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(54) **DRUM-TYPE WASHING MACHINE**

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(57) **ABSTRACT**

A drum-type washing machine includes left and right side plates formed of steel plates, the side plates defining side surfaces of an outer case, a front cover provided with an openable and closable door, the front cover defining a front surface of the outer case, an upper cover defining an upper surface of the outer case, a water tank oscillatably arranged in the outer case, and a rotary drum axially supported in the water tank, wherein a plurality of concave portions are formed on the left and right side plates, and the concave portion closer to the front surface of the outer case as a door side has an arc shape with a larger curvature. Thus, rigidity of the side plates in the up and down direction and the left and right direction is increased, so that vibration at the time of spin-drying is reduced.

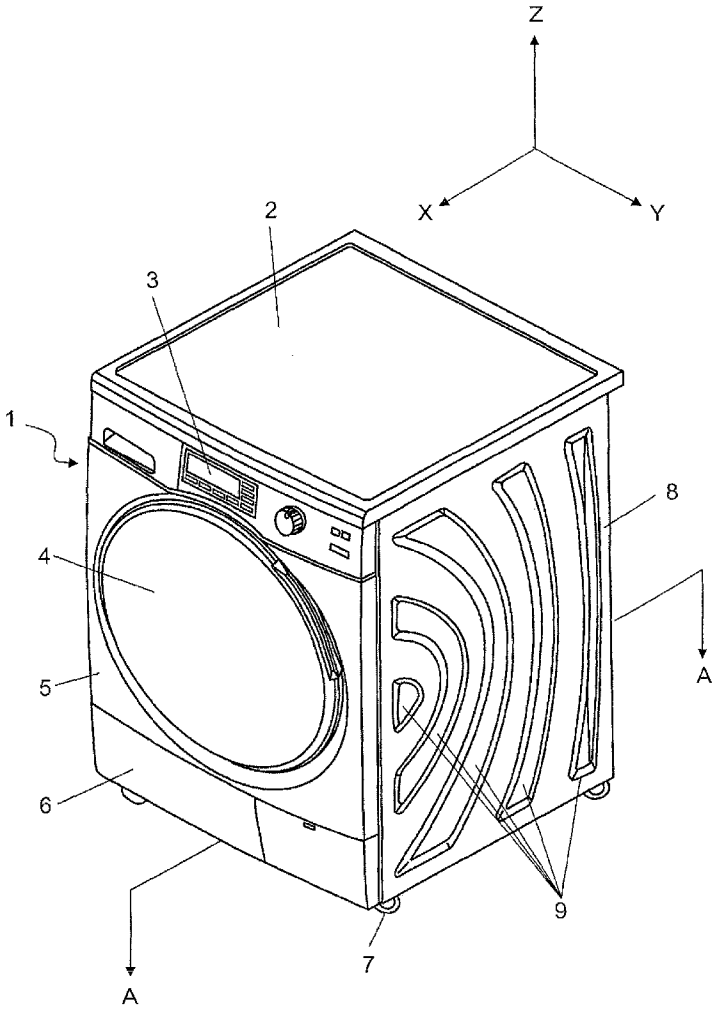


FIG. 1

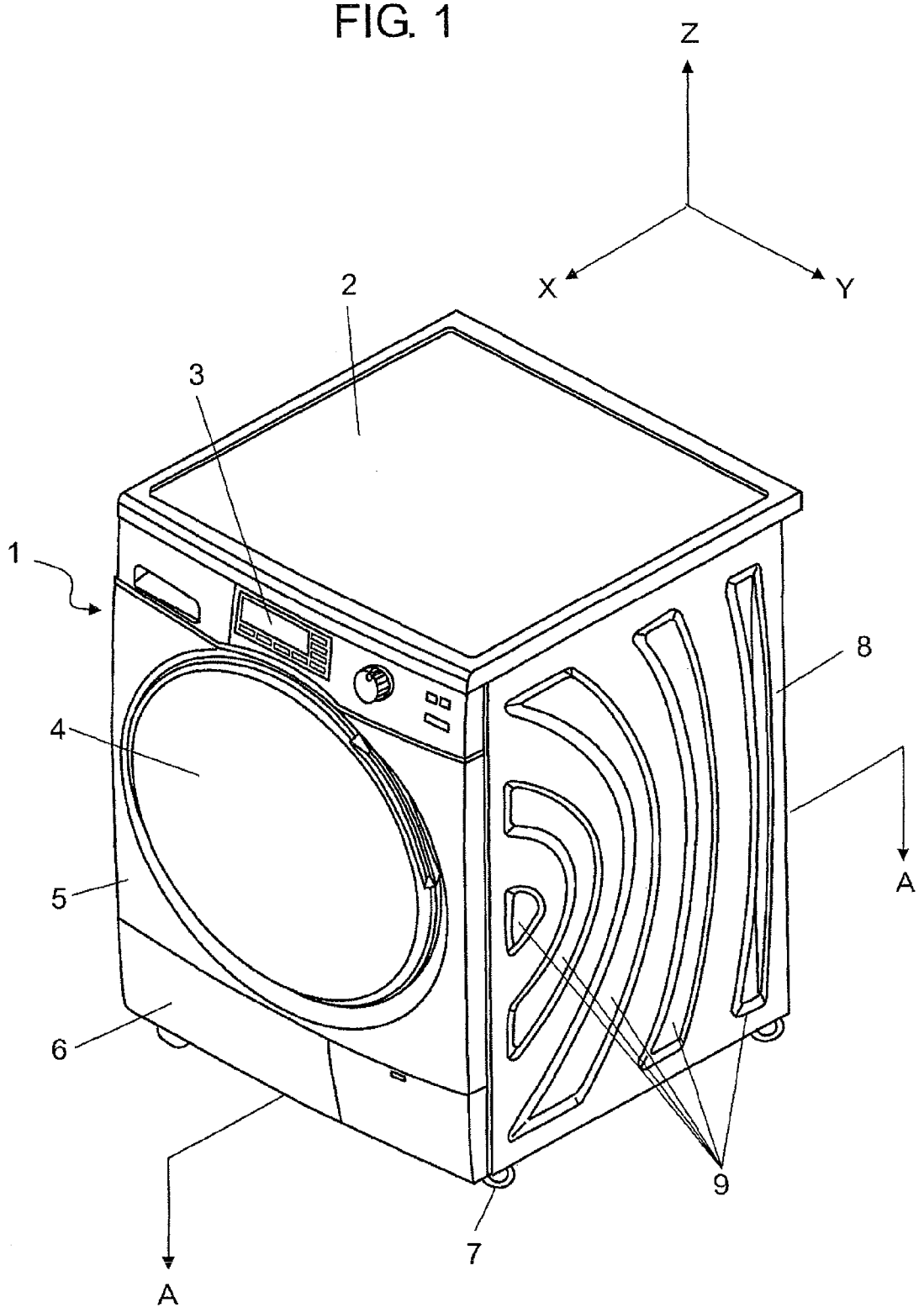


FIG. 2

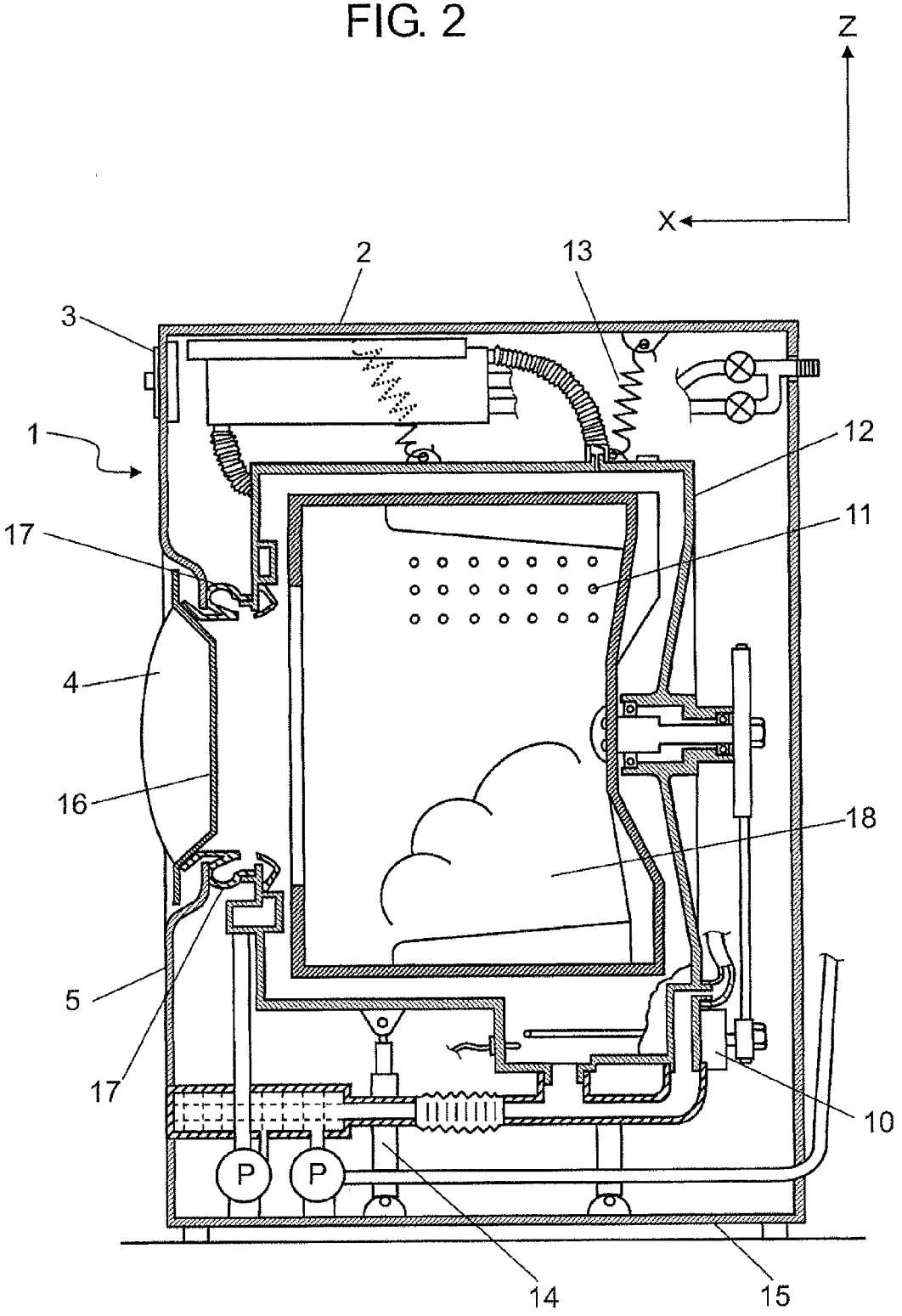


FIG. 3

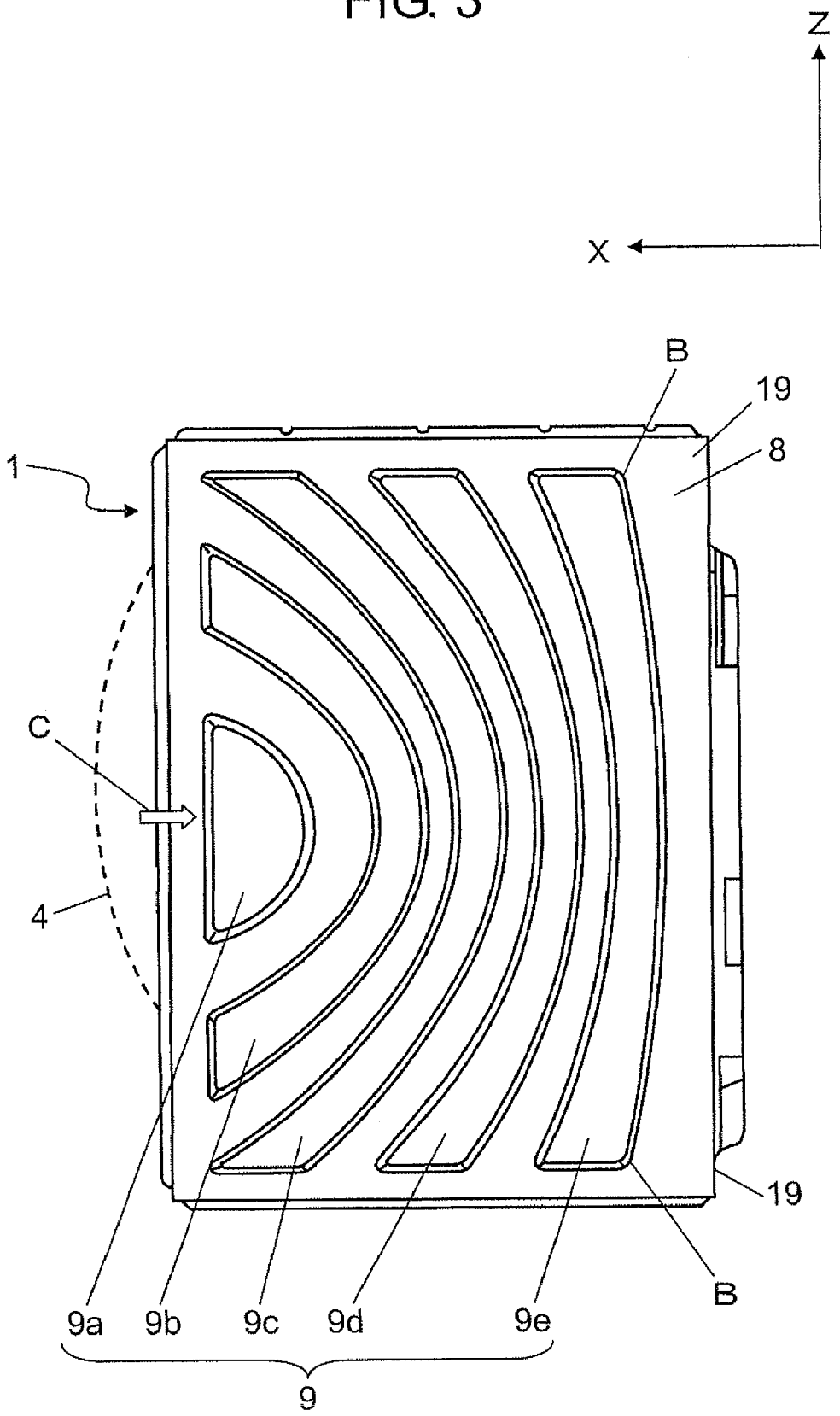
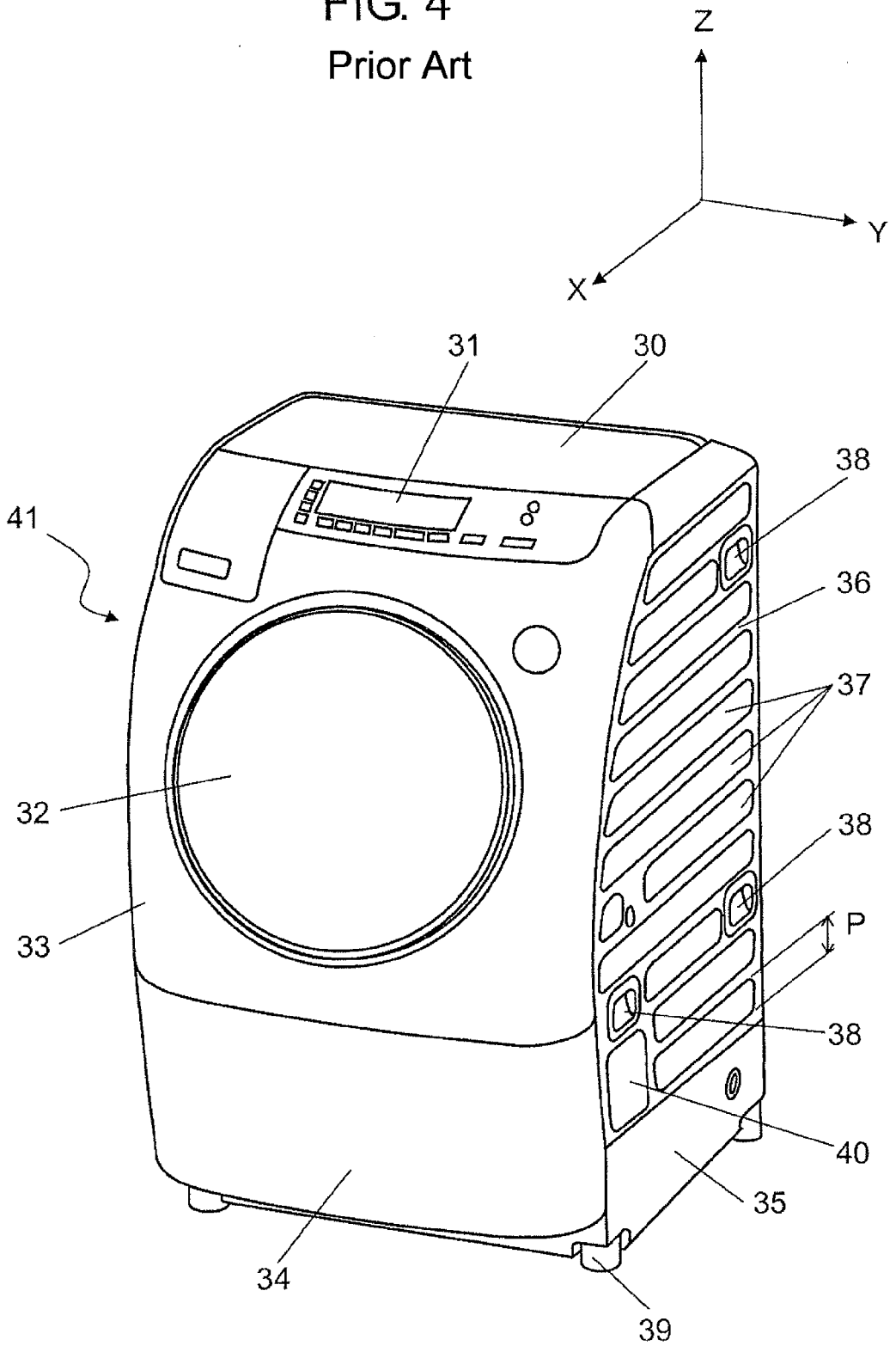


FIG. 4
Prior Art



DRUM-TYPE WASHING MACHINE

TECHNICAL FIELD

[0001] The present invention relates to a configuration of a side surface of an outer case of a drum-type washing machine.

BACKGROUND ART

[0002] Conventionally, regarding a configuration of a side surface of an outer case of a drum-type washing machine, formation of a plurality of concave portions extending in the horizontal direction in a thin steel plate serving as the side surface of the outer case by press working or the like is proposed in order to reduce vibration at the time of spin-drying and the like (for example, refer to Patent Literature 1).

[0003] FIG. **4** is a perspective view of an outer appearance of a conventional drum-type washing machine described in Patent Literature 1. As shown in FIG. **4**, an outer case **41** of the drum-type washing machine is a substantially rectangular parallelepiped which is vertically elongated. The outer case **41** includes an upper surface decorative cover **30** defining an upper surface of the outer case **41**, an operation panel **31** provided with a display screen and the like, the operation panel **31** defining a front surface upper part of the outer case **41**, a front surface decorative cover **33** provided with an openable and closable door **32** in a center, the front surface decorative cover **33** defining a front surface center part of the outer case **41**, a front surface lower part cover **34** defining a front surface lower part of the outer case **41**, and a leg base **35** provided with a leg portion **39** attached on the lower side, the leg base **35** defining a bottom surface of the outer case **41**.

[0004] Side plates **36** defining left and right surfaces of the outer case **41** are made of thin steel plates and have substantially rectangular shapes which are vertically elongated. The side plates **36** support the entire weight of the outer case **41** together with the leg base **35**.

[0005] As shown in FIG. **4**, grip portions **38** for carrying the drum-type washing machine and a concave portion **40** to which a caution seal or the like is attached are formed on the side plate **36**. On the entire surface of the side plate **36** excluding the grip portions **38** and the concave portion **40**, a plurality of concave portions **37** whose longitudinal directions are the horizontal direction are formed. In the side plate **36**, an area of the concave portions **37**, that is, an area of a plastically deformed part is larger than an area of a part where no concave portion **37** are formed. Thereby, surface rigidity of the entire side plate **36** is improved. A resonance frequency of the side plate **36** is increased so as to come away from a vibration frequency at the time of spin-drying. Thus, vibration of the outer case **41** is reduced.

[0006] The concave portions **37** are formed so as to extend in the horizontal direction over the entire surface of the side plate **36**. This is because the side plate **36** has a substantially rectangular shape which is vertically elongated, and a large number of concave portions **37** can be formed if size P set as vertical width of the concave portions **37** is fixed. By such arrangement, a large number of concave portions **37** are formed, so that the surface rigidity is improved.

[0007] Patent Literature 1: JP 2010-63893 A

DISCLOSURE OF THE INVENTION

Problems To Be Solved By the Invention

[0008] However, in a case where a shape of the side plate **36** is close to a regular square, the vibration is largely transmitted to the side plate **36** in any direction of the up and down direction and the front and rear direction. Meanwhile, even when the rigidity in the up and down direction is improved, the rigidity in the front and rear direction is not sufficiently improved with the above conventional configuration. Therefore, in a case where the shape of the side plate **36** is close to a regular square, the rigidity according to the above conventional configuration (rigidity in the front and rear direction in particular) is not always sufficient. As a result, there is a problem that the vibration of the side plate **36** is increased and an abnormal sound is generated at the time of a spin-drying operation. Alternatively, there is a problem that an opening and closing action of the door **32** on the front surface of the outer case **41** (at the time of closing in particular) reflects the side plate **36** so that the side plate **36** is vibrated and the abnormal sound is generated.

[0009] Since a drum-type washing machine has a large water-saving effect, a demand of the drum-type washing machine is increased in recent years. In accordance with this, the drum-type washing machine is required to have an increased capacity. In order to increase the capacity, a rotary drum **11** is formed so as to be elongated along an axis of rotation of the rotary drum **11** (i.e., formed in such a manner that depth of the rotary drum **11** is large). In such a way, depth of the product itself is increased in accordance with an increase in washable capacity of clothing. Thus, a rectangular shape in which size in the vertical direction and the lateral direction are close to each other, that is, a rectangular shape close to a regular square is increased in recent years as a shape of a side plate **8**.

[0010] The present invention is to solve the above conventional problems, and an object thereof is to provide a drum-type washing machine for reducing generation of vibration and an abnormal sound by having high rigidity not only in the up and down direction but also in the front and rear direction.

Means To Solving the Issue

[0011] In order to solve the above conventional problems, a drum-type washing machine of the present invention includes left and right side plates formed of steel plates, the side plates defining side surfaces of an outer case, a front cover provided with an openable and closable door, the front cover defining a front surface of the outer case, an upper cover defining an upper surface of the outer case, a water tank oscillatably arranged in the outer case, and a rotary drum axially supported in the water tank, wherein a plurality of concave portions are formed on the left and right side plates, and the concave portion closer to the front surface of the outer case as a door side has an arc shape with a larger curvature.

[0012] Thereby, high rigidity both in the up and down direction and in the front and rear direction is obtained, so that the generation of the vibration and the abnormal sound is reduced.

Effect of the Invention

[0013] With the drum-type washing machine of the present invention, high rigidity both in the up and down direction and in the front and rear direction is obtained, so that the generation of the vibration and the abnormal sound is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These aspects and features of the present invention will become clear from the following description taken in

conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

[0015] FIG. **1** is a perspective view of an outer appearance of a drum-type washing machine in an embodiment of the present invention;

[0016] FIG. **2** is a vertically sectional view of the same drum-type washing machine along the line A-A of FIG. **1**;

[0017] FIG. **3** is a plan view of the same drum-type washing machine when seen from the side; and

[0018] FIG. **4** is a perspective view of an outer appearance of a conventional drum-type washing machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] In a first aspect of the invention, a drum-type washing machine of the present invention includes left and right side plates formed of steel plates, the side plates defining side surfaces of an outer case, a front cover provided with an openable and closable door, the front cover defining a front surface of the outer case, an upper cover defining an upper surface of the outer case, a water tank oscillatably arranged in the outer case, and a rotary drum axially supported in the water tank, wherein a plurality of concave portions are formed on the left and right side plates, and the concave portion closer to the front surface of the outer case as a door side has an arc shape with a larger curvature. With such a configuration, high rigidity both in the up and down direction and in the front and rear direction is obtained, so that generation of vibration and an abnormal sound is reduced.

[0020] In a second aspect of the invention, in the drum-type washing machine of the first aspect of the invention, the concave portion arranged in a closest position to the front surface of the outer case as the door side has a substantially semicircular shape. With such a configuration, with respect to vibration transmitted to the side plates from a vicinity of the door at the time of a spin-drying operation, stronger surface rigidity is obtained by the substantially semicircular concave portion. Therefore, vibration transmission to the entire side plates is reduced, so that vibration of the entire product is suppressed. With respect to impact transmitted to the side plates via the front cover at the time of closing the door from a released state with strong force, strong surface rigidity of the substantially semicircular concave portion is obtained as well as at the time of the spin-drying operation. Therefore, an acoustic echo of the entire side plates is reduced.

[0021] In a third aspect of the invention, the drum-type washing machine of the first or second aspect of the invention, further includes a suspension hanging down the water tank in the outer case, a damper for damping vibration of the water tank, and a door packing arranged between the water tank and the front cover on the door side, wherein the water tank is supported by the suspension, the damper, and the door packing. With such a configuration, surface rigidity of the side plates corresponding to actions of the water tank in all directions at the time of the spin-drying operation is ensured, so that low vibration and low noise are achieved.

[0022] Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings. Hereinbelow, embodiments of the present invention will be described with reference to the accompanying drawings. It should be noted that the present invention is not limited to this embodiment.

Embodiment

[0023] FIG. **1** is a perspective view of an outer appearance of a drum-type washing machine in the embodiment of the present invention. FIG. **2** is a vertically sectional view of the same drum-type washing machine along the line A-A of FIG. **1**. FIG. **3** is a plan view of the same drum-type washing machine when seen from the side.

[0024] In FIG. **1**, an outer case **1** is a substantially rectangular parallelepiped which is close to a cube. The outer case **1** is provided with an upper surface decorative cover (upper cover) **2** defining an upper surface of the outer case **1**, an operation panel **3** provided with a display screen and the like, the operation panel **3** defining a front surface upper part of the outer case **1**, a front surface decorative cover (front cover) **5** provided with an openable and closable door **4** substantially in a center, the front cover **5** defining a front surface of the outer case **1**, a front surface lower part cover **6** defining a front surface lower part of the outer case **1**, and a leg portion **7** attached to a bottom surface of the outer case **1**.

[0025] The outer case **1** is further provided with left and right side plates **8** formed of thin steel plates and defining side surfaces of the outer case **1**. The side plates **8** have substantially rectangular shapes which are close to a regular square. It should be noted that FIG. **1** only shows one of the side plates **8**. In the following description, the direction perpendicular to the front surface decorative cover **5** is defined as the "front and rear direction" (X direction shown in FIG. **1**), the direction perpendicular to the side plates **8** is defined as the "left and right direction" (Y direction shown in FIG. **1**), and the direction perpendicular to the upper surface decorative cover **2** is defined as the "up and down direction" (Z direction shown in FIG. **1**).

[0026] As shown in FIG. **1**, a plurality of concave portions **9** are formed on the side plate **8**. When the outer case **1** is seen from the side (left and right direction), the concave portion **9** which is closer to the front surface of the outer case **1** on the door **4** side has an arc shape with a larger curvature. The concave portions **9** can be formed by pressing and drawing the steel plates to be the side plates **8**. By this drawing step, the concave portions **9** are plastically deformed. According to the drum-type washing machine in the present embodiment, surface rigidity of the side plates **8** of the thin steel plates is improved by utilizing the concave portions **9** formed on the side plates **8**. Vibration and an abnormal sound of the side plates **8** at the time of a spin-drying operation are reduced, and further, an acoustic echo, vibration, and the like of the side plates **8** at the time of closing the door **4** with strong force are reduced. A shape and the like of the concave portions **9** will be described later in detail.

[0027] Next, the vibration acting on the side plates **8** will be described with using FIG. **2**.

[0028] As shown in FIG. **2**, the outer case **1** is provided with a rotary drum **11** driven and rotated by a motor **10**, and a water tank **12** oscillatably arranged in the outer case **1**. The rotary drum **11** is axially supported in the water tank **12** in such a manner that the rotary drum **11** is rotatable about an axis of rotation parallel to the X direction.

[0029] Between an upper part of the water tank **12** and the upper surface decorative cover **2**, suspensions **13** are attached. The suspensions **13** hang down the water tank **12** in the outer case **1**. The water tank **12** is oscillatably suspended down and anti-vibration supported by the suspensions **13** in the outer case **1**. Between a lower part of the water tank **12** and an outer

case bottom plate **15**, dampers **14** are attached. The dampers **14** damping-support the water tank **12** so as to damp vibration of the water tank **12**.

[0030] Further, on the door **4** side of the water tank **12**, a door packing **17** is arranged between the water tank **12** and the front surface decorative cover **5**. The door packing **17** made from flexible material such as rubber is arranged so as to be brought into watertight contact with an indoor glass **16** when the door **4** is closed. By arranging the door packing **17** in such a way, the water tank **12** is brought into a watertight state against an exterior of the outer case **1** when the door **4** is closed. The water tank **12** is supported by the suspensions **13**, the dampers **14**, and the door packing **17**.

[0031] For example, at the time of the spin-drying operation, the rotary drum **11** is rotated at high speed. When the rotary drum **11** is rotated at high speed, clothing **18** as a laundry is moved in various directions in the rotary drum **11**. By the movement of the clothing **18** in various directions in such a way, impact is transmitted from the rotary drum **11** to the water tank **12**, and the water tank **12** is intricately moved and vibrated in the up and down direction, in the left and right direction, and in the front and rear direction.

[0032] Further, the vibration of the water tank **12** is transmitted to the side plates **8**. Specifically, the vibration of the water tank **12** is transmitted from the suspensions **13** and the dampers **14** to the side plates **8** (not shown in FIG. **2**) via the upper surface decorative cover **2** and the bottom plate **15**. This vibration is mainly composed of a wave motion in the up and down direction. Meanwhile, the vibration of the water tank **12** is transmitted from the door packing **17** to the side plates **8** (not shown in FIG. **2**) via the front surface decorative cover **5**. This vibration is mainly composed of a wave motion in the front and rear direction.

[0033] Therefore, rigidity of the side plates **8** is required to have surface rigidity corresponding to the vibration mainly in the up and down direction transmitted from the suspensions **13** and the dampers **14** to the side plates **8** via the upper surface decorative cover **2** and the bottom plate **15**, the vibration mainly in the front and rear direction transmitted from the door packing **17** to the side plates **8** via the front surface decorative cover **5** from the front side of the door **4** side, and the impact in the front and rear direction at the time of opening and closing the door.

[0034] In particular, in a case where the shape of the side plate **8** is a rectangular shape in which size in the vertical direction and the lateral direction are close to each other, that is, a shape close to a regular square, high surface rigidity not only in the up and down direction but also in the front and rear direction is required as the rigidity of the side plates **8**. In the present embodiment, the concave portions **9** are provided in order to obtain such surface rigidity.

[0035] Next, the concave portions **9** provided in order to obtain the above surface rigidity will be described with using FIG. **3**.

[0036] In FIG. **3**, the concave portions **9** formed on the side plate **8** include a concave portion **9***a* placed at the closest position to the front surface of the outer case **1** on the door **4** side and having a substantially semicircular shape, a concave portion **9***b* arranged at the close position to the door **4** next to the concave portion **9***a* and having a substantially arc shape with a large curvature, and concave portions **9***c*, **9***d*, **9***e* each having a substantially arc shape with a curvature successively decreased from the concave portion **9***b* toward the rear side. The concave portions **9***b*, **9***c*, **9***d*, **9***e* have substantially arc shapes extending from an upper end toward a lower end in the up and down direction while curving from the front side to the rear side of the outer case **1**. It should be noted that the concave portions **9** are recessed from the outer side of the outer case **1** toward the inner side of the outer case **1**.

[0037] The curvatures of the concave portions **9** are set by a catenary curve (catenary). As shown in FIG. **3**, the shape of the concave portion **9***a* arranged at the closest position to the door **4** (on the most front side in the front and rear direction) is a substantially semicircular shape. Thus, surface rigidity in the vicinity of a center part on the door **4** side of the side plate **8** is particularly improved. It should be noted that although the shape of the concave portion **9***a* is a substantially semicircular shape in the present embodiment, the shape is not limited to a substantially semicircular shape but may be a substantially semielliptical shape, a substantially arc shape, or other shapes. The "substantially semicircular shape" includes a semicircular shape, and the "substantially arc shape" includes an arc shape.

[0038] Meanwhile, the shape of the concave portion **9***e* which is the most distant from the door **4** (positioned on the most rear side in the front and rear direction) is a catenary curve of an arc shape with a small curvature close to a substantially vertical line. Ends B on the upper and lower sides and on the rear side of the concave portion **9***e* are close to upper and lower corner portions **19** of the side plate **8**. By forming the concave portions **9** in such a manner that the concave portion **9***e* has such a shape, an area of the concave portions **9** is increased as far as possible.

[0039] It should be noted that in a case where thickness of the side plate **8** is 0.6 mm, the surface rigidity of the side plate can be improved by setting depth of the concave portions **9** to 2.0 to 4.0 mm. However, the depth of the concave portions **9** is not limited to the above depth but can be appropriately set in consideration with the thickness of the side plate **8** and other design matters.

[0040] When the outer case **1** is seen from the side, centers in the up and down direction of the concave portions **9***a*, **9***b*, **9***c*, **9***d*, **9***e* are favorably set on a center of the door **4** and on the axis of rotation of the rotary drum **11**.

[0041] Actions and operations of the washing machine formed as above will be described below.

[0042] The side plates **8** according to the present invention have the plurality of arc-shaped concave portions so as to correspond to the vibration mainly in the up and down direction transmitted from the suspensions **13** and the dampers **14** to the side plates **8** via the upper surface decorative cover **2** and the bottom plate **15**, and the vibration mainly in the front and rear direction transmitted from the door packing **17** to the side plates **8** via the front surface decorative cover **5** from the front side of the door **4** side. With such a configuration of the side plates **8**, a complicated plane shape is formed by the concave portions **9** when seen from the side, differently from a configuration that uniform concave portions extending in the vertical direction are formed and a configuration that uniform concave portions extending in the horizontal direction are formed. Therefore, high surface rigidity both in the up and down direction and in the front and rear direction is obtained by virtue of the side plates **8**.

[0043] By arranging the substantially semicircular concave portion **9***a* at the closest position to the door **4** in the front and rear direction, strong surface rigidity is obtained with respect to the vibration mainly in the front and rear direction transmitted from the direction shown by an arrow C of FIG. **3** to the

side plates **8** via the door packing **17** in the vicinity of the door **4** at the time of spin-drying in particular. Therefore, vibration transmission to the entire side plates **8** is reduced, so that vibration of the entire product is suppressed.

[0044] The impact transmitted to the left and right side plates **8** via the door packing **17** and the front surface decorative cover **5** at the time of closing the door **4** with strong force from a released state is eased by virtue of the strong surface rigidity according to the substantially semicircular concave portion **9***a* as well as at the time of the spin-drying operation. Therefore, the acoustic echo, the vibration, and the like of the entire side plates **8** are reduced.

[0045] It is to be noted that, by properly combining the arbitrary embodiments of the aforementioned various embodiments, the effects possessed by them can be produced.

[0046] As described above, in the drum-type washing machine according to the present invention, the vibration of the outer case at the time of spin-drying and the abnormal sound at the time of opening and closing the door can be reduced by increasing the surface rigidity of the side plates **8**, in particular, the surface rigidity in the vicinity of the door **4** on the front surface. Therefore, the washing machine can be applied to other products accompanied by vibration and provided with an open/close door (such as a dehydrator and a clothes dryer).

[0047] Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

[0048] The entire disclosure of Japanese Patent Application No. 2011-030487 filed on Feb. 16, 2011 including specification, drawings, and claims is incorporated herein by reference in its entirety.

DESCRIPTION OF REFERENCE SIGNS

[0049] **1**: OUTER CASE

[0050] **2**: UPPER SURFACE DECORATIVE COVER (UPPER COVER)

[0051] **4**: DOOR

[0052] **5**: FRONT SURFACE DECORATIVE COVER (FRONT COVER)

[0053] **8**: SIDE SURFACE PLATE

[0054] **9**: RECESSED PORTION

[0055] **11**: ROTARY DRUM

[0056] **12**: WATER TANK

[0057] **13**: SUSPENSION

[0058] **14**: DAMPER

[0059] **17**: DOOR PACKING

1. A drum-type washing machine, comprising:

left and right side plates formed of steel plates, the side plates defining side surfaces of an outer case;

a front cover provided with an openable and closable door, the front cover defining a front surface of the outer case;

an upper cover defining an upper surface of the outer case;

a water tank oscillatably arranged in the outer case; and

a rotary drum axially supported in the water tank,

wherein a plurality of concave portions are formed on the left and right side plates, and the concave portion closer to the front surface of the outer case as a door side has an arc shape with a larger curvature.

2. The drum-type washing machine according to claim **1**, wherein

the concave portion arranged in a closest position to the front surface of the outer case as the door side has a substantially semicircular shape.

3. The drum-type washing machine according to claim **1**, further comprising a suspension hanging down the water tank in the outer case, a damper for damping vibration of the water tank, and a door packing arranged between the water tank and the front cover on the door side, wherein

the water tank is supported by the suspension, the damper, and the door packing.

4. The drum-type washing machine according to claim **2**, further comprising a suspension hanging down the water tank in the outer case, a damper for damping vibration of the water tank, and a door packing arranged between the water tank and the front cover on the door side, wherein

the water tank is supported by the suspension, the damper, and the door packing.

* * * * *