 are cut-away perspective views of the slide gate including the valve plate illustrated in FIG. 1. FIG. 2 illustrates an opened state and FIG. 3 illustrates a closed state.

[0029] Referring to FIGS. 1 to 3, two valve plates 110 and 120 of the exemplary embodiment are stacked on each other to constitute a slide gate 200. That is, the slide gate 200 is constituted by an upper valve plate 110 and a lower valve plate 120 and two valve plates 110 and 120 are configured similarly to the valve plate 100 illustrated in FIG. 1.

[0030] The upper valve plate 110 is oriented oppositely to the lower valve plate 120 at left and right sides thereof. That is, when the fourth short side 24 and the fifth short side 25 of the lower valve plate 120 are positioned toward the right side, the fourth short side 24 and the fifth short side 25 of the upper valve plate 110 are positioned toward the left side.

[0031] The orifice 19 of the upper valve plate 110 is connected with an upper nozzle (not illustrated) to maintain a state in which the molten steel continuously flows. When the orifice 19 of the lower valve plate 120 overlaps with the orifice 19 of the upper valve plate 110, the slide gate 200 is in an opened state and when the lower valve plate 120 slides to clog the orifice 19 of the upper valve plate 110, the slide gate 200 is switched to a closed state.

[0032] Referring back to FIG. 1, the valve plate 100 of the exemplary embodiment has the heptagonal shape to minimize stress generation as compared with a valve plate having a different shape in the related art. For example, a valve plate without the first long side 11 and the second long side 12 has a pentagonal shape and the valve plate 100 of the exemplary embodiment may have a lower maximum stress value than the pentagonal valve plate.

[0033] Table 1 given below shows a numerical analysis result having a maximum stress size depending on a ratio of $\delta 1$ and $\delta 2$ and a change of slopes θ of the first short side 21 and the second short side 22 under a condition in which the same clamp pressure is applied. Maximum stress means maximum tensile stress applied to the valve plate 100 and as the size of the maximum stress is smaller, less cracking occurs.

(Table 1)

Sample No.	1	2	3	4	5
$\delta 1$:$\delta 2$	0:0	0:1	1:1	1:3.1	1.5:1
θ(°)	8	11	13	15	16
Maximum stress (MPa)	438.8	421.5	415	398.3	382.5
Sample No.	6	7	8	9	
$\delta 1$:$\delta 2$	2:1	2.5:1	3:1	3.3:1	
θ(°)	20	25	30	35	

(continued)

Sample No.	6	7	8	9	
Maximum stress (MPa)	360.8	358.6	358.6	357.3	

[0034] In Table 1, sample 1 is the pentagonal valve plate and samples 2 to 9 are the heptagonal valve plates. Under a condition in which the same clamping pressure is applied to samples 1 to 9, it can be verified that maximum stress of samples 2 to 9 is reduced as compared with sample 1. In particular, as the lengths of the first long side 11 and the second long side 12 are greater than the length of the entire valve plate 100, it can be seen that the maximum stress is significantly reduced.

[0035] As the lengths of the first long side and the second long side are greater than the length of the valve plate, a horizontal component of the clamping pressure increases under the condition in which the same clamping pressure is applied, and as a result, stress generated due to thermal expansion is more suppressed.

[0036] Further, in the valve plate 100 of the exemplary embodiment, a length ratio ($\delta 1$:$\delta 2$) of the first part 11a and the second part 11b that divide the first long side 11 and a ratio (k1:k2) of the bottom side and the height of the right-angled triangle having the fourth short side 24 as the oblique side are associated with the stress of the valve plate 100.

[0037] FIG. 4 is a graph showing a numerical analysis result of a maximum stress size depending on a change of $\delta 1/\delta 2$ with respect to samples 10 to 13. Table 2 given below shows shape characteristics of samples 10 to 13.

(Table 2)

	Slope (°) of first short side	k1:k2	Diameter (mm) of orifice	Length (mm) of third short side
Sample 10	22.04	1.55:1	35	90
Sample 11	12.93	1.54:1	60	125
Sample 12	19.54	1.92:1	55	100
Sample 13	19.29	2.29:1	85	135

[0038] As shown in FIG. 4, as the $\delta 1/\delta 2$ value increases with respect to all of samples 10 to 13, it can be seen that the maximum stress generated on the valve plate 100 decreases. An effect may be seen, in which the maximum stress of the valve plate 100 decreases when the $\delta 1/\delta 2$ value is 2 or more and in particular, the maximum stress does not show a large variation when the $\delta 1/\delta 2$ value is 2 or more in samples 11 to 13.

[0039] In the valve plate 100, a lower limit of the $\delta 1/\delta 2$ value is 2 and the $\delta 1/\delta 2$ value may increase within an implementable range, but as the $\delta 1/\delta 2$ value increases, more materials are used, and as a result, $\delta 1/\delta 2$ may be set to satisfy a range of 2 to 3.5.

[0040] FIG. 5 is a graph showing a numerical analysis result of a maximum stress size depending on a change of k1/k2 with respect to samples 14 to 17. Table 3 given below shows shape characteristics of samples 14 to 17.

(Table 3)

	$\delta 1$:$\delta 2$	Slope (°) of first short side	Diameter (mm) of orifice	Length (mm) of third short side
Sample 14	3:1	22.04	35	90
Sample 15	1.17:1	12.93	60	125
Sample 16	2.08:1	19.54	55	100
Sample 17	2.11:1	19.29	85	135

[0041] As shown in FIG. 5, as the k1/k2 value decreases with respect to all of samples 14 to 17, it can be seen that the maximum stress generated on the valve plate 100 decreases. An effect may be seen, in which when the k1/k2 value is 2.75 or less, the maximum stress of the valve plate 100 decreases; and it is impossible to manufacture a sample having k1/k2 of 1.5 or less. Accordingly, k1/k2 may be set to satisfy a range of 1.5 to 2.75.

[0042] Meanwhile, in the valve plate 100 of the exemplary embodiment, a total length and a total width and the length $\delta 1$ of the first parts 11a and 21a and the length of the third short side 23 are associated with a stroke length which is a movement distance of the lower valve plate 120 when the slide gate 200 is actuated. In FIG. 1, the total length of the valve plate 100 is represented as D1 and the total width is represented as D2. In addition, in FIG. 3, the stroke length of the lower valve plate 120 is represented as S.

[0043] The total length D1 of the valve plate 100 may be set to satisfy a range of twice or three times greater than the stroke length S. When the total length D1 of the valve plate 100 is two times less than the stroke length S, since the length of the valve plate 100 is not sufficient according to an actuation direction of the valve plate 100, the lower valve plate 120 may not clog the orifice 19 of the upper valve plate 110 in the closed state, and as a result, there is a possibility that the molten steel will leak. Meanwhile, when the total length D1 of the valve plate 100 is three times greater than the stroke length S, a manufacturing cost of the valve plate 100 may increase due to excessive use of materials.

[0044] The total width D2 of the valve plate 100 may be set to satisfy a range of one to 1.5 times greater than the stroke length S. When the total width D2 of the valve plate 100 is 1.0 times less than the stroke length S, since the first and second long sides 11 and 12 and the orifice 19 are positioned excessively close to each other, there is a possibility that the crack will be generated in a vertical direction from the orifice 19. Meanwhile, when the total width D2 of the valve plate 100 is 1.5 times greater than the stroke length S, there is no change in performance of the valve plate 100, but the used materials may be wasted.

[0045] The length $\delta 1$ of the first parts 11a and 12a may be set to satisfy a range of 0.2 to 0.5 times smaller than the stroke length S. In addition, the length of the third short side 23 may be set to satisfy a range of 0.5 times or 1.0 times as large as the stroke length S.

[0046] As described above, the valve plate 100 of the exemplary embodiment has the heptagonal shape and slopes and lengths of the first short side 21, the second short side 22, the fourth short side 24, and the fifth short side 25 to which the clamping force is applied are optimized to reduce the maximum stress generated on the valve plate 100. As a result, the generation of cracking of the valve plate 100 is suppressed to improve a use life-span of the valve plate 100.

[0047] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

Claims

1. A valve plate for a slide gate, wherein:

the valve plate has a heptagonal shape including a first long side and a second long side extending parallel to each other on opposite sides of the valve plate, a first short side and a second short side slantingly contacting one end of the first long side and one end of the second long side, respectively, a third short side connecting the first short side and the second short side, and a fourth short side and a fifth short side slantingly contacting the other ends of the first long side and the second long side, respectively, and
the valve plate is symmetrical with reference to a central line parallel to the first long side and the second long side while maintaining the same distance from the first long side and the second long side and an orifice is formed on the central line,
wherein a respective virtual right-angled triangle having each of the fourth short side and the fifth short side as an oblique side is configured on the valve plate, and
the right-angled triangle has a bottom side having a length k1 and a height having a length of k2; and
wherein the fourth short side and the fifth short side are formed to satisfy the following condition:

$$1.5 \leq k1/k2 \leq 2.75.$$

2. The valve plate of claim 1, wherein:

the first long side and the second long side have the same length, and
the lengths of the first long side and the second long side are greater than the length of each of the first to fifth short sides.

3. The valve plate of claim 2, wherein:

the first short side and the second short side have the same length, and
the length of the third short side is less than the length of each of the first and second short sides.

4. The valve plate of claim 3, wherein:
corners contacting the fourth short side and the fifth short side are rounded.

5. The valve plate of claim 1, wherein:

the orifice is positioned between the first long side and the second long side, and
each of the first long side and the second long side is divded into a first part having a length of $\delta 1$ and a second part having a length of $\delta 2$ by a virtual vertical line which is orthogonal to the central line and meets a center of a shape of the orifice.

6. The valve plate of claim 5, wherein:
the first long side and the second long side are formed to satisfy the following condition:

$$2 \leq \delta 1/\delta 2 \leq 3.5$$

7. A slide gate including a valve plate of any one of claim 1 to claim 6 as an upper valve plate and a lower valve plate, wherein:
the lower valve plate moves by a stroke length of S along a length direction thereof to open and close an orifice of the upper valve plate.

8. The slide gate of claim 7, wherein:
a total length D1 of the valve plate belongs to a range of twice to three times greater than the stroke length S.

9. The slide gate of claim 8, wherein:
a total width D2 of the valve plate belongs to a range of once to 1.5 times greater than the stroke length S.

Patentansprüche

1. Ventilplatte für einen Schieberverschluss, wobei:

die Ventilplatte eine siebeneckige Form aufweist, die eine erste lange Seite und eine zweite lange Seite enthält, die sich parallel zueinander auf gegenüberliegenden Seiten der Ventilplatte erstrecken, wobei eine erste kurze Seite und eine zweite kurze Seite jeweils ein Ende der ersten langen Seite und ein Ende der zweiten langen Seite berühren, wobei eine dritte kurze Seite die die erste kurze Seite und die zweite kurze Seite verbindet, und wobei eine vierte kurze Seite und eine fünfte kurze Seite jeweils die anderen Enden der ersten langen Seite und der zweiten langen Seite schräg berühren, und wobei die Ventilplatte in Bezug auf eine Mittellinie parallel zur ersten langen Seite und zur zweiten langen Seite symmetrisch ist, während der gleiche Abstand von der ersten langen Seite und der zweiten langen Seite beibehalten wird und eine Öffnung an der Mittellinie ausgebildet ist, wobei ein entsprechendes virtuelles rechtwinkliges Dreieck, das jeweils die vierte kurze Seite und die fünfte kurze Seite als geneigte Seiten aufweist, auf der Ventilplatte angeordnet ist und das rechtwinklige Dreieck eine Bodenseite aufweist, die eine Länge k1 und eine Höhe mit einer Länge k2 aufweist; und
wobei die vierte kurze Seite und die fünfte kurze Seite ausgebildet sind, um die folgende Bedingung zu erfüllen:

$$1{,}5 \leq k1 / k2 \leq 2{,}75.$$

2. Ventilplatte nach Anspruch 1, wobei:
die erste lange Seite und die zweite lange Seite die gleiche Länge aufweisen und die Längen der ersten langen Seite und der zweiten langen Seite größer als sind die Länge jeder der ersten bis zur fünften kurzen Seiten.

3. Ventilplatte nach Anspruch 2, wobei:
die erste kurze Seite und die zweite kurze Seite die gleiche Länge aufweisen und die Länge der dritten kurzen Seite geringer ist als die Länge der ersten und der zweiten kurzen Seite.

4. Ventilplatte nach Anspruch 3, wobei:
die Ecken, die die vierte kurze Seite und die fünfte kurze Seite berühren, abgerundet sind.

5. Ventilplatte nach Anspruch 1, wobei:

die Öffnung zwischen der ersten langen Seite und der zweiten langen Seite angeordnet ist, und jede der ersten langen Seite und der zweiten langen Seite durch eine virtuelle vertikale Linie, die orthogonal zur Mittellinie ist und auf einen Mittelpunkt einer Form der Öffnung trifft, in einen ersten Teil, der eine Länge von $\delta 1$ aufweist, und einen zweiten Teil, der eine Länge von $\delta 2$ aufweist, unterteilt ist.

6. Ventilplatte nach Anspruch 5, wobei:
die erste lange Seite und die zweite lange Seite ausgebildet sind, um die folgende Bedingung zu erfüllen:

$$2 \leq \delta 1 / \delta 2 \leq 3{,}5.$$

7. Schieberverschluss, enthaltend eine Ventilplatte nach einem der Ansprüche 1 bis 6 als obere Ventilplatte und untere Ventilplatte, wobei:
die untere Ventilplatte sich um eine Hublänge S entlang ihrer Längsrichtung bewegt, um eine Öffnung der oberen Ventilplatte zu öffnen und zu schließen.

8. Schieberverschluss nach Anspruch 7, wobei:
eine Gesamtlänge D1 der Ventilplatte in einem Bereich liegt, der zwei- bis dreimal größer ist als die Hublänge S.

9. Schieberverschluss nach Anspruch 8, wobei:
eine Gesamtbreite D2 der Ventilplatte in einem Bereich liegt, der einmal bis 1,5 mal größer ist als die Hublänge S.

Revendications

1. Plaque de soupape pour une porte coulissante, dans laquelle :

la plaque de soupape a une forme heptagonale comprenant un premier côté long et un second côté long s'étendant parallèlement l'un à l'autre sur des côtés opposés de la plaque de soupape, un premier côté court et un deuxième côté court en contact oblique avec une extrémité du premier côté long et une extrémité du second côté long, respectivement, un troisième côté court reliant le premier côté court et le deuxième côté court, et un quatrième côté court et un cinquième côté court en contact oblique avec les autres extrémités du premier côté long et du second côté long, respectivement, et la plaque de soupape est symétrique par rapport à une ligne centrale parallèle au premier côté long et au second côté long tout en maintenant la même distance du premier côté long et du second côté long et un orifice est formé sur la ligne centrale, un triangle rectangle virtuel respectif ayant chacun du quatrième côté court et du cinquième côté court en tant que côté oblique étant configuré sur la plaque de soupape, et le triangle rectangle ayant un coté inférieur ayant une longueur k1 et une hauteur ayant une longueur de k2 ; et
le quatrième côté court et le cinquième côté court étant formés pour satisfaire à la condition suivante :

$$1{,}5 \leq k1 / k2 \leq 2{,}75.$$

2. Plaque de soupape selon la revendication 1, dans laquelle :
le premier côté long et le second côté long ont la même longueur et les longueurs du premier côté long et du second côté long sont supérieures à la longueur de chacun des premier au cinquième côtés courts.

3. Plaque de soupape selon la revendication 2, dans laquelle :
le premier côté court et le deuxième côté court ont la même longueur, et la longueur du troisième côté court est inférieure à la longueur de chacun des premier et deuxième côtés courts.

4. Plaque de soupape selon la revendication 3, dans laquelle :
les coins qui touchent le quatrième côté court et le cinquième côté court sont arrondis.

5. Plaque de soupape selon la revendication 1, dans laquelle :
l'orifice est positionné entre le premier côté long et le second côté long, et chacun du premier côté long et du second côté long est divisé en une première partie de longueur $\delta 1$ et en une seconde partie de longueur $\delta 2$ par une ligne

verticale virtuelle qui est orthogonale à la ligne centrale et rencontre le centre de la forme de l'orifice.

6. Plaque de soupape selon la revendication 5, dans laquelle :
le premier côté long et le second côté long sont formés pour satisfaire à la condition suivante :

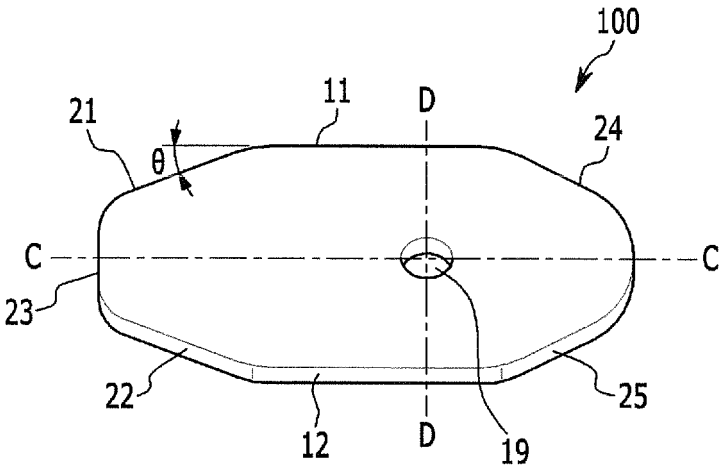
$$2 \leq \delta 1 / \delta 2 \leq 3,5.$$

7. Porte coulissante comprenant une plaque de soupape selon l'une quelconque des revendications 1 à 6, en tant que plaque de soupape supérieure et plaque de soupape inférieure, dans laquelle :
la plaque de soupape inférieure se déplace d'une longueur de course de S dans son sens de la longueur afin d'ouvrir et de fermer un orifice de la plaque de soupape supérieure.

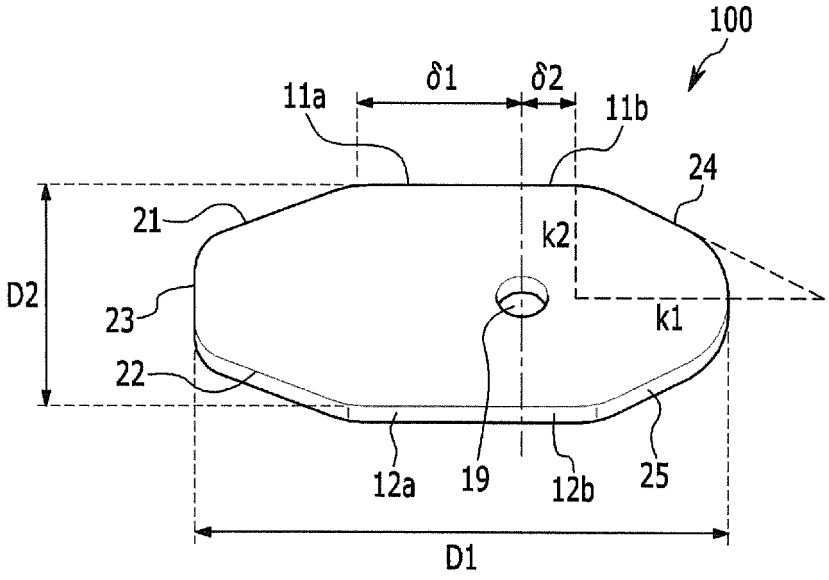
8. Porte coulissante selon la revendication 7, dans laquelle :
une longueur totale D1 de la plaque de soupape appartient à une plage étant deux à trois fois supérieure à la longueur de course S.

9. Porte coulissante selon la revendication 8, dans laquelle :
une largeur totale D2 de la plaque de soupape appartient à une plage étant une fois à 1,5 fois supérieure à la longueur de course S.

FIG. 1


100
11
D
21
θ
24
C
C
23
22
12
D
19
25

(a)


100
δ1
δ2
11a
11b
24
21
k2
D2
23
k1
22
12a
19
12b
25
D1

(b)

FIG. 2

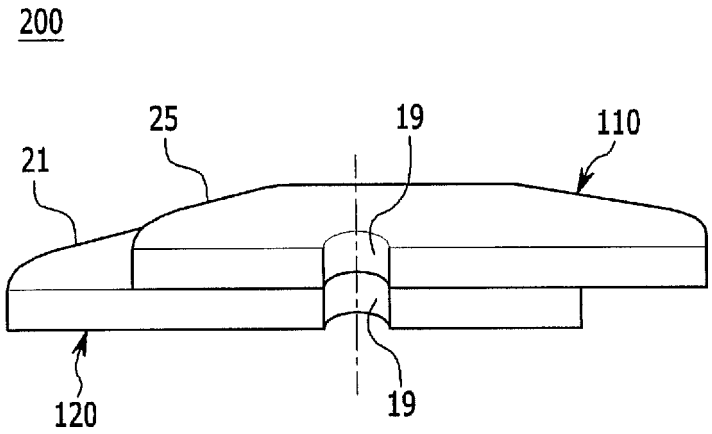


FIG. 3

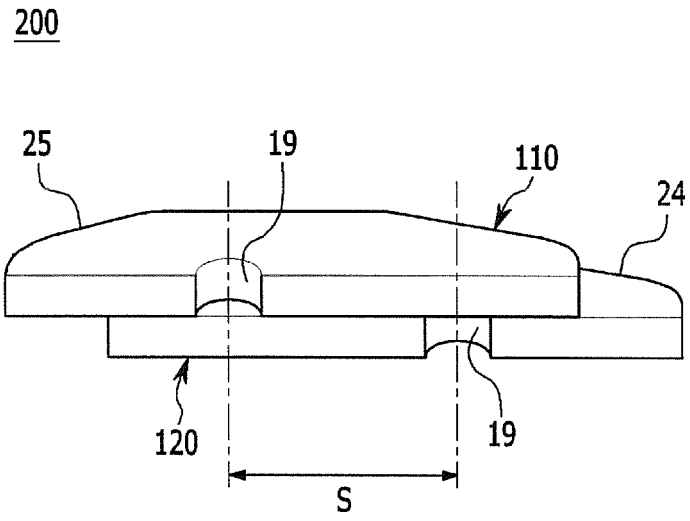


FIG. 4

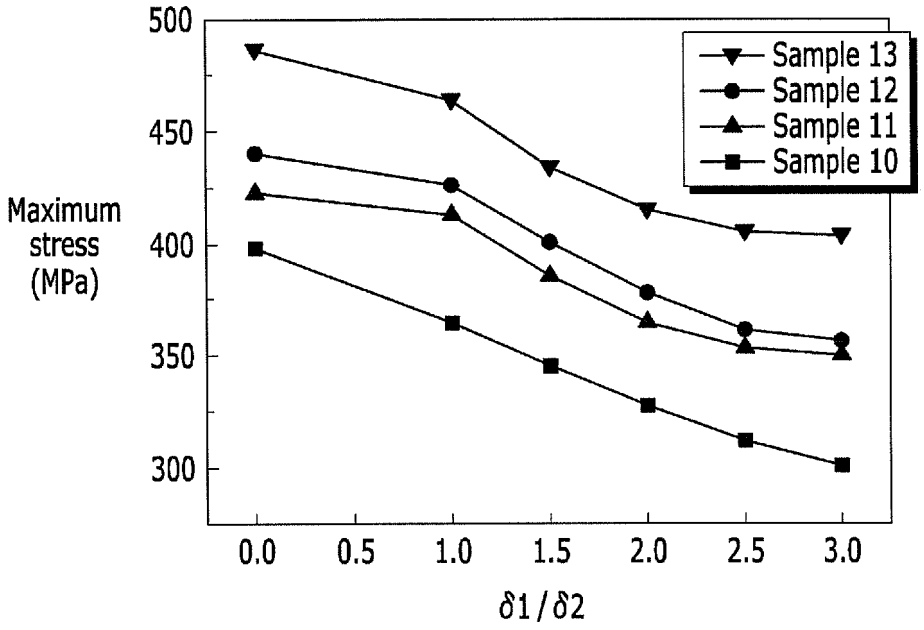
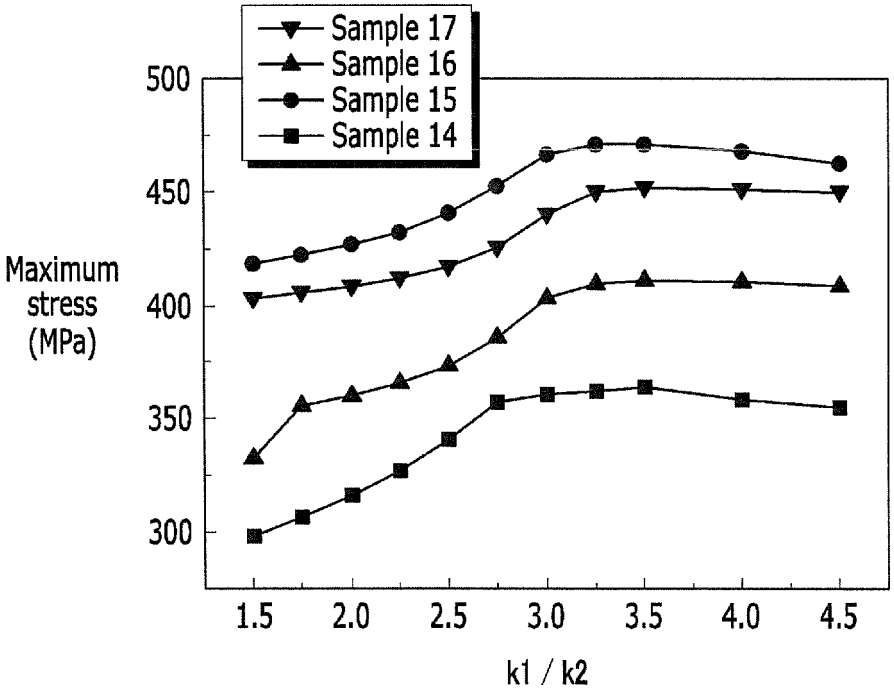

500
450
400
350
300
Maximum stress (MPa)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
δ1/δ2
Sample 13
Sample 12
Sample 11
Sample 10

FIG. 5


Sample 17
Sample 16
Sample 15
Sample 14
Maximum stress (MPa)
500
450
400
350
300
1.5
2.0
2.5
3.0
3.5
4.0
4.5
k1 / k2