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(54) CHEMICAL REINFORCING HOLDERS FOR GLASS SUBSTRATE

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(57) **ABSTRACT**

The present invention provides a holder that prevents a glass substrate from deforming during a chemical reinforcing process. The holder includes supporting members, each of which has a plurality of supporting concave portions. The supporting members are formed from a flat plate having a constant thickness so as not to have a portion having high thermal capacity. When the glass substrate is cooled, a thermal stress is not applied to the glass substrate.

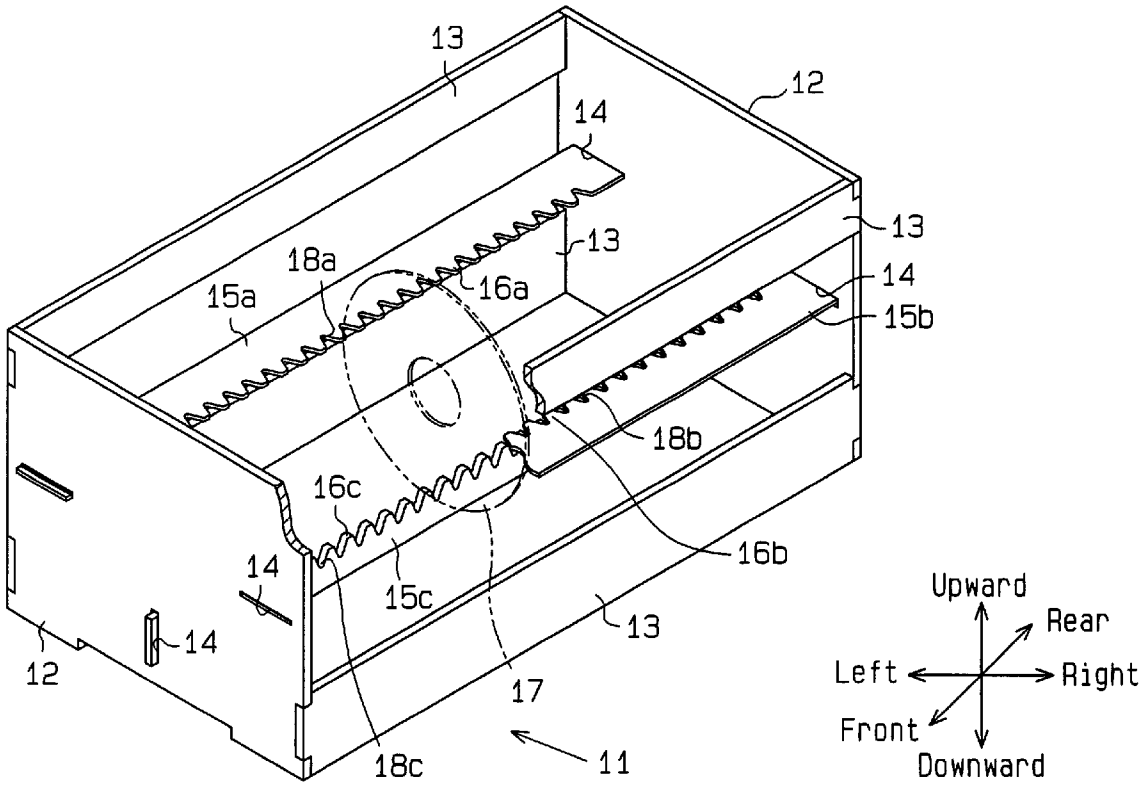


Fig.1

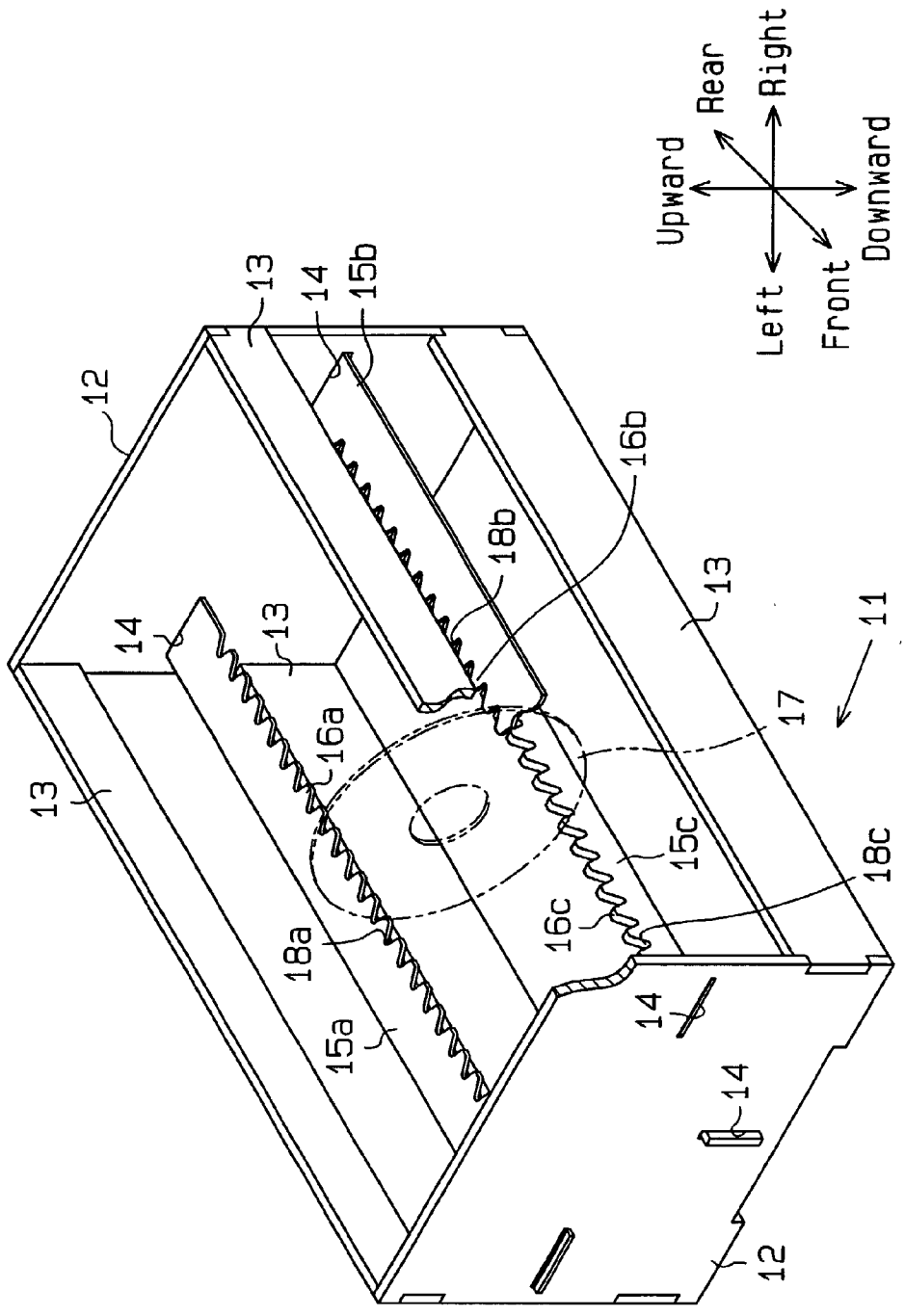

Upward
Rear
Right
Left
Front
Downward
12
13
14
15b
16b
18b
11
17
16a
15c
18c
16c
18a
15a

Fig.2

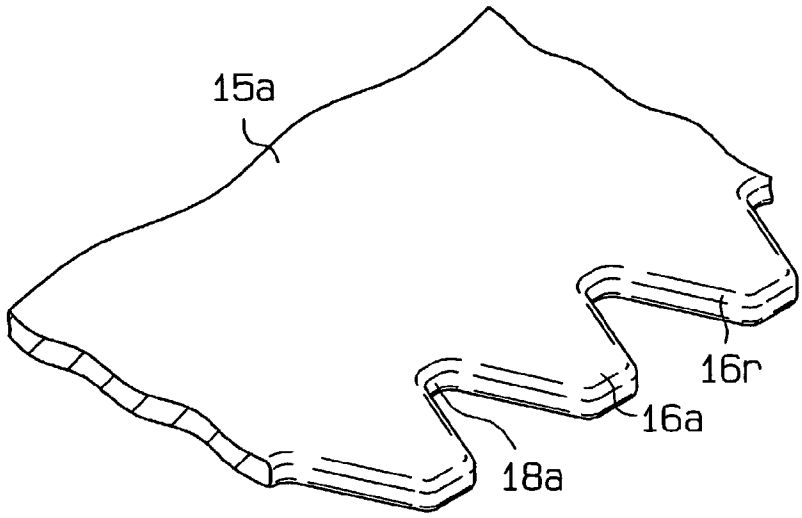


Fig.3A

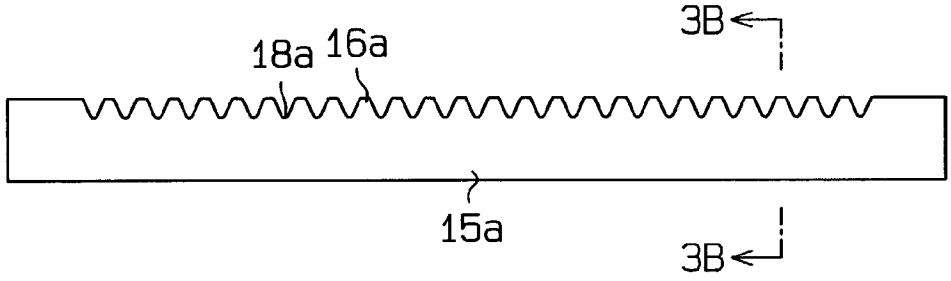


Fig.3B

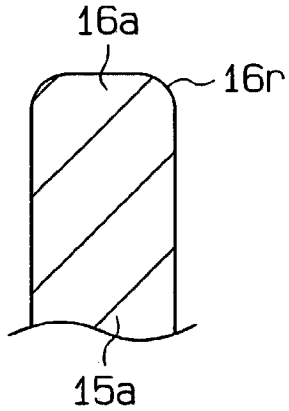


Fig.4

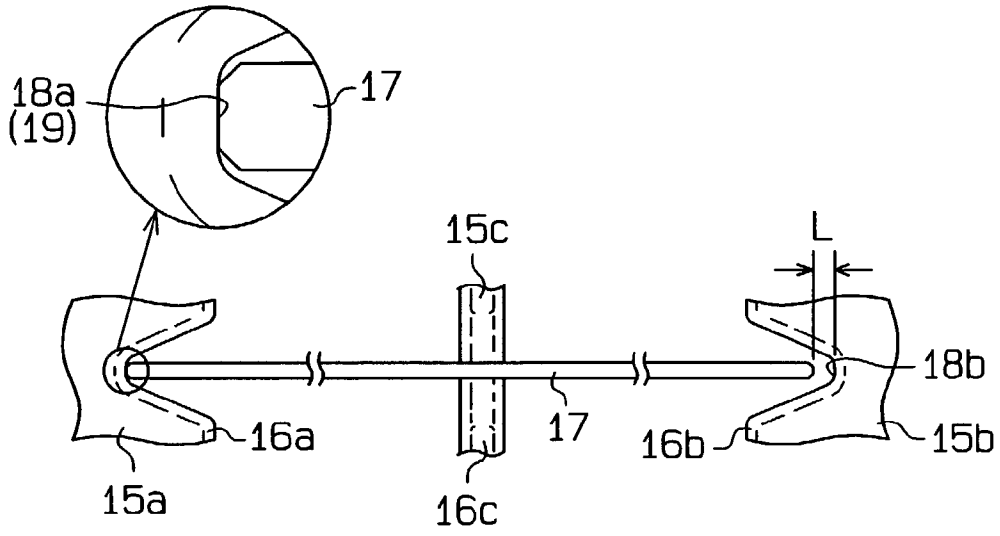
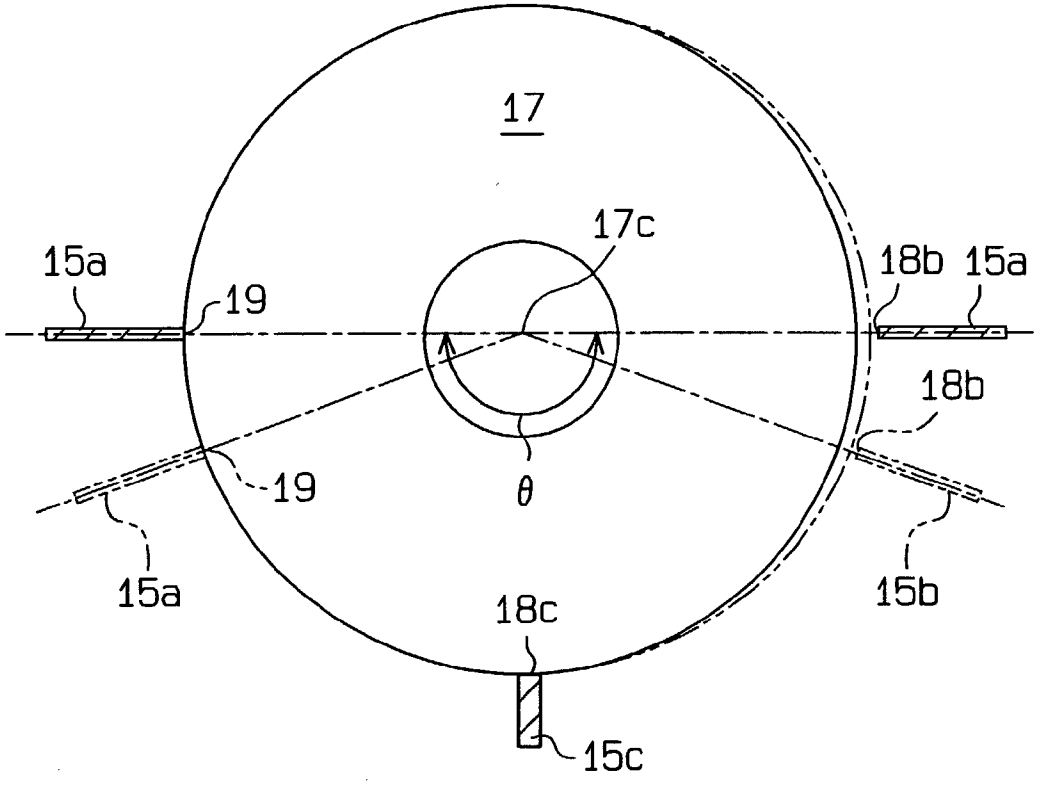

18a
(19)
17
15c
L
18b
16a
17
16b
15b
15a
16c

Fig.5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17c
15a
19
18b
15a
18b
19
θ
15a
15b
18c
15c

Fig.6A

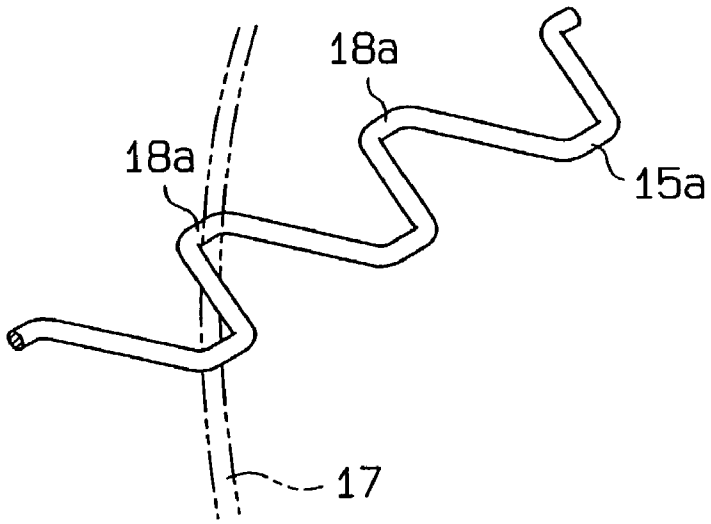


Fig.6B

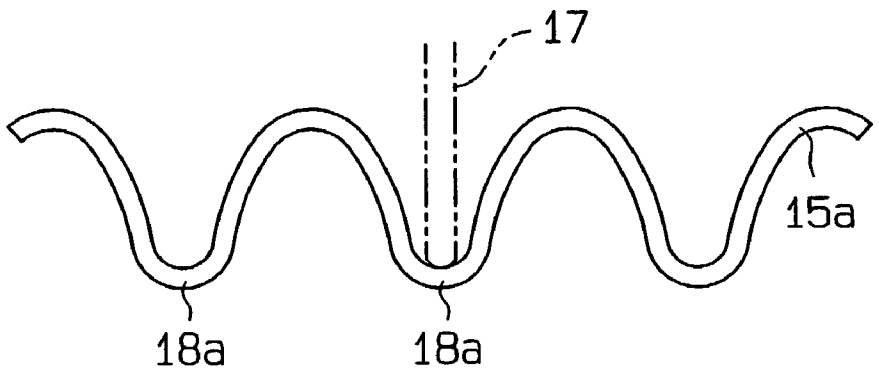
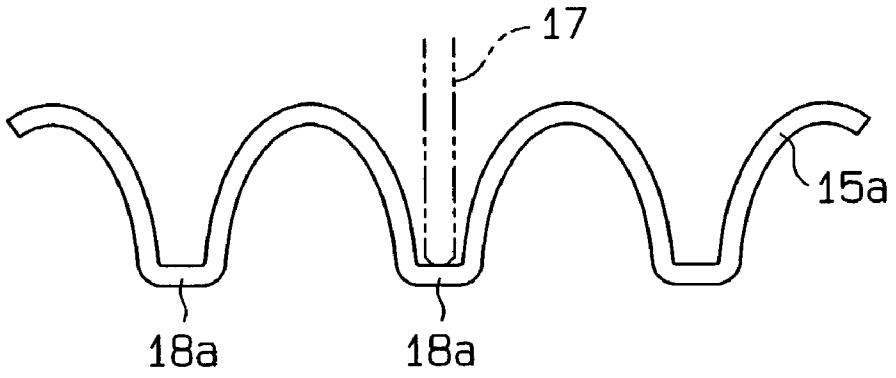


Fig.6C



CHEMICAL REINFORCING HOLDERS FOR GLASS SUBSTRATE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a holder for supporting a glass substrate for an information recording medium, such as a magnetic disc, a magneto-optical disc or an optical disc. Particularly, the invention relates to a holder for a chemical reinforcing process for immersing a glass substrate in a chemical reinforcing liquid.

[0002] Japanese Laid-Open Patent Publication No. Hei 7-176045 discloses a conventional holder for immersing a glass substrate in a chemical reinforcement tank in order to chemically reinforce the glass substrate. The conventional holder is formed by three rods, which are parallel with one another, and two side plates for fixing the ends of the rods. Annular beads are inserted into the respective rods and are fixed to the rods with predetermined intervals. A flat recess is partitioned between adjacent beads. The flat recesses of the three rods receive three outer edge portions of a glass substrate, respectively. As a result, the glass substrate is supported by the holder.

[0003] Chemical reinforcement of a glass substrate will be described. A holder which holds glass substrates is put into a tank which stores a chemical reinforcing liquid containing a potassium nitrate (KNO_3) liquid. After predetermined time, the holder is taken out from the tank, and the glass substrates and the holder are cooled to a room temperature.

[0004] In the conventional holder, since beads, each of which has a relatively large thermal capacity, are fixed to the rods, a cooling speed of the glass substrate at portions that contact with the rods is lower than that of the other portions in the glass substrate. For this reason, during the cooling, contraction of the portions contacting with the rods is small, but contraction of the other parts are large. Therefore, the conventional holder has a problem that a glass substrate is distorted.

SUMMARY OF THE INVENTION

[0005] An objective of the present invention is to provide a holder for glass substrates without distorting the glass substrate in chemical reinforcing process.

[0006] In order to achieve the above objective, the present invention provides a holder for holding glass substrates for an information recording medium and for immersing the glass substrates in a heated chemical reinforcing liquid. The holder includes a frame, and a plurality of supporting members mounted on the frame. Each of the supporting members has a plurality of supporting concave portions for receiving outer edges of the glass substrates, respectively, and thickness of the supporting members is constant.

[0007] A further perspective of the present invention is a holder for immersing a glass substrate in a chemical reinforcing liquid. The holder includes a frame, first, second and third supporting plates mounted on the frame. The first supporting plate has a first serrate portion that defines a first concave portion for receiving a first portion of the glass substrate. The second supporting plate has a second serrate portion that defines a second concave portion for receiving a second portion of the glass substrate. The third supporting plate has a third serrate portion that defines a third concave portion for receiving a bottom portion of the glass substrate.

[0008] A further perspective of the present invention is a holder for immersing a glass substrate in a chemical reinforcing liquid. The holder includes a frame, first, second and third supporting wires mounted on the frame. The first supporting wire has a first serrate portion that defines a first concave portion for receiving a first portion of the glass substrate. The second supporting wire has a second serrate portion that defines a second concave portion for receiving a second portion of the glass substrate. The third supporting wire has a third serrate portion that defines a third concave portion for receiving a bottom portion of the glass substrate.

[0009] Other aspects and advantages of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

[0011] **FIG. 1** is a partially broken perspective view of a holder according to one embodiment of the present invention.

[0012] **FIG. 2** is a perspective view of a supporting member.

[0013] **FIG. 3A** is a plan view of the supporting member.

[0014] **FIG. 3B** is a cross-sectional view taken along the line **3**B-**3**B of **FIG. 3A**.

[0015] **FIGS. 4 and 5** are plan view and side view of the supporting member which supports a glass substrate.

[0016] **FIGS. 6A, 6B** and **6**C show modified examples of the supporting member.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] A holder for a chemical reinforcing process according to one embodiment of the present invention will be described below.

[0018] As shown in **FIG. 1, a** holder **11** has frames **12** and **13**, first, second and third supporting members **15***a*, **15***b* and **15***c* fixed to the frames. The frames **12** and **13** include two side plates **12** and four elongate connecting plates **13** which are mounted in the four corners of the side plates **12**, respectively, and connect both the side plates **12**. It is preferred that the side plates **12** are made of metal such as nickel alloy, stainless steel, pure titanium or titanium alloy.

[0019] Near the center of three sides of each side plate **12** are formed with three supporting holes or slits **14**, respectively. The ends of the supporting members **15***a*, **15***b* and **15***c* are inserted into the two slits **14** opposed to each other, respectively. Each one end of the supporting members **15***a*, **15***b* and **15***c* is welded with one side plate **12**, and each other

end of the supporting members **15***a*, **15***b* and **15***c* is not welded with each slit **14** of the other side plate **12** to be supported thereto. In such a manner, the supporting members **15***a*, **15***b* and **15***c* are fixed between both the side plates **12**.

[**0020**] Each of the supporting members **15***a*, **15***b* and **15***c* is made of a flat thin plate. Each of the supporting members **15***a*, **15***b* and **15***c* is formed of a metal material such as nickel alloy, stainless steel, pure titanium or titanium alloy. Of these metal materials, nickel alloy having good corrosion resistance, mechanical property and processability, or a titanium alloy with high corrosion resistance, small specific gravity and small thermal capacity is preferred. Pure titanium is more preferable.

[**0021**] As shown in **FIG. 1**, one side of each of the supporting members **15***a*, **15***b* and **15***c* is formed with jagged serrate portion **16***a*, **16***b* and **16***c*, respectively. Namely, the serrate portions **16***a*, **16***b* and **16***c* are flush with the relating supporting members **15***a*, **15***b* and **15***c*. The serrate portions **16***a*, **16***b* and **16***c* include a plurality of supporting concave portions **18***a*, **18***b* and **18***c*, respectively. The serrate portion **16***a* of the first or left side supporting member **15***a* is opposed to the serrate portion **16***b* of the second or right side supporting member **15***b*. The serrate portion **16***c* of the third or lower supporting member **15***c* faces upward.

[**0022**] **FIG. 2** is an enlarged diagram of the left side supporting member **15***a*. The right side and the lower supporting members **15***b* and **15***c* have the same structure shown in **FIG. 2**. The plural supporting concave portions **18***a*, **18***b* and **18***c* are defined by ridgelines **16**r of the serrate portions **16***a*, **16***b* and **16***c*. The ridgeline **16***r* is chamfered by a wet barrel polishing process, so that a burr is removed. Therefore, outer surfaces of the serrate portions **16***a*, **16***b* and **16***c* are smooth. As shown in **FIG. 3**B, it is preferred that the ridgeline **16***r* is of a curved surface type.

[**0023**] As shown in **FIG. 5, a** glass substrate **17** is a disc having a circular hole at its center which is used as a substrate for an information recording medium such as a magnetic disc, a magneto-optical disc or an optical disc. A glass material forming the glass substrate **17** includes sodalime glass mainly containing silicon dioxide (SiO_2), sodium oxide (Na_2O) and calcium oxide (CaO); aluminosilicate glass mainly containing SiO_2, aluminum oxide (Al_2O_3) and R_2O (R indicates potassium (K), sodium (Na), lithium (Li)); borosilicate glass; lithium oxide (Li_2O)—SiO_2 glass; Li_2O—Al_2O_3—SiO_2 glass; and R'O—Al_2O_3—SiO_2 glass (R' indicates magnesium (Mg), calcium (Ca), strontium (Sr) and barium (Ba)). Moreover, the glass material also includes a glass for chemical reinforcing process where zirconium oxide (ZrO_2) or titanium oxide (TiO_2) is added to these glass materials. As shown in **FIG. 4**, an outer peripheral edge of the glass substrate **17** is chamfered.

[**0024**] As shown in **FIG. 4**, the three supporting concave portions **18***a*, **18***b* and **18***c* are arranged on the same plane so that the outer edge of the glass substrate **17** is received by the three supporting concave portions **18***a*, **18***b* and **18***c*. As shown in **FIG. 1**, the holder **11** can hold a plurality of glass substrates **17** in a vertically standing state.

[**0025**] One glass substrate **17** is inserted among the three supporting members **15***a*, **15***b* and **15***c*. As shown in **FIGS. 4 and 5**, a left edge portion of the glass substrate **17** is supported by the left supporting member **15***a*, and the bottom portion of the glass substrate **17** is supported by the supporting member **15***c*. A right outer peripheral surface of the glass substrate **17** is separated by a gap L from the supporting concave portion **18***b* of the right supporting member **15***b*. Preferably the gap L is 0.1 to 0.5 mm at normal temperature. In the case where the gap L is less than 0.1 mm, when the glass substrate **17** and the holder **11** are immersed in a chemical reinforcing liquid, there is a fear that the glass substrate **17** is pressed strongly between the supporting members **15***a*, **15***b* and **15***c* due to thermal expansion. In the case where the gap L is larger than 0.5 mm, the glass substrate **17** is not stably supported, and when it is oscillated, there is a fear that the glass substrate **17** may collide strongly with the supporting members **15***a*, **15***b* and **15***c* and be damaged.

[**0026**] As shown in **FIG. 5**, the glass substrate **17** comes in contact with the left supporting member **15***a* in a first position (supporting point) **19**. It is preferred that an angle (lower angle) θ between a plane which connects the supporting point **19** with a center **17***c* of the glass substrate **17** and a plane which connects the left supporting member **15***a* with the center **17***c* of the glass substrate **17** is 160 to 180°. In other words, it is preferred that the left supporting member **15***a* and the right supporting member **15***b* are separated from the lower supporting member **15***c* by 80 to 90° in a circumferential direction of the glass substrate **17** with respect to the center **17***c* of the glass substrate **17**. For example, the angle θ between the left and right supporting members **15***a* and **15***b* is 180° in a position indicated by a solid line in **FIG. 5**. In a position indicated by alternate long and two short dashes line, the angle θ between the left and right supporting members **15***a* and **15***b* is 160°.

[**0027**] In the case where the lower angle θ is less than 160°, there is a fear that the glass substrate **17** is oscillated relatively greatly due to vibration and is damaged. As the lower angle θ is smaller, the supporting of the glass substrate **17** becomes more unstable. Meanwhile, when the lower angle θ exceeds 180°, it is difficult to insert the glass substrate **17** into the holder **11**.

[**0028**] As shown in **FIG. 4**, the bottom portions of the supporting concave portions **18***a*, **18***b* and **18***c* have slightly larger width than a thickness of the glass substrate **17**. As shown in **FIG. 5**, the lower supporting member **15***c* is thicker than the left and right supporting members **15***a* and **15***b*.

[**0029**] Next, the chemical reinforcing process will be described.

[**0030**] A heated chemical reinforcing liquid is stored in a chemical reinforcement tank (not shown). Chemical reinforcement salt is, for example, KNO_3 or sodium nitrate ($NaNO_3$). The chemical reinforcing liquid contains sodium ions (Na^+) or potassium ions (K^+) which are monovalent metal ions having a relatively large ion radius. The holder **11** holding the glass substrate **17** is arranged in a cage, not shown, and the cage is put into the chemical reinforcement tank. As a result, the glass substrate **17** and the holder **11** are immersed in the heated chemical reinforcing liquid.

[**0031**] Metal ions having relatively small radius such as lithium ions (Li^+) and Na^+exist on the surface layer of the glass substrate **17**. When the glass substrate **17** is immersed

in the chemical reinforcing liquid, metal ions with relatively small surface layer are exchanged with relatively large metal ions in the chemical reinforcing liquid. With this ion exchange, a compression stress is applied to the surface layer of the glass substrate **17**. As a result, the glass substrate **17** is chemically reinforced.

[**0032**] In the case where the glass substrate **17** is subjected to chemical reinforcing process, firstly a plurality of glass substrates **17** are inserted between the supporting concave portions **18***a* and **18***b* of the left and right supporting members **15***a* and **15***b* from above the holder **11**, so that the bottom portions of the glass substrates **17** are brought into contact with the supporting concave portions **18***c* of the lower supporting member **15***c*. As a result, the plural glass substrates **17** are held at the holder **11** in the vertically standing state. A plurality of holders **11** are housed in the cage, not shown. The cage is put into the chemical reinforcement tank where the chemical reinforcing liquid is stored. As a result, the plural glass substrates **17** and holders **11** are immersed in the chemical reinforcing liquid.

[**0033**] In one embodiment, the chemical reinforcing liquid is obtained by heating KNO_3 and $NaNO_3$. A temperature of the chemical reinforcing liquid is preferably lower than a distortion point of a glass material by about 50 to 150° C. More preferably, the temperature of the chemical reinforcing liquid is about 350 to 400° C.

[**0034**] The glass substrates **17** are immersed in the chemical reinforcing liquid for predetermined time. During the immersing, Li^+on the surface layer of the glass substrate **17** is ion-exchanged with Na^+or K^+, and Na^+on the surface layer of the glass substrate **17** is ion-exchanged with K^+. The strength of the glass substrate **17** is improved by the ion exchange. As a result, when the glass substrate **17** is used for an information recording medium, its breakage due to high-speed rotation can be prevented.

[**0035**] In addition, during the immersing, the supporting members **15***a*, **15***b* and **15***c* and the glass substrate **17** are thermally expanded (alternate long and two short dashes line in **FIG. 5**). The glass substrate **17** is separated by a gap L from the bottom portion of the right supporting concave portion **18***b* at normal temperature. Even if the glass substrate **17** and the supporting members **15***a*, **15***b* and **15***c* are expanded, the gap L is set so that the glass substrate **17** does not come in contact with both the left and right supporting members **15***a* and **15***b*. For this reason, a deformation of the glass substrate **17** is prevented.

[**0036**] After the immersing for predetermined time, the cage is taken out from the chemical reinforcement tank, the glass substrates **17** and the holders **11** are cooled to normal temperature. As a result, the chemical reinforcement of the glass substrates **17** is completed.

[**0037**] According to one embodiment, the following advantages are obtained.

[**0038**] The supporting members **15***a*, **15***b* and **15***c* are relatively thin plate materials. For this reason, the supporting members **15***a*, **15***b* and **15***c* do not have portions with large thermal capacity unlike conventional annular beads. Therefore, while the glass substrates **17** and the holders **11** are being cooled, a thermal stress which is generated on the glass substrate **17** is reduced. A distortion is prevented by the chemical reinforcing process from occurring on the glass substrate **17**. As a result, the flat and chemically reinforced glass substrate **17** is obtained.

[**0039**] The serrate portions **16***a*, **16***b* and **16***c* which define the plural supporting concave portions **18***a*, **18***b* and **18***c* are formed on each one side of the supporting members **15***a*, **15***b* and **15***c*. As a result, the holder **11** can hold a plurality of glass substrates **17**. Moreover, insertion and taking-out of the glass substrate **17** can be easily carried out.

[**0040**] Ridgelines **16***r* of the serrate portions **16***a*, **16***b* and **16***c* undergo the wet barrel polishing process. For this reason, a burr on the surfaces of the serrate portions **16***a*, **16***b* and **16***c* is removed, and the ridgeline **16***r* is formed into a smooth curved surface. Therefore, a damage such as a break or a crack does not occur on the glass substrate **17**, and the glass substrate **17** can be easily inserted between the left and right supporting members **15***a* and **15***b*.

[**0041**] The left and the right supporting members **15***a* and **15***b* are separated by the lower angle θ, which is set within the range of 160 to 180°, against the center **17***c* of the glass substrate **17**. For this reason, the glass substrates **17** can be inserted into the holder **11** easily, and the glass substrates **17** can be supported by the holder **11** stably. Moreover, even if the holder **11** is vibrated, the glass substrate **17** is prevented from being oscillated and damaged.

[**0042**] When two places of the glass substrate **17** (first position (**19**) and bottom portion) come in contact with the supporting members **15***a* and **15***c*, the glass substrate **17** is separated by a gap L from the supporting member **15***b*. The gap L is set at 0.1 to 0.5 mm at normal temperature. For this reason, the holder **11** and the glass substrate **17** are heated, and even if the supporting members **15***a*, **15***b* and **15***c* and the glass substrate **17** are thermally expanded, the glass substrate **17** is not strongly pressed by the supporting members **15***a*, **15***b* and **15***c*. Further, even if the holder **11** is vibrated, the glass substrate **17** is prevented from being oscillated to be damaged.

[**0043**] The supporting members **15***a*, **15***b* and **15***c* are welded with one side plate **12** at each end of their longitudinal direction, and the other ends of the supporting members **15***a*, **15** and **15***c* are not welded to the other side plate **12** but are only inserted into the slits **14**. For this reason, even if the holder **11** is heated, the supporting members **15***a*, **15***b* and **15***c* are not distorted. In other words, the frames **12** and **13** are positioned so as to allow thermal expansion of the supporting members **15***a*, **15***b* and **15***c*.

[**0044**] Next, the present invention will be described in more detail by way of Examples.

EXAMPLES 1 to 7

[**0045**] In Examples 1 to 3, a holder **11** having supporting members **15***a*, **15***b* and **15***c* where ridgelines **16***r* of serrate portions **16***a*, **16***b* and **16***c* were not polished was used. Fifty glass substrates **17** were inserted into and taken out of the holder **11**, and this process repeated five times.

[**0046**] In Examples 4 to 7, a holder **11** having a supporting member **15** where ridgelines **16***r* of serrate portions **16***a*, **16***b* and **16***c* were polished by a wet barrel polishing process was used. One hundred glass substrates **17** were inserted into/taken out of the holder **11** five times.

[0047] A damage incidence on the glass substrate **17** was measured. The results are shown in Table 1. In Examples 1 to 3, the results are an average value of the fifty glass substrates **17**, and in Examples 4 to 7, the results are an average value of the one hundred glass substrates **17**.

TABLE 1

Example	1	2	3	4	5	6	7
Damage incidence (%)	10.67	27.33	5.33	0.33	0.67	0.00	1.00

[0048] Damage incidence in Examples 1 to 3 was relatively low. Damage incidence in Examples 4 to 7 was lower than that in Examples 1 to 3. This is because the ridgelines **16***r* of the serrate portions **16***a*, **16***b* and **16***c* are polished by the wet barrel polishing process.

[0049] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the present invention may be embodied in the following forms.

[0050] Three supporting members **15***a*, **15***b* and **15***c* form one set and two or more sets of them may be mounted on the side plates **12**. In this case, the holder **11** can hold two or more rows of plural glass substrates **17**. The number and size of the connecting plates **13** and mounting positions for the side plates **12** are changed suitably.

[0051] The supporting members **15***a*, **15***b* and **15***c* may be fixed to one side plate **12** by a lock mechanism or the like other than the welding method.

[0052] It is preferred that the bottom portions of the supporting concave portions **18***a*, **18***b* and **18***c* are polished by a method such as the wet barrel polishing process, but need not be polished. In this case, it is preferable that side portions which are contiguous with the bottom portions of the supporting concave portions **18***a*, **18***b* and **18***c* are polished.

[0053] As shown in **FIG. 4**, in one embodiment, bottom portions of the supporting concave portions **18***a*, **18***b* and **18***c* of the left and right supporting members **15***a* and **15***b* are flat, but approximately semicircular protrusions may be provided on the bottom portions of the supporting concave portions **18***a*, **18***b* and **18***c*, respectively. In this case, since the protrusions come in contact with the outer peripheral surface at one point, occurrence of distortion on the glass substrate **17** can be further suppressed. Therefore, flatness of the glass substrate **17** can be maintained more satisfactorily.

[0054] The supporting members **15***a*, **15***b* and **15***c* may be made of a line material such as a wire as shown in **FIGS. 6A, 6B** and 6C. **FIGS. 6A, 6B** and 6C show modified examples of one supporting member **15***a*, but the remaining supporting members **15***b* and **15***c* may have the same structure.

[0055] In the supporting member **15***a* (**15***b*, **15***c*) shown in **FIG. 6A, a** line material is bent with constant intervals in one plane so that a plurality of supporting concave portions **18***a* (**18***b*, **18***c*) are formed. The width of the bottom portion of the supporting concave portion **18***a* (**18***b*, **18***c*) adjacent to the outer edge of the glass substrate **17** is slightly larger than the thickness of the glass substrate **17**. Two side portions which are contiguous with the bottom portion of the supporting concave portion **18***a* (**18***b*, **18***c*) approach closer to each other as they are closer to the bottom portion. Namely, the supporting concave portions **18***a* (**18***b*, **18***c*) are formed into a trapezoid shape.

[0056] In the supporting member **15***a* (**15***b*, **15***c*) shown in **FIG. 6B, a** line material is bent so that a plurality of wave-shaped supporting concave portions **18***a* (**18***b*, **18***c*) are formed.

[0057] In the supporting member **15***a* (**15***b*, **15***c*) shown in **FIG. 6C, a** line material is bent with constant intervals on one plane with its plane having an approximately semi-elliptic shape, so that a plurality of supporting concave portions **18***a* (**18***b*, **18***c*) are formed. In this case, the bottom portions of the supporting concave portions **18***a* (**18***b*, **18***c*) have linear shape, and two side portions which are contiguous with the bottom portion gently approach each other as they are closer to the bottom portions.

[0058] A surface of the supporting member **15***a* (**15***b*, **15***c*) made of a linear line material is notched with constant intervals so that a plurality of supporting concave portions **18***a* (**18***b*, **18***c*) may be formed. In this case, it is preferred that the width of the bottom portion of the supporting concave portion **18***a* (**18***b*, **18***c*) is slightly larger than the thickness of the glass substrate **17** and two side portions which are contiguous with the bottom portion approach closer to each other as they are closer to the bottom portions.

[0059] The present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

What is claimed is:

1. A holder for holding glass substrates for an information recording medium and for immersing the glass substrates in a heated chemical reinforcing liquid, the holder comprising:

a frame; and

a plurality of supporting members mounted on the frame, wherein each of the supporting members has a plurality of supporting concave portions for receiving outer edges of the glass substrates, respectively, and wherein thickness of the supporting members is constant.

2. The holder according to claim 1, wherein the supporting members are plates having one edge formed with serrate portions including the plurality of supporting concave portions.

3. The holder according to claim 1, wherein each of the supporting members is a line member which is bent so that the supporting concave portions are formed.

4. The holder according to claim 1, wherein each of the supporting members has a ridgeline which defines the supporting concave portions, and wherein the ridgeline is chamfered.

5. The holder according to claim 4, wherein the ridgeline is chamfered by barrel polishing.

6. The holder according to claim 1, wherein the glass substrate is held vertically and the supporting members include:

a first supporting member which contacts with a first position of the outer edge of each glass substrate;

a second supporting member which is provided so as to be separated by a predetermined distance from the outer edge of the glass substrate in a second position separated from the first position of the glass substrate by 160 to 180° in a circumferential direction of the glass substrate with respect to the center of the glass substrate; and

a third supporting member for supporting the lower end of each glass substrate.

7. The holder according to claim 6, wherein the predetermined distance is set at 0.1 to 0.5 mm at normal temperature.

8. The holder according to claim 1, wherein the frame includes two side plates, each of which has a plurality of slits, and a connecting member for connecting the two side plates, and wherein both ends of the supporting members are inserted into the plurality of slits of the two side plates, respectively.

9. The holder according to claim 8, wherein one end of each of the supporting members is fixed to one of the two side plates, and the other end of each of the supporting members is mounted on the other side plate movably.

10. The holder according to claim 1, wherein each of the plural supporting members is formed so that the supporting concave portions are arranged in a plane.

11. The holder according to claim 1, wherein the chemical reinforcing liquid contains second ions which have an ion radius larger than an ion radius of first ions existing in a surface layer of each of the glass substrates, and the holder is used to exchange the first ions with the second ions and chemically reinforce the glass substrates.

12. A holder for immersing a glass substrate in a chemical reinforcing liquid, the holder comprising:

a frame;

a first supporting plate mounted on the frame, the first supporting plate having a first serrate portion that defines a first concave portion for receiving a first portion of the glass substrate;

a second supporting plate mounted on the frame, the second supporting plate having a second serrate portion that defines a second concave portion for receiving a second portion of the glass substrate; and

a third supporting plate mounted on the frame, the third supporting plate having a third serrate portion that defines a third concave portion for receiving a bottom portion of the glass substrate.

13. The holder according to claim 12, wherein the third supporting plate is thicker than the first and second supporting plates.

14. The holder according to claim 13, wherein the first, second and third supporting plates have ridgelines that defines the relating concave portions, respectively, and the ridgelines are chamfered.

15. The holder according to claim 12, wherein the first and second supporting members are separated by 160 to 180° in a circumferential direction with respect to the center of the glass substrate.

16. The holder according to claim 12, wherein the third supporting member is separated from the first and second supporting members by 80 to 90° in a circumferential direction with respect the center of the glass substrate.

17. The holder according to claim 12, wherein the frame is connected with the first, second and third supporting members so as to allow thermal expansion of the first, second and third supporting members.

18. A holder for immersing a glass substrate in a chemical reinforcing liquid, the holder comprising:

a frame:

a first supporting wire mounted on the frame, the first supporting wire having a first serrate portion that defines a first concave portion for receiving a first portion of the glass substrate;

a second supporting wire mounted on the frame, the second supporting wire having a second serrate portion that defines a second concave portion for receiving a second portion of the glass substrate; and

a third supporting wire mounted on the frame, the third supporting wire having a third serrate portion that defines a third concave portion for receiving a bottom portion of the glass substrate.

19. The holder according to claim 18, wherein the first, second and third serrate portions are formed by bending the first, second and third supporting wires.

20. The holder according to claim 19, wherein the third supporting wire is thicker than the first and second supporting wires.

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