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RECORD PLAYER

Abstract

To implement stable sound playback with high sound quality, a record player for playing back sound recorded on a phonograph record includes a rotator that rotates the phonograph record, a container arranged on a side of the rotator and capable of storing one of a liquid, powder, and gel, a float to be floated on the one of the liquid, the powder, and the gel stored, in a standstill state, in the container, an arm extended from the float in a direction of the rotator, and a phono cartridge attached to the arm and including a sound playback stylus.

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Background/Summary

TECHNICAL FIELD
[0001] The present invention relates to a record player.
BACKGROUND ART
[0002] In the above technical field, patent literature 1 discloses a record player in which a float **6** is floated on water in one container **5** provided on one side of a phonograph record (Vinyl) **11**, and a tone arm **1** is attached to the float **6** (FIG. **4**).
[0003] Patent literature 2 discloses a record player in which a float **14** is floated on a fluid in one container **10** provided above a phonograph record **16**, and a tone arm **26** is attached to the float (FIGS. **1** and **2**).
CITATION LIST
Patent Literature
[0004] Patent literature 1: Russian Patent No. 2463675
[0005] Patent literature 2: U.S. Pat. No. 3,235,267
SUMMARY OF THE INVENTION
Technical Problem
[0006] However, in the techniques described in the above literatures, if a phonograph record having large eccentricity or warp is played back, and the stylus of a phono cartridge receives a periodical force from the phonograph record, the posture of the phono cartridge is not stabilized.
[0007] The present invention enables to provide a technique of solving the above-described problem.
Solution to Problem
[0008] One example aspect of the invention provides a record player for playing back sound recorded on a phonograph record, comprising: [0009] a rotator that rotates the phonograph record; [0010] a container arranged near the rotator and capable of storing one of a liquid, powder, and gel; [0011] a float to be floated on the one of the liquid, the powder, and the gel stored in the container; [0012] an arm extended from the float in a direction of the rotator; [0013] a phono cartridge attached to the arm and including a sound playback stylus; and [0014] a guide mechanism that guides a force that the sound playback stylus receives from a sound groove provided in the phonograph record, [0015] wherein the guide mechanism includes at least two contact portions provided on a side wall of the float.
Advantageous Effects of Invention
[0016] According to the present invention, it is possible to implement playback of high-quality stable sound.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0017] FIG. **1** is a view showing the configuration of a record player according to the first example embodiment;
[0018] FIG. **2** is a perspective view showing the configuration of a record player according to the second example embodiment;
[0019] FIG. **3** is a partially transparent plan view showing the operation of the record player according to the second example embodiment;

[0020] FIG. **4** is a sectional view showing the operation of the record player according to the second example embodiment;
[0021] FIG. **5** is a view showing the configuration of a record player according to the third example embodiment;
[0022] FIG. **6** is a view showing the operation of the record player according to the third example embodiment;
[0023] FIG. **7** is a view showing the operation of the record player according to the third example embodiment;
[0024] FIG. **8** is a view for explaining the advantage of the record player according to the third example embodiment;
[0025] FIG. **9** is a view showing the configuration of a record player according to the fourth example embodiment;
[0026] FIG. **10** is a view showing the configuration of the record player according to the fourth example embodiment;
[0027] FIG. **11** is a view showing the configuration of the record player according to the fourth example embodiment;
[0028] FIG. **12** is a view showing the configuration of the record player according to the fourth example embodiment;
[0029] FIG. **13** is a view showing the configuration of the record player according to the fourth example embodiment;
[0030] FIG. **14** is a view showing the configuration of a record player according to the fifth example embodiment; and
[0031] FIG. **15** is a view showing examples of the shape of a float according to the first to fifth example embodiments.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[0032] Example embodiments of the present invention will now be described in detail with reference to the drawings. It should be noted that the relative arrangement of the components, the numerical expressions and numerical values set forth in these example embodiments do not limit the scope of the present invention unless it is specifically stated otherwise.

First Example Embodiment

[0033] A record player **100** according to the first example embodiment of the present invention will be described with reference to FIG. **1**. The record player **100** is a record player that plays back sound recorded on a phonograph record **110**.
[0034] As shown in FIG. **1**, the record player **100** includes a rotator **101**, a container **102**, a float **103**, an arm **104**, and a phono cartridge **105**.
[0035] The rotator **101** rotates the phonograph record **110**.
[0036] The container **102** is arranged near the rotator **101** and can store a liquid, powder, or gel.
[0037] The float **103** is floated on the liquid, powder, or gel stored in the container **102**.
[0038] The arm **104** is extended from the float **103** in the direction of the rotator **101**.
[0039] The phono cartridge **105** is attached to the arm **104** and includes a sound playback stylus **151**.
[0040] According to the above-described configuration, it is possible to provide a record player which has high sound quality because the phono cartridge **105** can make the stylus pressure constant without largely changing the posture even if the phonograph record **110** has eccentricity or warp.

Second Example Embodiment

[0041] A record player according to the second example embodiment of the present invention will be described next with reference to FIG. **2**. FIG. **2** is a perspective view for explaining the outline of a record player **200**.
[0042] The record player **200** that plays back sound recorded on a phonograph record includes a

rotator **201**, a container **202**, a float **203**, an arm **204**, and a phono cartridge **205**.
[0043] The rotator **201** rotates a phonograph record **210**.
[0044] The container **202** is arranged near the rotator **201** and can store a liquid, powder, or gel.
[0045] The float **203** is floated on the liquid, powder, or gel stored in the container **202**.
[0046] The arm **204** has a rod shape and is extended from the float **203** in the direction of the rotator **201**.
[0047] The phono cartridge **205** is attached to one end of the arm **204** and includes a sound playback stylus **251**.
[0048] The arm **204** is made of material, such as steel, having high rigidity and vibration absorbency such that it is not deformed by a load applied to itself or a load transmitted from the stylus of the phono cartridge **205**.
[0049] The rotator **201** is configured to include a so-called turn table and has a rotary driving function for rotating the phonograph record **210** clockwise. The rotator **201** includes a center spindle **211** as a rotation center shaft.
[0050] In this example embodiment, the rotator **201** has, for example, a flat plate shape having a square shape when viewed from above.
[0051] The container **202** is a rectangular parallelepiped, and is arranged along a side surface forming one side of the rotator **201**.
[0052] The rotator **201** and the container **202** are fixed on a flat plate shaped base **209**.
[0053] The rotator **201** functions as a turn table configured to rotate the phonograph record **210** on the base **209**.
[0054] The container **202** is made of, for example, a material such as a resin, a metal, glass, or ceramic. Here, the container **202** stores a liquid **220** such as water. The float **203** is floated on a fluid such as a liquid, powder, or gel stored in the container **202**. By selecting the fluid in the container **202** from substances other than water, a mass or a viscosity coefficient can be adjusted.
[0055] The float **203** is a columnar member whose cross section has, for example, a circular or elliptical shape, and can pivot. The float **203** is made of a material whose specific gravity is smaller than that of the fluid stored in the container **202**, for example, foamed polystyrene or wood.
[0056] The other end of the arm **204** extends through the float **203**, and a counterweight **241** is fixed to it.
[0057] The arm **204** preferably crosses the pivot axis (R-axis) of the float **203** inside the float **203**. This is because if these are made to cross in this way, the gravity center of an object formed by combining the arm **204**, the phono cartridge **205**, and the counterweight **241** and the gravity center of an object formed by combining the float **203**, a hollow shaft **231**, and rings **232** and **233** can stably be made to match. For this reason, even if the angle made by an arm shaft and a horizontal plane changes when following the warp of the phonograph record, the moment of a force about an R-axis, which is applied to the floating unit, balances. More specifically, the moment around the R-axis applied to the phono cartridge side and the moment around the R-axis applied to the counterweight side balance. [0058] As a result, the stylus pressure does not largely change, and therefore, the warp of the phonograph record does not greatly affect sound quality. For example, in a case where the stylus pressure is 0.02 N, the length of the arm is 200 mm, the warping amount of the phonograph record is 1.5 mm, and the total mass of the arm, phono cartridge, and counterweight is 150 g, the distance (deviation) between the arm shaft and the rotation axis crossing it is preferably about 4 mm or less in order to suppress the change of the stylus pressure due to the influence to 1% or less of the stylus pressure.
[0059] The counterweight **241** has a function of adjusting the stylus pressure, and has a columnar shape or the like. As the material, copper or lead having a large specific gravity is used.
[0060] The arm **204** has a long round bar or square bar shape, and the sound playback stylus **251** is arranged such that a perpendicular line down from the distal end of the sound playback stylus **251** to the rotation axis of the center spindle **211** is orthogonal to the axis of the arm **204**.

A plane including the rotation axis of the center spindle **211** and the distal end of the sound playback stylus **251** is orthogonal to the axis of the arm **204**.
[0061] Also, the sound playback stylus **251** is arranged such that the moving direction (R-axis direction) of the float **203** is parallel to a line that connects the sound playback stylus **251** and the center spindle **211**.
[0062] The arm **204** is preferably arranged to extend through the center of the moving-direction length of the float **203**. The float **203** preferably has a shape (for example, a columnar shape) symmetrical with respect to a plane passing through the center of the moving-direction length and perpendicular to the R-axis.
[0063] The float **203** can pivot about the R-axis parallel to a tracking direction T of the phono cartridge **205**.
[0064] On the base **209**, two columns **291** and **292** that are rectangular parallelepipeds are fixed. A rod-shaped shaft **293** is fixed in the R-axis direction between the columns **291** and **292**. The position and posture of the shaft **293** are preferably adjusted to be coaxial with the R-axis.
[0065] The columns **291** and **292** and the shaft **293** are all made of a material such as steel having high rigidity. Also, the surface of the shaft **293** is preferably coated with a material such as fluororesin having a friction coefficient of 0.1 or less.
[0066] On the other hand, the hollow shaft **231** that has a cylindrical shape and is concentric to the R-axis is fixed to the float **203** while extending through the float **203**. Like the arm, the hollow shaft **231** is made of a material such as steel having high rigidity.
[0067] The two rings **232** and **233** concentric to the hollow shaft **231** are fixed to the two ends of the hollow shaft **231**. The rings **232** and **233** each function as a sliding portion that guides the movement of the float **203** in the axial direction. For this reason, the rings **232** and **233** are preferably made of a material such as fluororesin having a friction coefficient of 0.1 or less.
[0068] The shaft **293** is supported by the column **291** and the column **292** while being inserted into the rings **232** and **233**.
[0069] Thus, a floating unit formed by the float **203** and the components (the arm **204**, the counterweight **241**, the phono cartridge **205**, the sound playback stylus **251**, the hollow shaft **231**, and the rings **232** and **233**) fixed thereto integrally pivots about the R-axis.
[0070] The level of the liquid **220** is adjusted to a position where no force in the vertical direction acts between the rings **232** and **233** and the shaft **293**. That is, the level of the liquid **220** is adjusted to a position where the rings **232** and **233** and the shaft **293** are coaxial.
[0071] The columns **291** and **292**, the shaft **293**, the hollow shaft **231**, and the rings **232** and **233** function as a guide mechanism that guides the float **203** such that the sound playback stylus **251** moves straightly toward the center of the phonograph record **210**. The guide mechanism receives a force F**2** in the circumferential speed direction, which the distal end of the sound playback stylus **251** receives from the contact to the phonograph record **210**, and guides the movement of the sound playback stylus **251** moving linearly in the direction of the center spindle **211**.
[0072] The phono cartridge **205** includes the sound playback stylus **251** configured to read unevenness formed in the sound groove of the phonograph record **210** and convert it into an electrical signal, and a power generation mechanism (not shown).
[0073] Many phonograph records have an eccentricity of about 2 mm at maximum due to errors in manufacturing. Since the sound playback stylus **251** can linearly be moved in the direction of the center spindle **211**, as described above, it is possible to follow the eccentricity of the phonograph record **210** and suppress degradation of sound quality.
[0074] In addition, many phonograph records have a warp of about 3 mm at maximum due to errors in manufacturing or deformation over time. In this case, along with the rotation of the warped phonograph record **210**, the position of the contact between the n sound playback stylus **251** and the upper surface of the phonograph record **210** in the vertical direction periodically changes. Since the pivotable float **203** supports the arm **204**, the sound playback stylus **251** can

follow the change of the position of the contact to the phonograph record **210** in the vertical direction (FIG. **4**) while minimizing the change of the force received by the sound playback stylus **251**.

[0075] In turn, the postures of the phono cartridge **205** and the sound playback stylus **251** can be stabilized. As a result, the sound playback stylus **251** can purely detect the unevenness in the sound groove of the phonograph record **210**.

[0076] Since the float **203** fixed (or connected) to the arm **204** pivots while remaining floating on the liquid **220** and thus absorbs swing in the vertical direction caused by the warp of the record, any adverse effect on the sound quality can be suppressed.

[0077] The weight and position of the counterweight **241** can be adjusted such that the force (so-called stylus pressure) that the sound playback stylus **251** gives to the phonograph record **210** falls within a predetermined range (for example, 0.001 to 0.01 N).

[0078] As shown in FIG. **3**, the sound playback stylus **251** moves from the outer peripheral portion of the phonograph record **210** to the center direction (the direction of the center spindle **211**) while following the groove of the phonograph record **210** rotating on the rotator **201**.

[0079] Along with the movement of the sound playback stylus **251**, the arm **204** also moves while keeping the posture (keeping the angle made with the R-axis at a right angle).

[0080] In other words, lengths L**1** and L**2** of the container **202** and the float **203** are set such that the sound playback stylus **251** can move from the outermost periphery of the phonograph record **210** to the center spindle **211**.

[0081] Of the weight of the floating unit, a component (99.0% to 99.9%) except the force (so-called stylus pressure) that the sound playback stylus **251** gives to the phonograph record **210** in the direction perpendicular to the record rotating surface can be supported by a buoyancy that the float **203** receives from the liquid **220**. Hence, when the float **203** moves, it receives substantially small resistance from the liquid **220** and can move very smoothly.

[0082] For this reason, the sound playback stylus **251** linearly moves toward the center spindle **211** very stably due to the force in the direction of the center spindle **211**, which is received from the groove of the rotating phonograph record **210**.

[0083] In this example embodiment, the floating unit in which the phono cartridge **205**, the arm **204**, the float **203**, and the counterweight **241** are integrally fixed (or connected) is supported by a buoyancy, and in this state, follows the swing in both the vertical direction and the tracking direction. Hence, even if the total weight of the floating unit is increased, the resistance to the follow-up increases only a little. For this reason, the total weight of the floating unit can be increased.

[0084] If the total weight of the structure that supports the phono cartridge **205** is increased, the posture of the phono cartridge **205** is stabilized by inertia, and the sound playback stylus **251** can faithfully convert the unevenness in the sound groove of the phonograph record **210** into a music signal.

[0085] The floating unit floats on the liquid **220** and moves in the R-axis direction due to the force that the stylus **251** receives from the groove of phonograph record **210**. At this time, the floating unit receives the frictional force F**2** in the circumferential speed direction of record rotation (the direction perpendicular to the R-axis) as well. The movement of the floating unit in the direction of the rotator **201** and rotation about the vertical axis are limited by the contacts between the rings **232** and **233** and the shaft **293**, and the floating unit moves in the R-axis direction. That is, the floating unit functions as the linear tracking guide of the sound playback stylus **251**.

[0086] At the time of rotation of the phonograph record **210**, the position of the contact between the distal end of the sound playback stylus **251** and the phonograph record **210** periodically changes in the tracking direction T due to the eccentricity of the phonograph record **210**. The floating unit in the floating state on the liquid follows the periodical position change while keeping posture. That is, the floating unit functions as a linear tracking guide even for the periodical position change of

the sound playback stylus **251** caused by the eccentricity of the phonograph record **210**.

Third Example Embodiment

[0087] A record player **500** according to the third example embodiment of the present invention will be described next with reference to FIG. **5**. FIG. **5** is a view for explaining the configuration of the record player **500** according to this example embodiment. The record player **500** according to this example embodiment is different from the second example embodiment in components for regulating the movement of the float. The rest of the components and operations is the same as in the second example embodiment. Hence, the same reference numerals denote the same components and operations, and a detailed description thereof will be omitted.

[0088] If the eccentricity of a phonograph record **210** is as large as 1 mm or more, the whole floating unit greatly swings along with rotation of the phonograph record **210** (FIG. **6**).

[0089] To solve this problem, in place of the rings **232** and **233** according to the second example embodiment, a contact portion **532**, a shaft **593** configured to be brought into contact with the contact portion **532**, and members **591** and **592** configured to rigidly fix the shaft **593** to a base **509** are provided. The shaft **593** has, for example, a columnar shape.

[0090] The contact portion **532** is fixed at the center of the total length of a float **503** in the R-axis direction. The distal end of the contact portion **532** has a sharp point shape to point-contact the shaft **593**.

[0091] With respect to the eccentricity of the phonograph record **210**, the whole floating unit pivots about the distal end of the contact portion **532** as the center (FIG. **6**). This makes it possible to release a moment given by the force that the stylus receives due to the eccentricity of the phonograph record **210** and reduce a side force (a force in the tracking direction T that a sound playback stylus **251** receives from the sound groove of the phonograph record) that adversely affects sound quality.

[0092] If the amount of eccentricity is ±1.5 mm, and the arm length is about 200 mm, the angle change is only ±0.5° or less, and the influence on sound quality is considered to be little.

[0093] Leaf springs **531** and **533** are provided on the surface of the float **503** on the side of the rotator **201** to sandwich the contact portion **532** in the R-axis direction. When the leaf springs **531** and **533** are brought into contact with the shaft **593**, adjustment can be done such that the center of pivot of the floating unit about the vertical axis is set at the distal end of the contact portion **532**.

[0094] If the spring constant of the leaf springs **531** and **533** is too large, the contact portion **532** separates from the shaft **593** along with swing, resulting in an adverse effect on sound quality. Hence, the spring constant of the leaf springs need to be set sufficiently small. The spring constant of the leaf springs **531** and **533** is set to a value with which the distal end of the contact portion **532** is easily moved up to a position where the distal end of the contact portion **532** contacts the shaft **593** by a force F**2** applied to the distal end of the sound playback stylus **251**, for example, 0.001-0.005 N/cm.

[0095] The contact portion **532**, the leaf springs **531** and **533**, and the shaft **593** function as a guide mechanism that guides the force that the sound playback stylus **251** receives from the sound groove provided in the phonograph record **210**. That is, the guide mechanism includes at least two contact portions that are provided on the side wall of the float **203** and contact the shaft **593**.

[0096] The surfaces of the contact portion **532**, the leaf springs **531** and **533**, and the shaft **593**, which come into contact with each other, are preferably coated with a material such as fluororesin having a friction coefficient smaller than 0.1. The contact portion **532** is provided between the leaf springs **531** and **533** serving as the contact portions. The leaf springs **531** and **533** have elasticity larger (smaller elastic modulus) than the contact portion **532**. The contact portion **532** is preferably made of a material having a large Young's modulus (high rigidity) such that the deformation caused by the force F**2** becomes as small as possible, for example, 0.1 μm or less.

[0097] As shown in FIG. **7**, the contact portion **532** is preferably a part of a cylindrical shape when viewed from the R-axis direction. The contact portion of the distal end of the contact portion **532** to

the shaft **593** has a shape conforming to an arc with respect to the R-axis as the center such that, when the phonograph record rotates, and the float **503** periodically pivots due to the warp of the phonograph record **210**, the pivot center of the float **503** is always on the R Axis.
[0098] In the above-described example embodiments, the floats **103**, **203**, and **503** each have a pivotable shape. An advantage will be described with reference to FIG. **8**.
[0099] As shown in FIG. **8**, if the float has a pivotable shape such as a columnar shape, a cylindrical shape, or a conical shape, the sound playback stylus **251** can follow the phonograph record **210** with a substantially constant stylus pressure even if the phonograph record has a warp.
[0100] The float is not limited to one. A plurality of floats joined by rigid bodies may be used. If two floats apart in the R-axis direction are used, a stable arrangement can be obtained.
[0101] To adjust the vertical direction position of the sound playback stylus **251**, an external tank with a pump configured to supply/discharge a fluid **220** to/from a container **202** may be installed.
Fourth Example Embodiment
[0102] A record player **900** according to the fourth example embodiment of the present invention will be described next with reference to FIGS. **9** to **12**. FIGS. **9** to **12** are views for explaining the configuration of the record player **900** according to this example embodiment. The record player **900** according to this example embodiment is different from the second example embodiment in a float and components around a container. The rest of the components and operations is the same as in the second example embodiment. Hence, the same reference numerals denote the same components and operations, and a detailed description thereof will be omitted.
[0103] As shown in FIG. **9**, the shape of a container **902** is a cylindrical shape whose diameter is larger than that of a cylindrical float **903**.
[0104] A support member **931** extending upward is fixed to the upper portion of the float **903**. Also, the upper end of the support member **931** is fixed to the inner wall of a ring-shaped member **932**. On the outer wall of the ring-shaped member **932**, arms **904** and **905** are extended in opposite directions. A counterweight **241** is fixed to the distal end of the arm **904**, and a cartridge **205** is fixed to the distal end of the arm **905**.
[0105] An opening portion **921** is provided in the upper portion to the container **902** to prevent interference between the support member **931** and the container **902** if the float **903** moves. Since the opening portion **921** is provided in the upper portion of the container **902**, a liquid, powder, or gel in the container **902** is hardly spilled out even if vibration/impact is applied due to an earthquake or the like or the device itself is erroneously tilted.
[0106] FIG. **10** is a view of the container **902** seen through. The float **903** is provided with a through hole **1031** passing through the center axis. In the container **902**, a columnar shaft **1093** is fixed at a position coaxial with the center axis when the container **902** is considered to have a cylindrical shape. A mount **1006** and a mount **1007** are installed near the two ends of the container **902** on the upper surface of a base **209** and support the container **902**.
[0107] FIG. **11** is a perspective view showing only the float **903** and elements around it. Leaf springs **1131** and **1132** are fixed to the two end faces of the float **903**. A ring **1133** is fitted near the center of the through hole **1031** of the float **903** and contacts the shaft **1093**.
[0108] The shaft **1093** is not in contact with the float **903**. The diameter of the through hole **1031** of the float **903** is larger by several mm or larger than the diameter of the shaft **1093**. Only the leaf spring **1131**, the leaf spring **1132**, and the ring **1133** are in contact with the shaft **1093**. The leaf spring **1131**, the leaf spring **1132**, and the ring **1133** contact a side (the left side in FIG. **11**) of the shaft **1093**. The shaft **1093**, the leaf springs **1131** and **1132**, and the ring **1133** function as a guide mechanism that guides the float **903** such that a sound playback stylus **251** moves straight toward the center of a phonograph record **210**. The mass (gravity) of the float **903** is supported not by the shaft **1093** but by a buoyancy received from a liquid **220**.
[0109] FIG. **12** is a sectional view passing through the center axis of the arm **905** and a vertical line. If a lid is provided on the opening portion **921** of the container **902**, the liquid can be made

more difficult to spill. The lid may be closed only in an nonuse state. Alternatively, the lid may automatically be closed when the container **902** vibrates or tilts.

[0110] FIG. **13** is a sectional view taken along a horizontal plane passing through the center axis of the arm **905**. The ring **1133** is fixed to the inner wall of the through hole **1031**. The shaft **1093** and the ring **1133** function as a guide mechanism by sliding in the tracking direction (R-axis direction) while abutting in the direction of the distal end of the arm **905** (in the rightward direction in FIG. **13**).

[0111] Each of the leaf springs **1131** and **1132** is a member formed by bending a thin plate made of an elastic material such as aluminum or resin and having a thickness of, for example, 0.1 mm, and is fixed to the side wall of the float by an adhesive or the like.

[0112] The leaf springs **1131** and **1132** are deflected, thereby absorbing (turning aside) swing of the float **903** in the tracking direction which is caused by fine eccentricity of a record groove. At this time as well, since the shaft **1093** and the ring **1133** slide while keeping contact, a music signal is not disturbed by an unnecessary position change (displacement) in the arm shaft direction.

Fifth Example Embodiment

[0113] A record player **1400** according to the fifth example embodiment of the present invention will be described next with reference to FIG. **14**. FIG. **14** is a view for explaining the configuration of the record player **1400** according to this example embodiment. The record player **1400** according to this example embodiment is different from the second example embodiment in that two floats are provided in two containers. The rest of the components and operations is the same as in the second example embodiment. Hence, the same reference numerals denote the same components and operations, and a detailed description thereof will be omitted.

[0114] The record player **1400** that plays back sound recorded on a phonograph record **210** includes a rotator **201**, two containers **1402** and **1403**, two floats **1404** and **1405**, a beam **1406**, and a phono cartridge **205**.

[0115] The containers **1402** and **1403** are arranged to sandwich the rotator **201** and can store a liquid, powder, or gel. The rotator **201** and the containers **1402** and **1403** are fixed to a table **209**.

[0116] The containers **1402** and **1403** are rectangular parallelepipeds and are made of a material not passing a liquid, for example, a resin, a metal, glass, or ceramic. Here, the containers **1402** and **1403** store a liquid **220** such as water. The two floats **1404** and **1405** are floated on a fluid such as a liquid, powder, or gel stored in the two containers **1402** and **1403**, respectively. By selecting the fluid from substances other than water, a mass or a viscosity coefficient can be adjusted.

[0117] Here, the floats **1404** and **1405** each have a rectangular parallelepiped shape. However, the present invention is not limited to this, and these can have any long shape that smoothly moves in the containers **1402** and **1403**. The float may be a columnar member whose cross section has, for example, a circular or elliptical shape. The floats **1404** and **1405** are made of a material whose specific gravity is smaller than that of the fluid stored in the containers **1402** and **1403**, for example, foamed polystyrene or wood.

[0118] The beam **1406** has two ends fixed to the two floats **1404** and **1405**, and connect the two floats **1404** and **1405**. The beam **1406** has a long round bar or square bar shape, and a line that connects a center C of the beam **1406** and a center spindle **211** is orthogonal to the axis of the beam **1406**. Also, the moving directions of the floats **1404** and **1405** are parallel to the line that connects the center C of the beam **1406** and the center spindle **211**.

[0119] In FIG. **14**, the two ends of the beam **1406** are fixed to the upper surfaces

[0120] of the two floats **1404** and **1405**. However, the present invention is not limited to this. The two ends may be fixed to the side surfaces of the two floats **1404** and **1405** on the side of the rotator **201**. The two ends of the beam **1406** are preferably arranged at the center of the moving direction length of the floats **1404** and **1405**.

[0121] A suspension mechanism **1408** that suspends the phono cartridge **205** and follows the vertical movement of a sound playback stylus **251** is attached to the beam **1406**. The phono

cartridge **205** includes the sound playback stylus **251** configured to read unevenness formed in the sound groove of the phonograph record **210** and convert it into an electrical signal, and a power generation mechanism (not shown).

[0122] The suspension mechanism **1408** is a so-called tone arm, connects the beam **1406** and the phono cartridge **205** and includes a pin **1481**, a counterweight **1482**, and an arm **1483**. The pin **1481** is fixed to a position apart from the center C of the beam **1406**. The arm **1483** can pivot about the pin **1481**. The phono cartridge **205** is fixed to one end of the arm **1483**, and the counterweight **1482** is fixed to the other end. The weight of the counterweight **1482** and the positions of pin **1481** and the counterweight **1482** on the arm **1483** can be adjusted such that a force (so-called stylus pressure) that the sound playback stylus **251** gives to the phonograph record **210** in the direction perpendicular to the record rotating surface falls within a predetermined range (for example, 0.001 to 0.01 N).

[0123] The material of the beam **1406** and the arm **1483** is steel having high rigidity, and this can reduce deformation due to a force received by the sound playback stylus **251**.

[0124] As for the sound playback stylus **251**, the phono cartridge **205** is preferably attached to exist on a plane that includes a line connecting the center C and the center of the center spindle **211** and is perpendicular to the upper surface of the rotator **201**.

[0125] The sound playback stylus **251** moves from the outer peripheral portion of the phonograph record **210** to the center direction (the direction of the center spindle **211**) following the groove of the phonograph record **210** rotating on the rotator **201**. Along with the movement of the stylus **251**, the beam **1406** also moves toward the center of rotation of the center spindle **211** while keeping the posture. At this time, the two floats **1404** and **1405** move while remaining floating in the containers **1402** and **1403**.

[0126] Lengths L**1** and L**2** of the containers **1402** and **1403** and the floats **1404** and **1405** are set such that the sound playback stylus **251** can move from the outermost periphery of the phonograph record **210** to the center spindle **211**. The container **1402** and **1403**, or the float **1404** and the float **1405** preferably have the same size and same shape.

[0127] The floats **1404** and **1405**, the beam **1406**, the phono cartridge **205**, and the suspension mechanism **1408** integrally move as a whole, and the whole will be referred to as a floating unit here. The floats **1404** and **1405**, beam **1406**, the phono cartridge **205**, and the suspension mechanism **1408** are preferably configured such that the gravity center of the whole floating unit is located at the distal end of the sound playback stylus **251**. This is because if the distal end of the sound playback stylus **251** can be made to match the gravity center of the whole floating unit, the moment of a force that rotates the floating unit about the stylus is never generated even by forces in all directions that the sound playback stylus **251** receives from the phonograph record **210**. Note that to make the distal end of the sound playback stylus **251** match the gravity center of the whole floating unit, it is also effective to paste a weight for adjusting the gravity center to a part of the beam **1406**.

[0128] Of the weight of the floating unit, a component (about 99.8%) except the force (so-called stylus pressure) that the sound playback stylus **251** gives to the phonograph record **210** in the direction perpendicular to the record rotating surface can be supported by a buoyancy that the floats **1404** and **1405** receive from the fluid **220**. Hence, when the floats **1404** and **1405** move, these receive only a small resistance from the fluid and can move very smoothly. For this reason, the sound playback stylus **251** can linearly move toward the center spindle **211** very stably due to a force F**1** in the direction of the center spindle **211**, which is received from the groove of the rotating phonograph record **210**.

[0129] The sound playback stylus **251** also receives a force F**2** in the circumferential direction of the phonograph record **210** from the groove of the rotating phonograph record **210**. The magnitude of the force F**2** is about 0.005 to 0.05 N, although it changes depending on the state of the record or the shape of the stylus.

[0130] According to this example embodiment, the two floats **1404** and **1405** move in the substantially same direction at the substantially same speed, and thus, the sound playback stylus **251** at the center performs linear tracking.
[0131] Upon receiving the force F**2**, the floating unit moves in the direction of the force F**2**. However, stoppers **1441** and **1442** provided on the float **1404** abut against the inner wall of the container **1402** on the phonograph record side, thereby stopping the movement by the force F**2**.
[0132] The position (height) of the stoppers **1441** and **1442** in the vertical direction is preferably the same as the position (the distal end of the stylus) at which the sound playback stylus **251** receives the force from the phonograph record. The stoppers **1441** and **1442** may be rotatable rollers.
[0133] An example of the material of the stoppers **1441** and **1442** is a material such as aluminum that has such a rigidity that prevents these from causing deformation of 0.001 mm or more by the force F**2**.
[0134] The stoppers **1441** and **1442** are, for example, cubes whose sides each have a length of about 2 mm. Since the stoppers **1441** and **1442** serve as slide guides that guide the movement in the direction of the float **1404**, a material such as fluororesin having a small friction coefficient (a friction coefficient of 0.1 or less, and about 0.05 to 0.1 in general fluororesin) is used at least for the surfaces.
[0135] Note that the inner wall surface of the container **1402** that the stoppers **1441** and **1442** contact is preferably coated with a material such as fluororesin having a small friction coefficient (a friction coefficient of 0.1 or less). In addition, the slide guide is not limited to the form of the stoppers **1441** and **1442** and may be a roller, a magnetic member, or a noncontact guide using air or a fluid.
[0136] Note that due to a very small frictional force generated between the stoppers **1441** and **1442** and the inner wall of the container **1402**, in the floating unit, a moment M of a very small force is generated about an axis perpendicular to the rotating surface of the record, but this moment can be received by the stoppers **1441** and **1442**. This makes it possible to linearly move the sound playback stylus **251** toward the center spindle **211** (so-called linear tracking) in a stable posture without rotation.
[0137] Many phonograph records have an eccentricity of about 2 mm at maximum due to errors in manufacturing. Since the sound playback stylus **251** can linearly be moved in the direction of the center spindle **211**, as described above, it is possible to follow the eccentricity of the phonograph record and suppress degradation of sound quality.
[0138] In addition, many phonograph records have a warp of about 3 mm at maximum due to errors in manufacturing or deformation over time. In this case, along with the rotation of the warped phonograph record **210**, the force that the phono cartridge **205** receives from the upper surface of the phonograph record **210** periodically changes. Since the suspension mechanism **1408** as described above is provided, the sound playback stylus **251** can follow the upper surface position of the phonograph record **210** while minimizing the change of the force.
[0139] By the operations of the above-described floating unit and the suspension mechanism **1408**, the postures of the phono cartridge **205** and the sound playback stylus **251** can be stabilized. As a result, the sound playback stylus **251** can purely detect only the unevenness in the sound groove of the phonograph record **210**.
[0140] Note that the vertical direction positions of the floats **1404** and **1405** preferably match, and to do this, a tubular member that connects the containers **1402** and **1403** and distributes the liquid **220** may further be provided. Note that to avoid damage to peripheral devices caused by spill-out of the fluid **220**, a water absorbing material such as diatomite may be spread outside the containers **1402** and **1403**. To adjust the position of the cartridge, an external tank with a pump configured to supply or suck the fluid **220** may be installed.
Other Example Embodiments

[0141] While the invention has been particularly shown and described with reference to example embodiments thereof, the invention is not limited to these example embodiments. It will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the claims.

[0142] For example, the float may have a rectangular parallelepiped shape. If the float has a rotating body shape, it can be selected from cross sectional shapes **1501** to **1504** passing through the rotation axis as shown in FIG. **15**. The cross sectional shape is not limited to those shown in FIG. **15**, and a rectangular shape, a rectangular shape with round corners, an elliptical shape, or a shape drawn by various free curves can be used.

[0143] This application is based upon and claims the benefit of priority from Japanese patent application No. 2022-122270, filed on Jul. 29, 2022, Japanese patent application No. 2022-122271, filed on Jul. 29, 2022, and Japanese patent application No. 2022-177246, filed on Nov. 4, 2022, the disclosure of which is incorporated herein in its entirety by reference.

Claims

1. A record player for playing back sound recorded on a phonograph record, comprising: a rotator that rotates the phonograph record; at least one container arranged on a side of said rotator and capable of storing one of a liquid, powder, and gel; at least one float to be floated on the one of the liquid, the powder, and the gel stored, in a standstill state, in said container; an arm extended from said float in a direction of said rotator; and a phono cartridge attached to said arm and including a sound playback stylus.

2. The record player according to claim 1, wherein said float has a shape pivotable about an axis parallel to a tracking direction of said phono cartridge.

3. The record player according to claim 2, wherein said float has a rotating body shape.

4. The record player according to claim 1, further comprising a guide mechanism that guides said float such that said sound playback stylus moves straight toward a center of the phonograph record.

5. The record player according to claim 4, wherein said guide mechanism includes a rod-shaped shaft extending through said float, which is parallel to a tracking direction of said phono cartridge.

6. The record player according to claim 5, wherein said guide mechanism further includes one or more rings that contact said shaft.

7. The record player according to claim 1, wherein said at least one container comprises two containers, said at least one float comprises two floats each of which be floated on one of liquid, powders, and gel stored in each of said two containers, and said arm is a beam that connects said two floats.

8. The record player according to claim 7, further comprising a suspension mechanism that is attached to said arm, suspends said phono cartridge, and follows vertical movement of said sound playback stylus.