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(71) Applicant: **Hamamura, Hiroshi**
154-3, Jinzaioki-cho
Izumo-shi, Shimane(JP)

(72) Inventor: **Hamamura, Hiroshi**
154-3, Jinzaioki-cho
Izumo-shi, Shimane(JP)

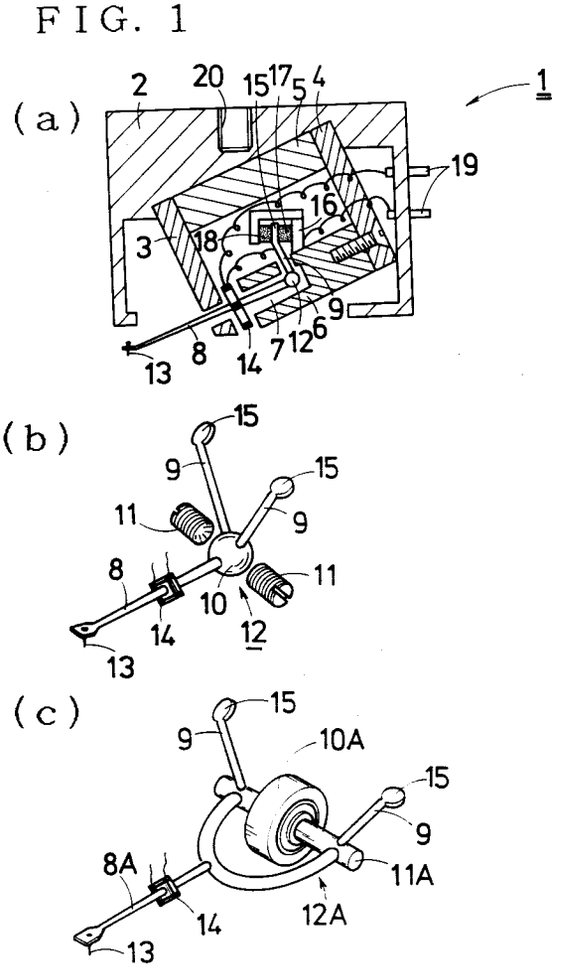
(74) Representative: **Dipl.-Ing. H. Hauck, Dipl.-Ing. E. Graalfs, Dipl.-Ing. W. Wehnert, Dr.-Ing. W. Döring**
Neuer Wall 41
D-20354 Hamburg (DE)

(54) Cantilever damping method and cartridge.

(57) The invention prevents a tone arm's unnecessary vibration caused by vibrations of a cantilever to allow the cantilever to vibrate precisely following wave shapes in sound grooves of records, thereby faithfully reproducing phonic information recorded in the records.

The invention provides a standing damping bar on the cantilever directly thereto or through other parts to change upward or downward vibration of the cantilever to the damping bar's modified vibration directed in a direction extending to or away from the tone arm spindle and cause the modified vibration to be damped forward or rearward in that direction, thereby causing the cantilever to be subjected to reaction force from the tone arm spindle.

FIG. 1



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BACKGROUND OF THE INVENTION

The invention relates to a cartridge for a record player, and more particularly to a unique damping method for a cantilever of the cartridge and a cartridge and a head shell employing the unique damping method for the cantilever.

Compact discs (CD) are in their days now particularly in Japan while records, the analog sound source, appear to be a has-been. This is from such characteristics of CDs not found in the records that CDs are easy to handle without having surface noise and causing listeners to feel a sense of reverberation, while they achieve a larger dynamic range. There are also heard such contrary opinions that CD sound is artificial, rough and cool as metals and plain without having expansion since sound out of audible range are deleted. Some people think better of records in this respect.

Definite characteristics of records not found in CDs may be pointed out not merely nostalgically in that records include also sounds out of the audible range in the sound grooves to provide continuity of sounds, and an excellent sound reproducing device may be used to obtain deep, warm, charming and fine excellent sounds. Particularly, the analog sound source is most suitable for reproducing recorded sounds of classical music and jazz obtained by a good use of actual fine performance of specific musical instruments.

Here the point is performance of the sound reproducing device, particularly, a record player which when poor in performance merely provides reproduced sounds that are not at all compared with those of CDs. Hence, many users including enthusiastic music lovers still seek record players and cartridges of high performance and such products when on the market are expensive.

Reproduction of sounds recorded in records is carried out in the known manner as follows. A stylus tip fixed at a free end of the cantilever traces sound groove of the record to swing upward, downward, leftward or rightward corresponding to wave shapes of the sound groove, and the swing (vibration) is transmitted to a generator mechanism in the cartridge through the cantilever. Voice current generated by the generator mechanism is amplified by an amplifier as in the case of CDs and then output from a speaker. The stylus tip, cantilever and a damper are collectively called a stylus hereunder according to circumstance.

To faithfully reproduce sounds recorded in records, it is required: (a) to cause the stylus tip to accurately trace the sound groove, (b) to cause the stylus tip and cantilever to accurately swing upward, downward, leftward or rightward corresponding to the wave shapes of the sound groove and (c) to accurately generate voice current based on the vibrations of the cantilever.

A conventional cartridge has a structure as shown in Fig. 10. The exemplified cartridge 101 is the orthophone style of high quality and comprises a body housing therein a front yoke 102, a rear yoke 103 and a magnet 104 sandwiched therebetween, the rear yoke 103 having at its lower end a pole piece 105 which is fixed thereto, extends frontward and slightly downward and receives in a recess at the free end a cantilever 107 which mounts at its free end a stylus tip 106 and is connected at the root portion with a suspension wire 108 fixed at its other end to the pole piece 105.

The cantilever 107 is supported to the utmost end of the pole piece 105 through a damper 109 and has a coil 110 fixed near the root portion of the cantilever 107. The coil 110 is adapted to vibrate in a magnetic flux between the pole piece 105 and the front yoke 102 to convert the vibrations of the cantilever 107 to voice current. The cartridge in which electrical energy is generated by vibrating the coil is called MC (moving coil) type, a sort of electromagnetic type.

The cartridge 101 is fixed, in use, to a head shell 112 at the utmost end of a tone arm 111 as shown in Fig. 11. The tone arm 111 is freely rotated, raised up and inclined around a spindle 114 firmly standing on the body of a record player 113. Reference numeral 115 denotes a turntable, 116 a record and 117 a counterbalance.

The cantilever 107 of the above cartridge 101 has a lever structure of a fulcrum, the point at which the suspension wire 108 is fixed, a forcing point, the stylus tip 106 and an operating point, the damper 109. Hence, responsive to upward or downward force F1 applied to the stylus tip 106 by the sound groove of the record, moment of inertia based on the spindle 114 for rotation of the tone arm 111 acts as reaction force F2 on the cartridge 101 in the upward or downward direction to cause the cantilever 107 to shake with respect to the fulcrum. In other words, the upward and downward vibrations of the stylus tip 106 caused by the sound groove are transmitted to the tone arm 111 through the damper 109 and the cartridge 101. The tone arm 111 which is adapted to be readily raised and inclined for a suitably and well following the surface of records is apt to shake upward and downward following vibrations of the cantilever 107.

There are such other various cartridges generally put in use now as MM (moving magnet) type wherein a magnet is adapted to be moved and MI (moving iron) type wherein an iron member is adapted to be moved, each type belonging to the aforesaid electromagnetic type, and those of a condenser type, a photoelectric type or the like. Also, such feature of cartridge is used that the cantilever

is not fixed at the fulcrum and shakes with respect to the damper portion serving as a dummy fulcrum. Every conventional cartridge does, irrespective of their specific constructions and types, not prevent the upward and downward vibration of cantilever from causing the upward and downward shaking of the tone arm, resulting in the following various problems.

First, since the shake of tone arm 11 causes reaction force to be applied to the cartridge 101 to fluctuate, stylus force always fluctuates. That is, the cartridge 101 is not firmly grasped by the tone arm 111 to be, for example, in the state of a hung curtain which is definitely supported at one end but freely moves or shakes at the substantial portion by itself by air or any force, so that the stylus leaps meaninglessly in the worst case to cause the stylus tip to inaccurately trace the sound groove, thereby causing vibrations of the cantilever 107 to inaccurately transmit the wave shapes of the sound groove, resulting in that high-pitched tones are not caught to merely provide sounds having no power, relevant modulation and depth, and actual sounds are not reproduced. Particularly, when low-pitched tones of sounds for which cutting is performed to a larger degree are traced, resonance amplitude of the tone arm 11 becomes large, so that the tone arm 111 deflects to be unable to catch delicate sounds in high-pitched tone region which are mixed with low-pitched tones, thereby merely providing reproduced sounds having no power and clearness.

Furthermore, resonating sounds of the tone arm 111 which has a larger moment of inertia than the cantilever 107 is also transmitted late to the cartridge 101, so that any sound which not recorded in the record and is similar with reverberation is added into the reproduced sound to cause the same to be deteriorated in quality as those by mumbling.

These defects are well known by the makers and the enthusiastic users and various countermeasures have been groped for. For example, moment of inertia is made higher by increasing weights of cartridges or tone arm (not the stylus force). This feature provide depressed and heavy sounds which cause listeners to feel a preferable sense of graveness but also have a restraint or oppressive feeling. When the tone arm or cartridges of decreased weight is used, this provides sounds which cause listeners to feel a sense of lightness and freedom but are thin and not deep. Further strenuous modifications are that a damper is interposed between portions of the tone arm divided in two, a casing for cartridges or other parts employs a special material, or various combinations of amplifiers and speakers are designed.

Also, with guessing that the shake of tone arm is unavoidable, such feature is adopted that the tone arm is made of and given a special material and form to reduce the resonating sounds or have resonance out of the audible range. The feature does not provide a fundamental solution to the problem. Furthermore, an expensive record player uses a field damper but it does not prevent that anti-vibration oil itself shakes, thereby merely providing a reproduced sound which is oppressive as a whole.

There is also a problem that lateral vibration of the cantilever 107 causes the tone arm 111 to shake laterally due to the fact that there is not provided any element which surely stops the lateral vibration. It is in a sense that a car is driven with rubbing a guardrail on the road, leading to that the stylus does not have smoothness and stability in movement, makes higher stylus noise and damages the sound groove of records, and further hinders a precise reproduction of stereophones also due to the upward and downward shaking of the tone arm 111. Any relevant countermeasures to the problem have been neither taken nor well known generally.

SUMMARY OF THE INVENTION

An object of the invention is to prevent the shaking of a tone arm of a record player to allow a stylus tip and a cantilever to vibrate accurately following the wave shapes of sound groove of a record, thereby reproducing recorded sounds precisely.

A further object of the present invention is to provide a cartridge or a head shell which has such a structure that vibration of a cantilever is changed in operating direction about 90° to be directed into a direction extending to or away from a rotation spindle for the tone arm to receive reaction force from the rotation spindle.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1(a) is a longitudinal sectional view showing an example of a cartridge of the present invention.

Fig. 1(b) is an enlarged perspective view showing a supporting method of a cantilever and a damping bar each used in the cartridge shown in Fig. 1(a).

Fig. 1(c) is an enlarged perspective view showing another supporting method of a cantilever and a damping bar.

Figs. 2, 3, 4 and 5 are schematic sectional views showing modified embodiments of separate cartridges.

Fig. 6 is a schematic sectional view showing an example of a head shell of the present invention.

Fig. 7 is a schematic sectional view showing an example of an adapter for mounting a cartridge of the present invention.

Fig. 8(a) is a schematic sectional view showing a further modified cartridge.

Fig. 8(b) is an enlarged perspective view showing a supporting method of a cantilever and a damping bar used in the cartridge shown in Fig. 8-(a).

Fig. 9 is a schematic sectional view showing a modified example of a head shell.

Fig. 10 is a schematic sectional view showing the state that a conventional cartridge is mounted to a conventional head shell.

Fig. 11 is a schematic side view of a record player.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Under the foregoing circumstances, the inventor has achieved the present invention through trial and error for preventing the tone arm in a record player from shaking unnecessarily. Basic concept of the present invention is to change at about 90° the operating direction of the upward or downward vibration of the cantilever to cause the operating direction to be directed into a direction extending to or away from the tone arm rotation spindle so as to obtain reaction force to the cantilever vibration from the tone arm rotation spindle, so that the tone arm does not unnecessarily shake upward and downward to thereby stably hold the cartridge. Also, the invention similarly changes the operating direction of force from leftward and rightward vibration of the cantilever to cause the same operating direction of that force to be directed into a direction extending to or away from the tone arm rotation arm.

In detail, such feature may be employed that the cantilever is provided at its root portion with a standing damping bar, an intersection between the cantilever and the damping bar is supported in a manner of being swingably upward, downward, leftward and rightward and an utmost end of the damping bar is sandwiched at its front and rear sides by dampers. This feature provides that upward or downward vibration of the utmost end of the cantilever is changed in operating direction about 90° to provide forward or backward vibration of the utmost end of the damping bar, so that reaction force to vibrations of the cantilever can be obtained from the tone arm rotation spindle. The supporting portion for the damping bar is subjected only to rotational force but substantially not or at any meaningless values to upward, downward, leftward or rightward force, so that the supporting portion does substantially not transmit force to move up or down the tone arm. Leftward or rightward vibration of the cantilever is similarly received by the tone arm rotation spindle.

The upward and downward direction means a perpendicular direction to a record player when placed horizontally and the leftward or rightward direction and forward or backward direction are set by viewing the cartridge from the tone arm rotation spindle. Also, the forward or backward direction of the cartridge in the case that the damping bar is sandwiched at its forward and backward sides is set with respect to an extending direction of the cantilever as the root portion thereof being at the front side and the stylus tip at the back side.

The forward or backward direction of the cartridge generally corresponds to that viewed from the tone arm rotation spindle. In case of that the cartridge is mounted to a linear tone arm with having an offset angle thereto about 10 to 20°, or a tone arm bent at its utmost end is used in order to reduce tracking error, the vibrating direction of the damping bar slightly shifts from the direction extending to the tone arm rotation spindle. The slight shift may be negligible, or that cartridge may be slightly shifted in position in mounting to those tone arms to allow vibrating direction of the damping bar to correspond to the direction extending to the tone arm rotation spindle.

Means for supporting the cantilever and damping bar freely swingably may employ such supporting means as a ball joint or a gyro member that does not move in position but is freely shiftable in direction. A ball bearing may be used as the supporting means depending on specific usages. The damping bar may be provided on the cartridge body (other than the cantilever) as standing directly from the cartridge body or through other parts. In this case, an adapter interposed between a head shell and a cartridge or the head shell itself serves to work for the function of changing the operating direction of the vibrations. In case of using a head shell having this function, a cartridge may use a general one. Also, in case of using the adapter, the cartridge and the head shell may use conventional ones.

The dampers may use elastic members, such as rubber, plastic or the like customarily employed. Also, such feature may be employed that the damping bar has at utmost end a magnet fixed thereto and additional magnets having the same polarity are arranged facing the front and back sides of that magnet, thereby using repulsive force of the magnets as the damper. The damper or the magnets may be provided with a position adjuster comprising a screw or the like to enable adjustment of vibrations of the cantilever.

The damping bar may be single or use two damping bars standing in a V-like shape. Stereophonic recording is the main current today and sound grooves of the records are cut slantwise leftward and rightward at 45° with respect to the perpendicular direction, so that when two damping bars are provided slantwise at 45° with respect to perpendicular direction, each damping bar makes damping following vibrations of the cantilever according precisely to the left and right wave shapes of the sound groove, thereby providing a complete stereophonic sound. Also, two or four damping bars may be provided in a X-like shape to cause each damping bar to be damped. Use of a single damping bar may fully control the leftward or rightward vibration but has less efficiency in comparison with the case of two damping bars.

A spring serving also as a damper may be substituted for the damping bar. In this case, upper end of the spring is fixed directly to the cartridge body to be directed toward the tone arm rotation spindle so as to transmit vibrations of the cantilever thereto. This feature provides a similar effect to the case using a pipe-like shaped damping bar.

When using a single damping bar, features therefor may be modified as follows. For example, the cantilever is provided at its root portion with a damping bar which stands thereat, is spherical at its utmost end and is supported at and near the connecting part between the cantilever and the damping bar to a cartridge body by use of an elastic supporting member. A hard cup-like shaped stopper having a recess slightly larger in size than the damping bar's spherical end is fixed to the cartridge body, and the spherical end of the damping bar extending almost perpendicularly is received in, contacted with and held by the recess of the cup-like shaped stopper. This feature does, similarly with the foregoing features, provide that vibrations of the cantilever are converted into vibrations of the damping bar in a direction extending to or away from the tone arm rotation spindle, so that the spherical utmost end of the damping bar is controlled by the recess of the cup-like shaped stopper to cause vibrations of the damping bar to be transmitted to the tone arm rotation spindle, thereby receiving reaction force therefrom. This feature is different from the aforesaid feature in that the supporting part for the damping bar uses an elastic member for absorbing any force (other than rotational force) to be applied to the supporting part due to the feature that clearance between the spherical end of damping bar and the recess of the cup-like shaped stopper is small and the stopper is made of a hard material, such as metal or the like.

The present invention is not directed to a problem of a larger irregularity on the record surface due to its bending or the like. The tone arm is, as conventionally, moved up and down following such irregularity on the record surface to make arrangement thereagainst. But, the stylus tip at the end of the cantilever stably traces the sound groove and is substantially not subjected to unnecessary reaction force or the like from the tone arm itself. Further, the damping mechanism for cantilever according to the present invention may be applicable to every cartridge in MC, MM and MI types, condenser type, photo-electric type or the like used conventionally. When using the cartridge and others according to the present invention, a heavier tone arm which gives a larger moment of inertia to a certain extent provides a preferable result.

Records more faithfully record phonic information of a master tape than CDs do, but the phonic information recorded in the records are hitherto not fully reproduced. The cartridge according to the present invention is, as aforesaid, not subjected to reaction force from the tone arm itself due to the force of inertia thereof but is firmly held by the tone arm, and the stylus tip traces the sound groove of records as if it sticks fast thereto, so that the phonic information can be reproduced faithfully. Hence, the reproduced sounds have a larger dynamic range and are clean-cut as those of CDs while being fine, deep and clear as inherently. Also, high-pitched tones can be clearly reproduced to sharply provide powerful, vivid, stereophonic and warm sounds. Particularly, when the tracking error angle is near zero, the reproduced sounds are very much stereophonic to cause the listener to have an illusion as if he is actually at a concert.

It is natural that the cartridge of the present invention does not fully exhibit its ability when an amplifier, a speaker and a record player themselves are poor in efficiency. But, the quality of reproduced sounds is further improved by the cartridge of the present invention but not the conventional cartridge when they are applied to the same reproducing device.

EXAMPLES

Next, the present invention will be detailed with referring to specific examples shown in the attached drawings.

Example 1

Fig. 1(a) is a longitudinal sectional view showing an example of a cartridge according to the present invention, and Fig. 1(b) a perspective view showing a cantilever and a damping bar used in the cartridge shown in Fig. 1(a).

The cartridge 1 is MC type improved based on the orthophone style shown in Fig. 10 and comprises, as that of Fig. 10, a casing 2 serving as a

body in which a front yoke 3 and a rear yoke 4 sandwiches a magnet 5, the rear yoke 4 having at its lower end a pole piece 6 fixed thereto and extending forward and slightly downward. The pole piece 6 has a groove 7 wherein a cantilever 8 and a damping bar 9 are supported. The front yoke 3, rear yoke 4, pole piece 6 and magnet 5 form a loop of magnetic line of force, and magnetic field is generated between the lower end of the front yoke 3 and the utmost end of the pole piece 6.

The cantilever 8 is made of a pipe or a rod and has at its root portion a spherical member 10 as shown in Fig. 1(b). Two damping bars 9 are provided at the top of the spherical member 10 to stand in a V-like shape and substantially perpendicularly to the cantilever 8. The angle of the V-like shape is about 90° corresponding to sound groove of records. The spherical member 10 is supported at its both sides by two ball holders 11 fixed in the groove 7 to constitute a rotation supporting part 12 in a ball-joint-like formation, so that the cantilever 8 is supported to the pole piece 6 in a manner of being freely swingable upward, downward, leftward and rightward. The upright damping bars 9 may be provided directly on a portion of the cantilever 8 which portion is placed forward or backward of the spherical member 10.

A stylus tip 13 is fixed at the utmost end of the cantilever 8, and a coil 14 for generating electrical energy is mounted on the cantilever 8 at the point near the utmost end of the pole piece 6. The damping bar 9 is bent at its utmost end to extend perpendicularly and have a disc-like shaped damper-contact part 15. The damper-contact part 15 is sandwiched at its front and rear sides by dampers 17 and 18 placed in a damper accommodating part 16 fixed on the upper side of the pole piece 6. Lead wires are connected between the coil 14 and four terminal pins 19 (two pins are shown in Fig. 1), and the casing 2 has at the upper part a thread bore 20 for fixing the casing to a head shell.

When the cartridge 1 is mounted to a tone arm 111 shown in Fig. 11, vibrations of the stylus tip 13 is transmitted to the damping bars 9 through the cantilever 8 to cause the damper-contact parts 15 at the utmost end of damping bars to vibrate in a direction extending to or away from the spindle 114 for rotation of the tone arm 111. For example, when the stylus tip 13 is moved up by force F1 from the sound groove of record, the damper-contact part 15 at the end of damping bar shifts forward, so that the damper-contact part 15 presses the damper 17 to be subjected to buffer action of the damper 17 and return to the original position, thereby giving a downward force to the stylus tip 13.

In detail, the force pressing the damper 17 is transmitted to the spindle 114 through the tone arm 111 and returns as reaction force F3 from the spindle 114. In this instance, the rotation supporting part 12 does merely change the operating direction of the applied force and does substantially not function upward, so that an upward force is not exerted on the head shell 112 and there causes almost no reaction force from the head shell 112 to the cantilever 8.

When the stylus tip 13 vibrates leftward and rightward, one of the damper-contact parts 15 of the damping bars is subjected to a force urging this the damper-contact part forward and the other to a force urging the damper-contact part backward, so that each damper-contact part presses the dampers 17 and 18 respectively to receive reaction force from the spindle 114 similarly with the foregoing case. Hence, the stylus tip 13, in turn, the cantilever 8 when vibrates in any direction as upward, downward, leftward, rightward or slantwise or the like manner receives reaction force from the tone arm spindle 114 but substantially not from the head shell 112 itself. Also, the spindle 114 for rotation of the tone arm firmly stands on the record player 113, so that the cantilever 8 does not vibrate due to reaction force from the spindle 114, whereby the head shell 112 does not vibrate unnecessarily to allow voice current from the coil 14 to be based only on vibration of the cantilever 8, thereby providing reproduced sounds of quite high quality. Also, the dampers 17, 18 are subjected to the force only in the direction that they are pressed not as in the conventional cartridge 101, thereby stably providing the buffer action.

Next, various modified embodiments will be detailed. The drawings related thereto are schematic diagrams emphasizing the principal parts and having the same reference numerals for the same parts as those used in the above example. The mounting method for the damping bars 9 are not limited to those shown and may use a single damping bar 9.

Construction of the rotation supporting part 12 is not limited to those shown and may alternatively use a gyro member in place of the spherical member 10 and the ball holders 11, or use a ball bearing 10A and a shaft member 11A. In the rotation supporting part 12A shown in Fig. 1(c), a Y-like shaped cantilever 8A and two damping bars 9 are fixed to a shaft member 11A inserted into and fixed to an inner race of a ball bearing 10A, and an outer race of the ball bearing 10A is mounted and fixed to the pole piece 6. In this case, the cantilever 8A and damping bars 9A can readily vibrate also leftward and rightward or laterally due to play between the inner and outer races of the ball bearing 10A.

Example 2

Fig. 2 shows an example of a cartridge of MM type. The cartridge 21 comprises a casing 2 having a frame member 22 which is fixed to the inner surface of the upper part of the casing 2, extends downward and mounts two sets of coils 23. A small magnet 24 is fixed at the substantial middle point of the cantilever 8 to be adapted to be moved in and out from the shown gap of the frame member 22. The magnet 24 which is smaller and lighter than the coil 14 has such an advantage that the cantilever 8 is subjected to less load.

The cartridge is different from the cartridge 1 of the above example in that dampers 17, 18 are each fixed to the utmost ends of screws 25, 26 respectively, the bolt 25 being supported to the casing 2 and the bolt 26 to a support 27 projecting on the inner surface of the casing 2, each bolt being adjustable longitudinally. This example has the same structure of pole piece 6, rotation supporting part 12 and others as those of the first example and similarly provides reproduced sounds of improved quality.

Example 3

Fig. 3 shows a cartridge 31 which is a modified MM type and different from those examples in the construction of damper portions and the generator mechanism. In the cartridge 31, a magnet 32 is fixed to the utmost end of a damping bar 9 and magnets 33, 34 of the same magnetic pole are spaced at predetermined intervals from the front and rear sides of the magnet 32, thereby using repulsive force of the magnets as a damper. The magnets 33, 34 serve as the dampers 17, 18 of the above examples. Since there is no contact between the magnets and the damping bar 9, vibration of the damping bar 9 is a quite natural one not as in the case wherein the damping bar is arranged to contact with the dampers 17, 18.

The magnets 33, 34 are fixed to the upper inner surface of the casing 2 through supports 35, 36 in a manner of being adjustable in positions. Coils 37, 38 are arranged to house therein the magnets 33, 34, so that when the magnet 32 vibrates, voice current is generated at the coils 37, 38.

Example 4

A cartridge 41 shown in Fig. 4 is a kind of combination of the cartridge 21 (Fig. 2) and that 31 (Fig. 3) to be MI type. In the cartridge 41, a magnet 42 is fixed to the utmost end of a damping bar 9 and sandwiched at the front and rear sides by dampers 17, 18 made of an elastic member. Magnetic members 43, 44, such as iron bars mounting the dampers 17, 18 are interposed between generator coils 45 and 46. Reference numerals 47 and 48 denote supports which project in the casing 2 for supporting the magnetic members 43, 44 and coils 45, 46.

Example 5

Fig. 5 shows an example of a cartridge 51 using a damping spring 52 in place of the damping bars 9. The generator mechanism is MM type as in the cartridge 21 (Fig. 2) and may employ other types. In the cartridge 51, two short rods 53 in place of the damping bars 9 are provided as standing on the top of a spherical member 10 and the damping springs 52 are retained at their root portions to the rods 53. Remote ends of the damping springs 52 are retained, as directed forward, to a support 54 projecting on the upper inner surface of the casing 2. The damping springs 52 serve also as dampers 17, 18 to eliminate the same.

Example 6

The cartridges referred to in the above examples are embodiments of the damping method according to the present invention. A cartridge according to the present invention should not be limited to those. The foregoing cartridges are separately formed from the tone arm to thereby be replaceable but may be integrally formed with the tone arm. Furthermore, the damping method according to the present invention can be embodied not only in the cartridges but also in a head shell or the like. Fig. 6 shows an example of a head shell provided with a damping mechanism for cantilever and mounting a general cartridge.

In the head shell 61, a casing 62 has at the lower part a plate 62a fixed thereto, and a root portion of a member 63 for mounting a cartridge is supported at the remote end of the plate 62a in a manner of being freely swingably upward, downward, leftward and rightward. A thicker rod or the like may be used in place of the plate 62a. A rotation supporting part 64 may be similar in construction, for example, with the rotation supporting part 12, 12A for cartridges as shown in Figs. 1(b) and 1(c). Also, a damping bar 65 is provided as standing on the root portion of the cartridge mounting member 63 and sandwiched at the front and rear sides of the utmost end by dampers 66a, 66b mounted on the head shell body. Reference numerals 67a and 67b denote screws for tightly holding the dampers and 68a, 68b supports for supporting the screws.

When a general cartridge 101 is mounted to the head shell 61 to reproduce sounds recorded in

records, upward or downward vibration of a cantilever 107 is changed in operating direction by the structure of the head shell 61 so as to be directed in a direction extending to or away from the tone arm spindle 114 (Fig. 11), thereby preventing the head shell 61 from shaking upward and downward. Resultantly, reproduced sounds have improved quality similarly with the case using the cartridge according to the present invention.

The shown head shell 61 is a universal type to be used in a record player wherein head shells are replaceable. The head shell structure may be applicable to a head shell integrally formed with a tone arm. Also, most of the conventional cartridges in replacement type may be applied to the head shell 61 by use of a screw 69 or other means.

Example 7

A modified adapter may be interposed between a conventional head shell 112 and cartridge 101 in order to obtain the effect of improvement of quality of reproduced sounds as in the present invention. Fig. 7 shows an example of the feature wherein an adapter 71 having a damping mechanism for a cantilever is mounted to a general head shell and mounts a general cantilever 8.

In the adapter 71 for mounting a cartridge, a casing 72 has at the lower part a plate 72a fixed thereto, and a root portion of a member 73 for mounting a cartridge is supported at the remote end of the plate 72a in a manner of being freely swingably upward, downward, leftward and rightward. A rotation supporting part 74 may be similar in construction, for example, with the rotation supporting part 12, 12A for cartridges as shown in Figs. 1(b) and 1(c). Also, a damping bar 75 is provided as standing on the root portion of the cartridge mounting member 73 and sandwiched at the front and rear sides of the utmost end by dampers 76a, 76b mounted on the head shell body. Reference numerals 77a and 77b denote screws for tightly holding the dampers and 78a, 78b supports for supporting the screws, 79 a screw for fixing the adapter 71 to the head shell 112 and 80 a screw for fixing a cartridge 101 to the adapter 71.

The cartridge mounting adapter 71 may be applicable to most of tone arms in cartridge replacement type and economically usable in association with a conventional record player and cartridge in hand.

When the adapter 71 is mounted to a head shell 112 in the cartridge replacement type and mounts a general cartridge 101 to reproduce sounds recorded in records, upward or downward vibration of a cantilever 107 is changed in operating direction by the structure of the adapter 71 so as to be directed in a direction extending to or away from the tone arm spindle 114 (Fig. 11), thereby preventing the head shell 112 from shaking upward and downward. Resultantly, reproduced sounds have improved quality similarly with the case using the cartridge according to the present invention.

Example 8

Next, a cartridge and a head shell with a separate damping method for a cantilever from those of the above examples will be detailed with referring to Figs. 8 and 9. A cartridge 81 shown in Fig. 8(a) has MM type of generator mechanism as of the cartridge 21 (Fig. 2) but is different therefrom in the damping mechanism. In the cartridge 81, the cantilever 8 is, as shown in Fig. 8(b), provided at its root portion with a single damping bar 82 which is fixed thereat, stands substantially perpendicularly and is supported and fixed at and near the connecting portion between the cantilever and the damping bar to the pole piece 6 by use of an elastic support means 83 having cushioning efficiency. The supporting of this connecting portion to the pole piece 6 constitutes a kind of loose rotation-supporting part 84 wherein the connecting portion can shift upward, downward, leftward, rightward, forward and backward.

The damping bar 82 has a spherical member 85 at its remote end. A hard cup-like shaped stopper 87 which has a recess 86 slightly larger in size than the spherical member 85 is fixed to a casing 2. The spherical member 85 of the damping bar 82 is contacted with and held by the recess 86 of the stopper 87. Hence, when the cantilever 8 vibrates upward, downward, leftward or rightward, the utmost end of the damping bar 82, in turn, the spherical member 85 vibrates forward, backward, leftward or rightward with respect to the direction extending to or away from the tone arm spindle. The vibration of the spherical member 85 is controlled by the recess 86 of the cup-like shaped stopper 87 to be transmitted to the tone arm spindle, thereby receiving reaction force therefrom, so that the head shell 112 is prevented from vibrating similarly in the foregoing examples and the effect of improvement of quality of reproduced sounds can be obtained.

In the example, there is smaller clearance between the spherical member 85 and the recess 86 and the cup-like shaped stopper 87 is made of a hard member. Hence, the rotation supporting part 84 is subjected to any force other than rotational force. To absorb that force, the support means 83 is made of an elastic member. The utmost end of the damping bar 82 is not limited to be the spherical member 85 but may have a spherical surface at

the top of the damping bar. Also, it is preferable to use metal, hard plastic or the like for the cup-like shaped stopper 87.

Example 9

A head shell 91 shown in Fig. 9 adopts the similar structure of rotation supporting part 84 with the cartridge 81 of Example 8. A casing 92 has at the lower part a plate 92a fixed thereto, and a root portion of a member 93 for mounting a cartridge is supported at the remote end of the plate 92a in a manner of being freely swingably upward, downward, leftward and rightward. The cantilever mounting member 93 is provided at its root portion with a damping bar 95 which is fixed thereat, has a spherical surface 94 at utmost end, stands substantially perpendicularly and is supported and fixed at and near the connecting portion between the cartridge mounting member and the damping bar to the casing 92 by use of an elastic support means 96.

A hard cup-like shaped stopper 98 which has a recess 97 slightly larger in size than the spherical surface 94 of the damping bar is fixed to the casing 92. The spherical surface 94 at the utmost end of damping bar is contacted with and held by the recess 97 of the stopper 98. Hence, when the cantilever 8 vibrates upward, downward, leftward or rightward, the spherical surface 94 at utmost end of the damping bar vibrates forward, backward, leftward or rightward with respect to the direction extending to or away from the tone arm spindle. The vibration of the spherical surface portion is controlled by the recess 97 of the cup-like shaped stopper 98 to be transmitted to the tone arm spindle, thereby receiving reaction force therefrom, so that the head shell 112 is prevented from vibrating similarly in the foregoing examples and the effect of improvement of quality of reproduced sounds can be obtained. The cantilever damping mechanism may be incorporated with the adapter shown in Fig. 7 to obtain the same effect as above.

EFFECTS OF THE INVENTION

As seen from the above, the cantilever damping method according to the present invention changes through the damping bar the cantilever's upward, downward, leftward, rightward and slantwise vibrations upon reproduction of recorded sounds to modified vibrations having vibration component directed to a direction extending to or away from the tone arm spindle, and causes the modified vibrations to be damped forward or rearward in that direction, so that reaction force from the tone arm spindle is applied in that direction to the cantilever, in turn, the stylus tip.

Resultantly, the following various excellent effects not found conventionally are obtainable.

(1) The cantilever does substantially not apply vibrations to the tone arm to thereby receive no reaction force therefrom, so that the cartridge itself does not shift upward, downward, leftward or rightward to be held stably by the tone arm and only the stylus tip and cantilever do vibrate precisely following the sound groove to reproduce quite faithfully phonic information recorded in records.

Records record phonic information of a master tape as they are. The obtained reproduced sounds from the records have expansion of sound and charm not obtainable by CDs and are fine and sharp and also dynamic and cleancut as CDs. This means that the present invention provides an ideal sounds reproducing method.

(2) Since the tone arm itself does not vibrate as seen above, the cartridge smoothly slides on the record surface as sticking fast thereto and the stylus does neither leap meaninglessly nor apply extra force to side surfaces of the sound groove, thereby giving no damages to the records and providing reproduced sound which is of no surface noise to be smooth and free.

(3) Stylus force is constant, and force to be applied to the stylus tip by each crest in the sound groove when the stylus tip crests the crests is returned as it is to the stylus tip through operation of the dampers, so that the stylus tip when descends from each crest traces the sound groove at the same constant stylus force as that in the stylus tip's cresting the crests. Hence, delicate vibrations included in those of large amplitude can be also surely caught, thereby enabling high and low-pitched tones and dynamics to be well reproduced.

(4) Since there is generated no reverberation due to resonance of the tone arm, the reproduced sound is free of those unclear as mumble, while having a larger dynamic range and being clear and cleancut.

(5) Leftward and rightward vibrations of the cantilever are also damped by receiving reaction force from the tone arm spindle, so that stereophones are precisely reproduced to obtain reproduced sounds which are excellently stereophonic, vivid and deep to cause listeners to have an illusion as if they are actually at a concert.

Furthermore, the cartridge and head shell according to the present invention is an incarnation of the cantilever damping method according to the invention and have the following characteristics.

(1) Obtainable by use of the cartridge and head shell according to the present invention is the

abovesaid innovative effect of improvement of sound quality. The present invention even when applied to a comparatively cheaper record sound reproducing system can provide reproduced sounds equivalent to those obtained by a high-grade reproducing system using a conventional cartridge. When used in an expensive sound reproducing system, the invention provides excellent reproduced sounds equivalent to those just of a master tape for records or provided by professional sound-reproducing systems used in a broadcasting station.

(2) The cartridge and head shell of the invention have simple constructions and are manufactured at a cost equal to that for the conventional devices or less than that depending on specific constructions.

(3) The cartridge may be widely applicable to various cartridges of specific generator systems and may be formed integrally with the tone arm. Also, the damping mechanism for cantilever may be provided in a head shell or an adapter other than the cartridge, so that the head shell, adapter and cartridge cover every kind of record players. (4) The cartridge is not required to provide dampers for a cantilever to thereby allow the cantilever to have larger freedom in movement and mount coil and magnets of larger sizes and weights, thereby enabling improvement of generator efficiency.

Claims

1. A damping method for a cantilever by changing vibrations of a cantilever to a damping bar's modified vibrations having vibration component directed to a direction extending to or away from a tone arm spindle, the damping bar being provided as standing on the cantilever or a cartridge directly thereto or through other parts, and causing the damping bar's modified vibrations to be damped forward or rearward in that direction by use of a damper, so that reaction force from the tone arm spindle is applied in that direction to the cantilever.

2. A damping method for a cantilever as set forth in claim 1, wherein a magnet is fixed at utmost end of the damping bar and additional magnets each having the same polarity are arranged forwardly and backwardly of that magnet, so that repulsive force of the magnets is used as a damper.

3. A damping method for a cantilever as set forth in claim 1, wherein the damping bar employs a spring serving also as a damper, so that vibrations of the cantilever is transmitted through an upper end of the spring to the direction extending to or away from the tone arm spindle.

4. A damping method for a cantilever as set forth in claim 1 or 3, wherein there are provided two damping bars angularly spaced away from each other, so that vibrations of the damping bars due to leftward and rightward vibrations of the cantilever are damped in the direction extending to or away from the tone arm spindle.

5. A damping method for a cantilever by changing vibrations of a cantilever to a damping bar's modified vibrations having vibration component directed to a direction extending to or away from a tone arm spindle, the damping bar being provided as standing on the cantilever or a cartridge directly thereto or through other parts and being supported at and near its root portion by a damper, and causing the damping bar's modified vibrations to be damped by a cup-shaped stopper covering a spherical utmost end of the damping bar, so that reaction force from the tone arm spindle is applied in that direction to the cantilever.

6. A cartridge wherein a cartridge body is mounted to an utmost end of a tone arm, a cantilever is supported at or near its root portion to the cartridge body in a manner of being freely swingable upward, downward, leftward or rightward, a damping bar is provided as standing at or near the root portion of the cantilever in such a manner that at least utmost end of the damping bar extends substantially perpendicularly, and the utmost end of the damping bar is sandwiched at the front and rear sides by a damper mounted to the cartridge body.

7. A cartridge as set forth in claim 6, wherein a magnet is fixed to the end of the damping bar and sandwiched at the front and rear sides by dampers comprising an elastic member, and magnetic members mounted to the dampers are arranged facing generating coils.

8. A cartridge wherein a damping bar having a spherical surface at its utmost end is provided as standing at or near the root portion of a cantilever and is supported at and near the connecting portion between the cantilever and the damping bar to a cartridge body by use of an elastic member, and a hard cup-like shaped stopper having a recess slightly larger in size than the spherical surface of damping bar is fixed to the cartridge body, so that the utmost end portion of the damping bar extending substantially perpendicularly is contacted with and

held by the recess of the cup-like shaped stopper.

9. A head shell wherein a head shell body is placed at an utmost end of a tone arm, a cartridge mounting member is supported at or near its root portion to the head shell body in a manner of being freely swingable upward, downward, leftward or rightward, a damping bar is provided as standing at or near the root portion of the cartridge mounting member in such a manner that at least utmost end of the damping bar extends substantially perpendicularly, and the utmost end of the damping bar is sandwiched at the front and rear sides by a damper mounted to the head shell body.

10. A head shell wherein a damping bar having a spherical surface at its utmost end is provided as standing at or near the root portion of a cartridge mounting member and is supported at and near the connecting portion between the cartridge mounting member and the damping bar to a head shell body by use of an elastic member, and a hard cup-like shaped stopper having a recess slightly larger in size than the spherical surface of damping bar is fixed to the head shell body, so that the utmost end portion of the damping bar extending substantially perpendicularly is contacted with and held by the recess of the cup-like shaped stopper.

11. A cartridge mounting adapter interposed between a head shell placed at utmost end of a tone arm and a cartridge, wherein an adapter body is mounted and fixed to the head shell, a cartridge mounting member is supported at or near its root portion to the adapter body in a manner of being freely swingable upward, downward, leftward or rightward, a damping bar is provided as standing at or near the root portion of the cartridge mounting member in such a manner that at least utmost end of the damping bar extends substantially perpendicularly, and the utmost end of the damping bar is sandwiched at the front and rear sides by a damper mounted to the adapter body.

FIG. 1

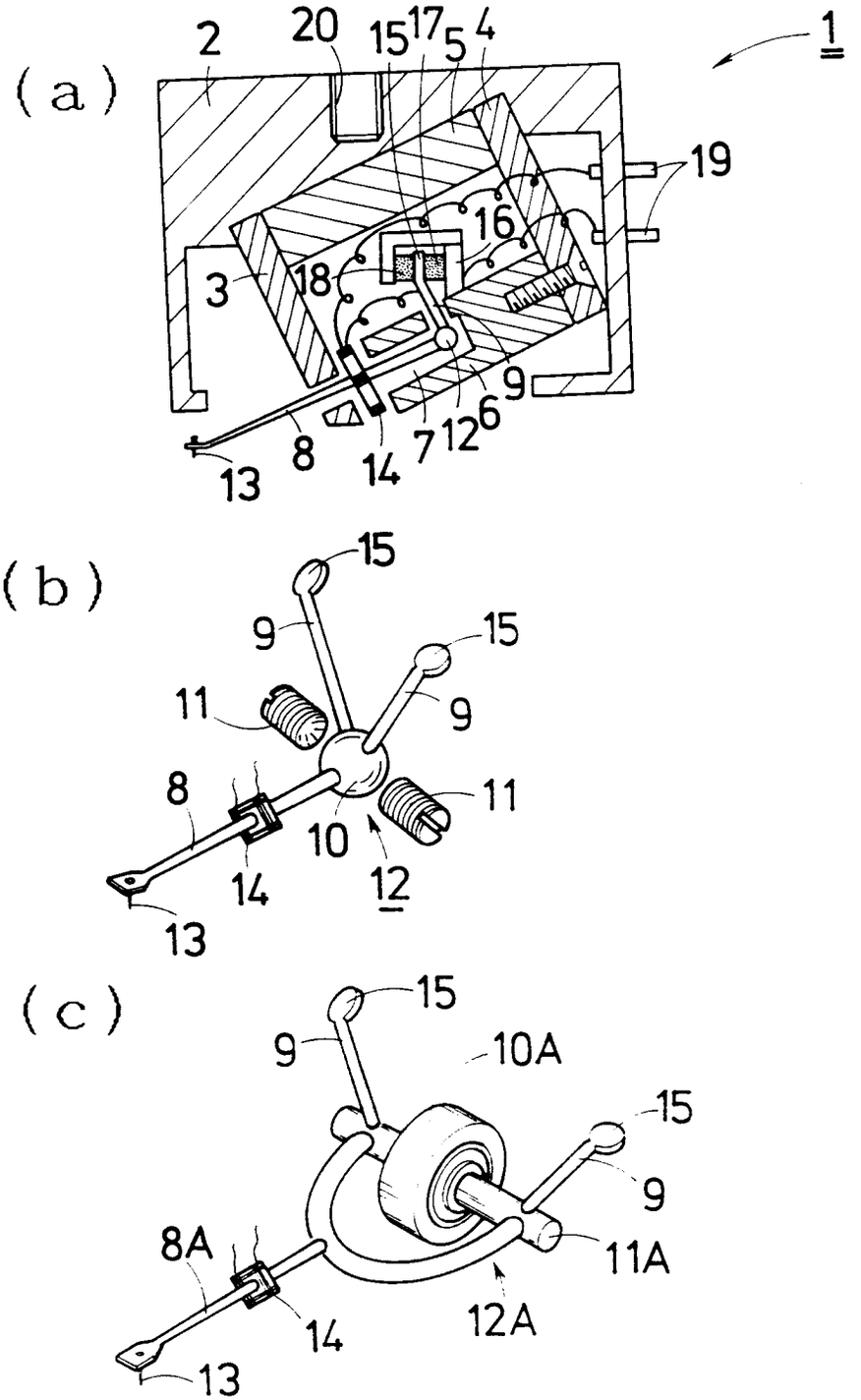
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FIG. 2

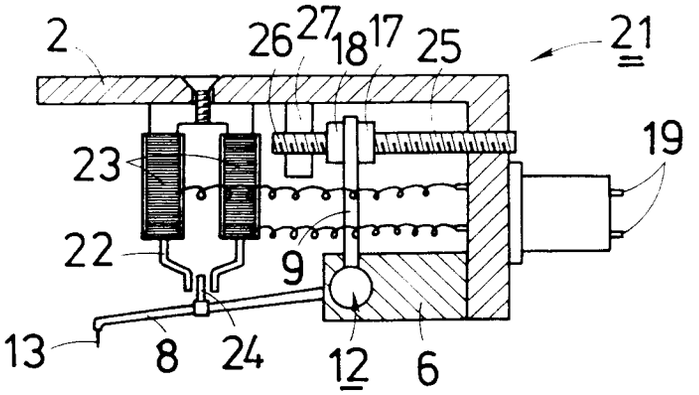


FIG. 3

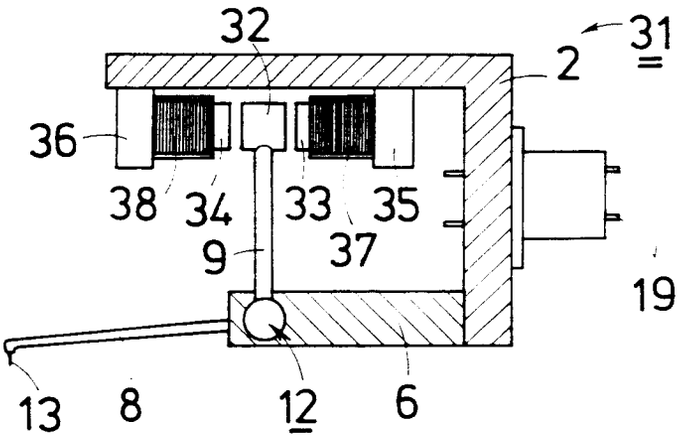


FIG. 4

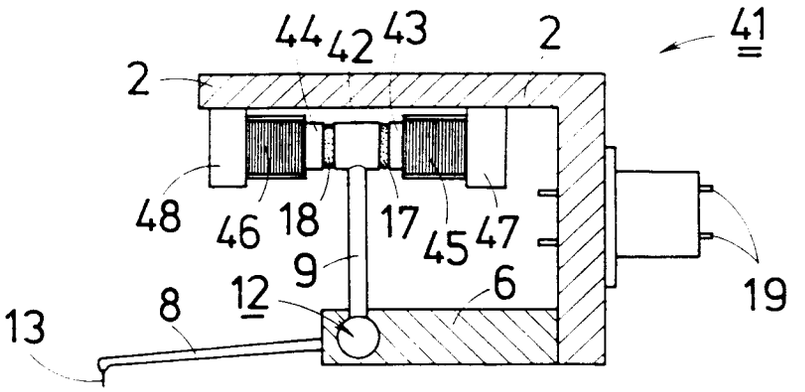
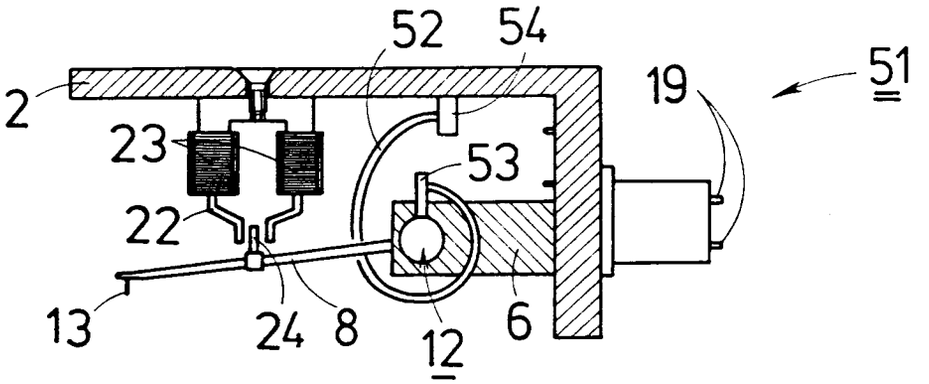


FIG. 5



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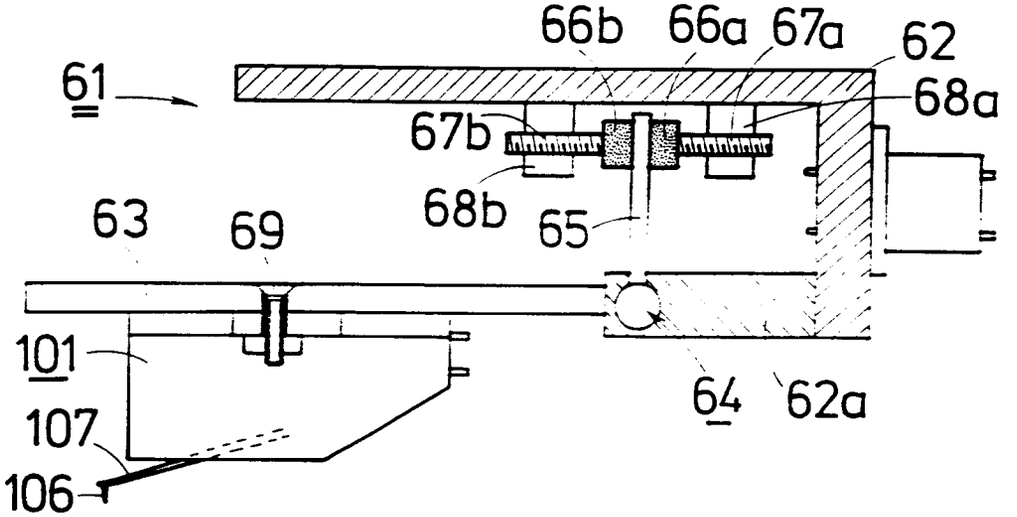


FIG. 7

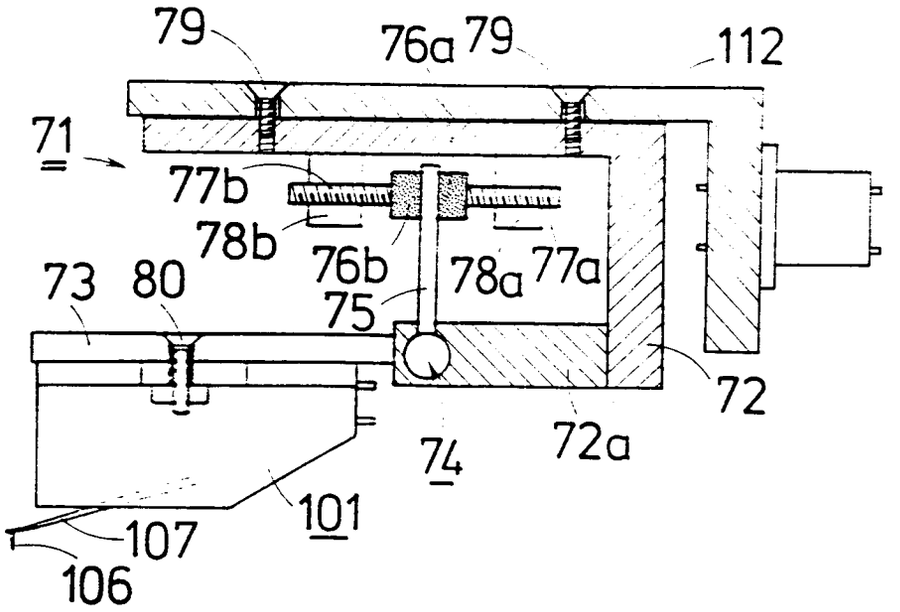
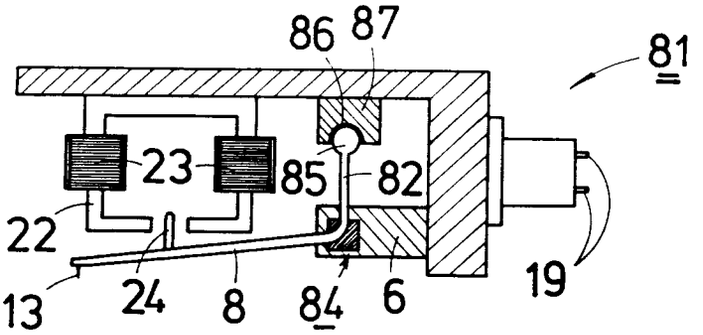


FIG. 8

(a)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(b)

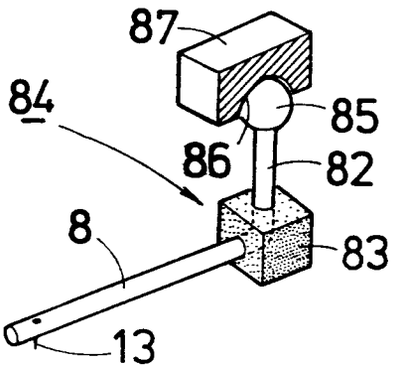
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FIG. 9

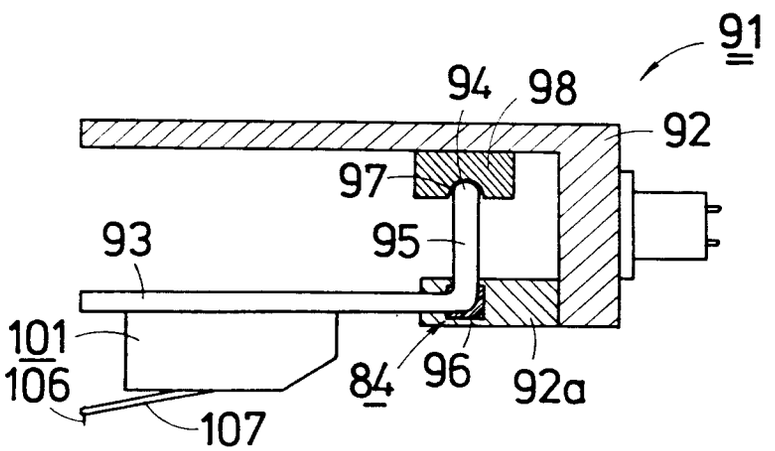
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FIG. 10

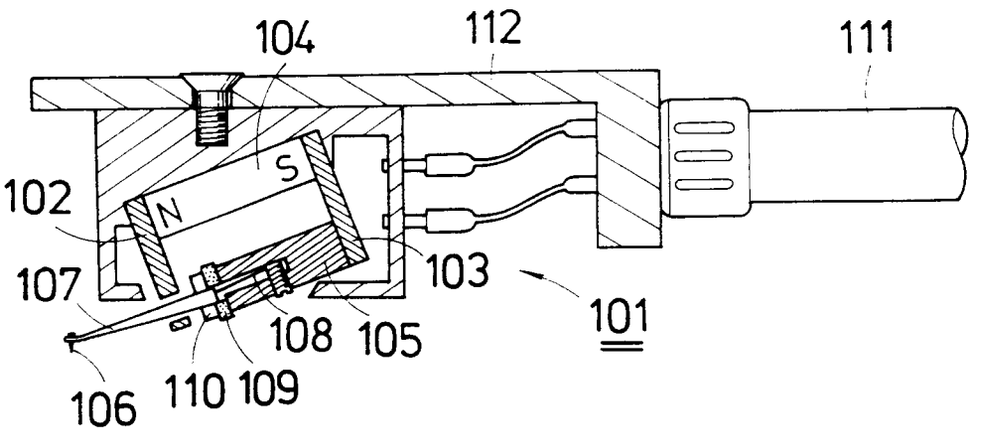
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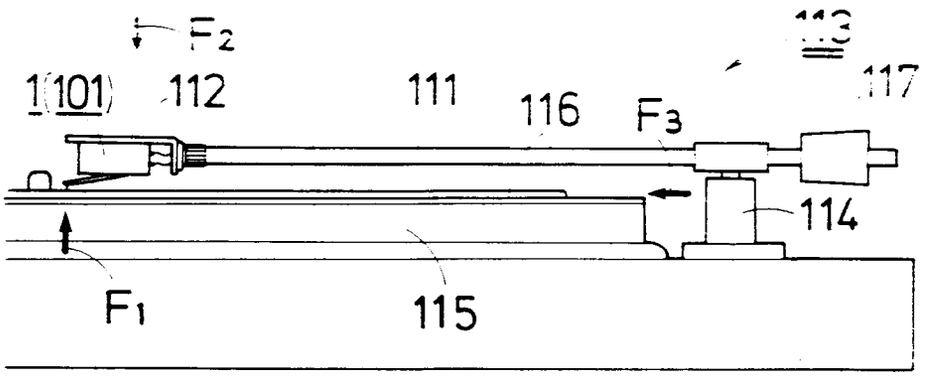
FIG. 11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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 2244

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X A	US-A-3 956 598 (KAWAKAMI ET AL.) * column 2, line 31 - line 58 *	1,4 5	H 04 R 1/16
X A	FR-A-2 069 957 (ELECTROACOUSTIC GMBH) * page 2, line 21 - line 37; page 4, line 27 - page 5, line 24; page 6, line 11 - line 29 *	1,4 5	
A	US-A-3 142 729 (DAVIS) * column 2, line 5 - column 3, line 26 *	1,2,4,5	
A	FR-A-2 525 060 (RCA) * page 1, line 1-5; page 2, line 31 - line 34; page 4, line 14 - line 24 *	1,3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H 04 R

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
THE HAGUE	13-10-1992	ZANTI P V L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

European Patent Office

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid,

namely claims:

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions,
namely:

see sheet -B-

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid,

namely claims:

☒ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims,

namely claims: 1-5

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1-5 : Damping method for a cantilever inside a cartridge.

2. Claims 6-11 : Cartridge mounting adapter to a head shell.