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[71] Applicant: AAC Acoustics Technology (Shenzhen) Co., Ltd.

Address:, No. 18 Xinxi Road, North Zone, High-tech Industrial Park, Nanshan District, Shenzhen, Guangdong Province, 518057

Co-applicant: AAC Acoustics Technology (Changzhou) Co., Ltd.

[72] Inventors: Dong Leping; Pu Yonghua

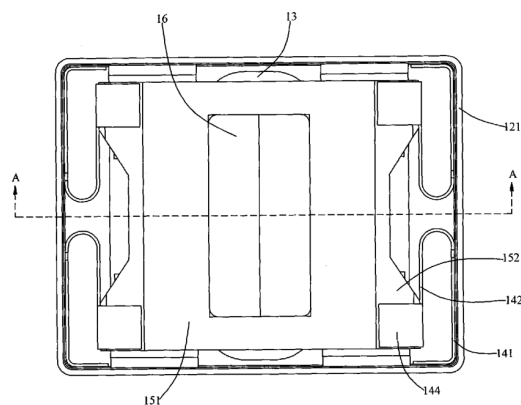
1 page of claims, 5 pages of description, 3 pages of drawings

[54] Title

Flat linear vibration motor

[57] Abstract

A flat linear vibration motor, which comprises an upper cover, a base that mates the upper cover to form an accommodating space, a coil received in the accommodating space and positioned on the base, elastic supports connected to the base, and a permanent magnet suspended within the accommodating space by the elastic supports, wherein the base is provided with a plurality of side walls and a bottom wall perpendicular to the side walls; the coil is arranged on the bottom wall and located below the permanent magnet in the central position with a gap between the coil and the permanent magnet; magnetic poles of the permanent magnet directly face the coil, and the magnetic poles of the permanent magnet directly facing the coil are polarized in opposite direction; and the elastic support is provided with a fixing portion connected to the base, an elastic arm extending from the fixing portion and facing the fixing portion and having an elastic deformation direction parallel to the bottom wall of the base, and an engaging portion extending from the elastic arm and connected to the permanent magnet such that the permanent magnet can move in a direction parallel to the bottom wall.



1. A flat linear vibration motor, which comprises an upper cover, a base that mates the upper cover to form an accommodating space, a coil received in the accommodating space and positioned on the base, elastic supports connected to the base, and a permanent magnet suspended within the accommodating space by the elastic supports, wherein the base is provided with a plurality of side walls and a bottom wall perpendicular to the side walls, the coil is arranged on the bottom wall and located below the permanent magnet in the central position with a gap between the coil and the permanent magnet, characterized in that: magnetic poles of the permanent magnet directly face the coil, and the magnetic poles of the permanent magnet directly facing the coil are polarized in opposite direction; and the elastic support is provided with a fixing portion connected to the base, an elastic arm extending from the fixing portion and facing the fixing portion and having an elastic deformation direction parallel to the bottom wall of the base, and an engaging portion extending from the elastic arm and connected to the permanent magnet such that the permanent magnet can move in a direction parallel to the bottom wall.

2. The flat linear vibration motor according to claim 1, wherein the permanent magnet is an integral structure.

3. The flat linear vibration motor according to claim 1, wherein the permanent magnet comprises two separate magnets.

4. The flat linear vibration motor according to claim 1, 2 or 3, wherein the permanent magnet is connected to the elastic arm of the elastic support through a counterweight, the counterweight being provided with a main body and a positioning portion extending from the main body and connected to the elastic arm, the main body being provided with a through hole, and the permanent magnet being fixed in the through hole.

5. The flat linear vibration motor according to claim 4, wherein the material density of the counterweight is not less than 7.8 g/cm^3 .

6. The flat linear vibration motor according to claim 1, wherein the fixing portion of the elastic support is provided with a first positioning portion positioned on a certain side wall of the base and a second positioning portion extended from the first positioning portion and positioned on a side wall adjacent to the certain side wall.

7. The flat linear vibration motor according to claim 1 or 6, wherein the engaging portion of the elastic support comprises a clamp extending from a side edge of the elastic arm away from the fixing portion, the clamp being composed of an upper clamping portion and a lower clamping portion extending from two side edges of the elastic arm and opposite each other.

Flat linear vibration motor

[Technical field]

The invention relates to a vibration motor, and in particular to a flat linear vibration motor used in portable consumer electronic products.

[Background]

Portable consumer electronic products, such as mobile phones, handheld game consoles, navigation devices, or handheld multimedia entertainment devices, generally use vibration motors for system feedback, such as incoming call prompts for mobile phones, vibration feedback for game consoles and the like. The motors used therein mainly include cylindrical iron core motors, coreless motors, and flat motors.

With the development of consumer electronic products towards lightness and thinness, their various internal components also need to adapt to the trend towards lightness and thinness. Motors are no exception.

Linear vibration motor refers to the reciprocating motion in which the vibration direction of the vibrator is a straight line. It is widely used and installed on consumer electronics products for its stable vibration and low noise. For the structure of the linear vibration motor, please refer to Chinese patent application No. CN200480000815.4 published on November 23, 2005, US patent No. 6,466,682 published on October 15, 2002, and US patent No. 7,099,489 published on August 29, 2006, etc.

However, the vibration direction of the vibrator of the above-mentioned vibration motor is vertical, that is, it is perpendicular to the installation plane. Because the vibration direction is perpendicular to the installation plane, it is necessary to provide a large vertical height for the vibrator to move up and down, thus increasing the height of the entire motor, which is not conducive to the development of thinness.

Therefore, it is necessary to propose a new technical solution to reduce the height of the motor.

[Summary]

The technical problem to be solved by the present invention is to provide a flat linear vibration motor with reduced height.

The present invention solves the above-mentioned technical problem using the following technical solution:

A flat linear vibration motor, which comprises an upper cover, a base that mates the upper cover to form an accommodating space, a coil received in the accommodating space and positioned on the base, elastic supports connected to the base, and a permanent magnet suspended within the accommodating space by the elastic supports, wherein the base is provided with a plurality of side walls and a bottom wall perpendicular to the side walls; the coil is arranged on the bottom wall and located below the permanent magnet in the central position with a gap between the coil and the permanent magnet; magnetic poles of the permanent magnet directly face the coil, and the magnetic poles of the permanent magnet directly facing the coil are polarized in opposite directions; and the elastic support is provided with a fixing portion connected to the base, an elastic arm extending from the fixing portion and facing the fixing portion and having an elastic deformation direction parallel to the bottom wall of the base, and an engaging portion extending from the elastic arm and connected to the permanent magnet such that the permanent magnet can move in a direction parallel to the bottom wall.

As an improvement of the present invention, the permanent magnet is an integral structure.

As an improvement of the present invention, the permanent magnet comprises two separate magnets.

As an improvement of the present invention, the permanent magnet is connected to the elastic arm of the elastic support through a counterweight, the counterweight being provided with a main body and a positioning portion extending from the main body and connected to the elastic arm, the main body being provided with a through hole, and the permanent magnet being fixed in the through hole.

As an improvement of the present invention, the material density of the counterweight is not less than 7.8 g/cm^3 .

As an improvement of the present invention, the fixing portion of the elastic support is provided with a first positioning portion positioned on a certain side wall of the base and a second positioning portion extending from the first positioning portion and positioned on a side wall adjacent to the certain side wall.

As an improvement of the present invention, the engaging portion of the elastic support comprises a clamp extending from a side edge of the elastic arm and away from the fixing portion, the clamp being composed of an upper clamping portion and a lower clamping portion extending from two side edges of the elastic arm and opposite each other.

Compared with the prior art, the present invention has the following advantages: because the vibration direction is parallel to the bottom wall, the thickness in the height direction can be greatly reduced.

[Description of drawings]

Fig. 1 is a perspective view of a flat linear vibration motor of the present invention.

Fig. 2 is an exploded perspective view of the flat linear vibration motor of the present invention.

Fig. 3 is a top view of the flat linear vibration motor of the present invention, with an upper cover removed for viewing.

Fig. 4 is a schematic perspective view of an elastic support of the flat linear vibration motor of the present invention.

Fig. 5 is a sectional view along a line A-A in Fig. 3 .

Fig. 6 is a schematic view of the principle of the flat linear vibration motor of the present invention.

Fig. 7 is a schematic view of another embodiment of the present invention.

[Detailed description]

The content of the present invention will be described in detail below in conjunction with the accompanying drawings.

The present invention is a flat linear vibration motor, which is mainly used in consumer electronic products such as mobile phones and handheld game consoles.

Referring to FIG. 1 to FIG. 3, a flat linear vibration motor 10 comprises an upper cover 11, a base 12 that mates with the upper cover 11 to form an accommodating space, a toroidal coil 13, a plurality of elastic supports 14, a counterweight 15, and a permanent magnet 16.

The base 12 is provided with a plurality of side walls 121 and a bottom wall 122 perpendicularly connected to the side walls 121. The coil 13 is positioned on the bottom wall 122 and has its coil lead (not shown) welded to a conducting plate 123 positioned on the bottom wall 122, in order to obtain an alternating current from the outside. The elastic supports 14 are positioned on the base 12, preferably, positioned on the side walls 121 of the base 12. The counterweight 15 is suspended within the accommodating space by the elastic supports 14. The counterweight 15 comprises a main body 151 and a plurality of positioning portions 152 extending from the main body 151, and these positioning portions 152 cooperate with the elastic supports 14 to assemble the counterweight and the elastic supports. A through hole 153 is provided in the central position of the main body 151, and the through hole 153 is used for positioning the permanent magnet 16 therein. Therefore, both the counterweight 15 and the permanent magnet 16 are suspended within the accommodating space by the elastic supports 14.

Referring to FIG. 4 and FIG. 5, the elastic support 14 comprises a fixing portion 141 positioned on the side wall 121 of the base 12, an elastic arm 142 extending from the fixing portion 141 and facing the fixing portion 141 and elastically deforming towards the fixing portion 141 or away from the fixing portion 141 (i.e., an X-X direction shown in FIG. 4), and an engaging portion 144 extending from the elastic arm 142 and cooperating with the positioning portion 152 of the counterweight 15. In practice, the elastic deformation direction of the elastic arm 142 is perpendicular to the side wall 121 of the base 12. Preferably, the elastic arm 142 is connected to the fixing portion 141 by a U-shaped connecting portion 143, so as to increase the elasticity of the elastic arm 142. In practice, the elastic arm 142 can also be bent and extended directly from an end of the fixing portion 141, such that the elastic arm 142 and the fixing portion 141 form a V shape. The engaging portion 144 and the positioning portion 152 of the counterweight 15 can be assembled by mechanical means such as bonding, welding, injection molding and the like. In this embodiment, a method for stably assembling the positioning portion 152 is provided, that is, the engaging portion 144 comprises a clamp extending from a side edge of the elastic arm 142 away from the fixing portion 141. Preferably, the clamp comprises an upper clamping portion 144a and a lower clamping portion 144b extending from two side edges of the elastic arm 142 and opposite each other. The upper clamping portion 144a and the lower clamping portion 144b are respectively positioned on the upper and lower sides of the positioning portion 152, that is, the counterweight 15 is positioned in a clamping manner. In order to make the assembling more reliable, means such as bonding with glue, welding and the like can be further used. The coil 13 and the permanent magnet 16 are placed such that the coil 13 is located below the permanent magnet 16 in the central position, and there is a gap perpendicular to the direction of the bottom wall 122 between the coil 13 and the permanent magnet 16. In order to better fix the elastic support 14, its fixing portion 141 is provided with a first positioning portion 141a positioned on a certain side wall of the base 12 and a second positioning portion 141b extending from the first positioning portion 141a and positioned on a side wall adjacent to the certain side wall, in order to make the positioning effect of the elastic support 14 more stable.

Further referring to FIG. 5, in this embodiment, the permanent magnet 16 positioned within the through hole 153 of the counterweight 15 is an integral structure. However, a two-pole magnetization method is used such that magnetic poles of its one half (labeled 16a) are polarized opposite to magnetic poles of the other half (labeled 16b), and magnetic pole planes of the permanent magnet 16 are parallel to the bottom wall 122 of the base 12 (also parallel to the coil 13), that is, the N pole or S pole of the permanent magnet 16 directly faces the bottom wall 122 of the base 12 (also directly faces the coil 13).

Referring to FIG. 6, the counterweight weight 15, the permanent magnet 16, and the coil 13 are taken out to illustrate the principle. The coil 13 obtains an alternating current from the outside, the current flowing along the winding direction of the coil 13, as shown in the figure. At a certain moment, the direction of the current in the coil 13 is as shown in the figure, wherein the direction of the current in the left ring is perpendicular to the page of the figure and inward, marked as $\otimes$ in the figure, and the direction of the current in the right ring is perpendicular to the page of the figure and outward, marked as $\odot$ in the figure. Directions of magnetic force lines at positions of the rings are simply and schematically indicated in the figure. According to the left-hand rule, the magnetic field force on the left ring is F1 with a direction to the right, the magnetic field force on the right ring is F2 with a direction also to the right, and both forces have the same magnitude, and therefore, the direction of the magnetic field force on the entire coil is to the right. However, since the coil 13 itself is positioned on the base, the coil cannot move, but due to the relationship between the action force and the reaction force, the two halves of the permanent magnet 16 are respectively subjected to F1' and F2', which are opposite in direction to F1 and F2 and have the same magnitude. Moreover, both the permanent magnet 16 and the counterweight 15 are suspended within the accommodating space, and the elastic deformation direction of the elastic arm 142 (referring to FIG. 4 and FIG. 5) of the elastic support 14 is perpendicular to the side wall 121 of the base 12, that is, it is parallel to the bottom wall 122, and therefore, the permanent magnet 16 and the counterweight 15 move together to the left (in the direction of arrows F1', F2' in the figure) under the action of the magnetic field force. If the direction of the current changes, the permanent magnet 16 moves to the right together with the counterweight 15. In this way, a left-right reciprocating motion, i.e., a vibration parallel to the bottom wall, is generated.

The counterweight 15 functions to strengthen the vibrating force, making the vibration stronger. However, in practice, the counterweight may be omitted, that is, the permanent magnet 16 is directly connected to the elastic supports 14. In addition, if the counterweight is used, it is preferable to use a material with a density of not less than 7.8 g/cm³, such as nickel, tungsten and alloys thereof.

Referring to FIG. 7, another embodiment of the present invention is shown where two magnets 17, 18 are provided as permanent magnets, and magnetic pole directions of the two magnets are opposite, which can also produce the same effect as the previous embodiment. The two magnets can be assembled together by bonding or other methods. Alternatively, they can be placed separately by means of providing two through holes in the counterweight, with the same effect as above. Therefore, in practice, either an integral permanent magnet or a permanent magnet composed of two magnets is feasible, as long as the permanent magnet has opposite poles on the side facing the bottom wall of the base.

Because the vibration direction is parallel to the bottom wall, the thickness in the height direction can be greatly reduced, and theoretically, the distance between the upper cover and the permanent magnet or the counterweight can be infinitely small, and the distance between the permanent magnet or the counterweight and the coil can also be infinitely small. In practical applications, consumer electronics products are strictly required in thickness, that is, the thickness is required to be as small as possible, but the width is less strictly required relative to the thickness.

The above description gives preferred embodiments of the present invention, and the scope of protection of the present invention is not limited by the above embodiments. Any equivalent modifications or changes made by those skilled in the art based on the disclosure of the present invention should be included in the scope of protection of the claims.

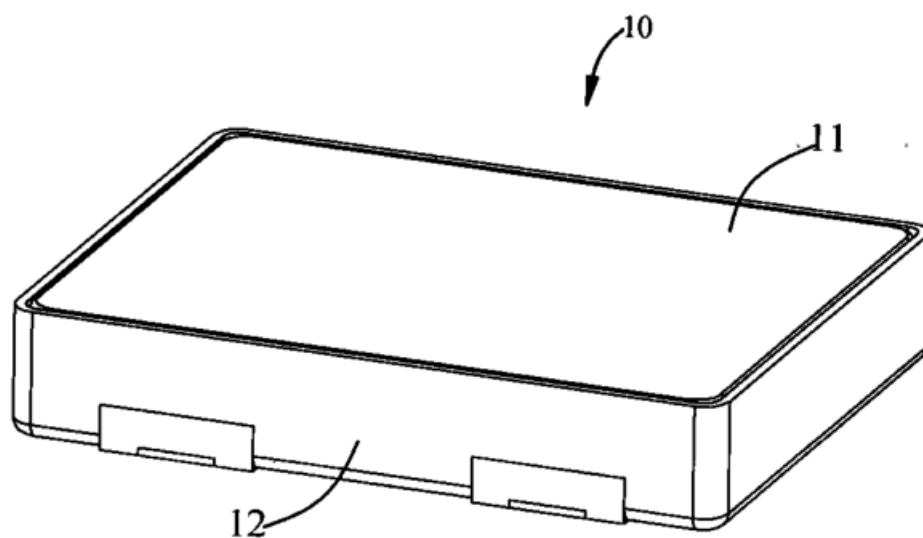


FIG. 1

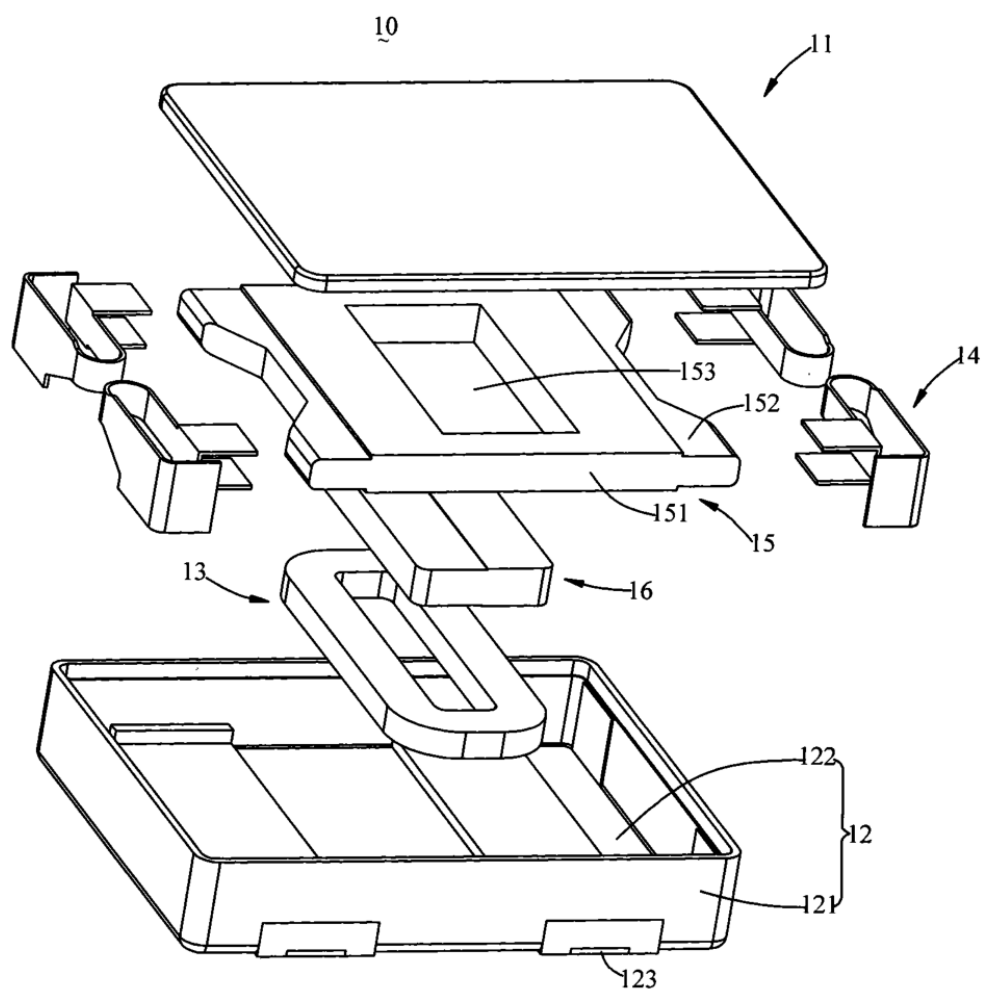


FIG. 2

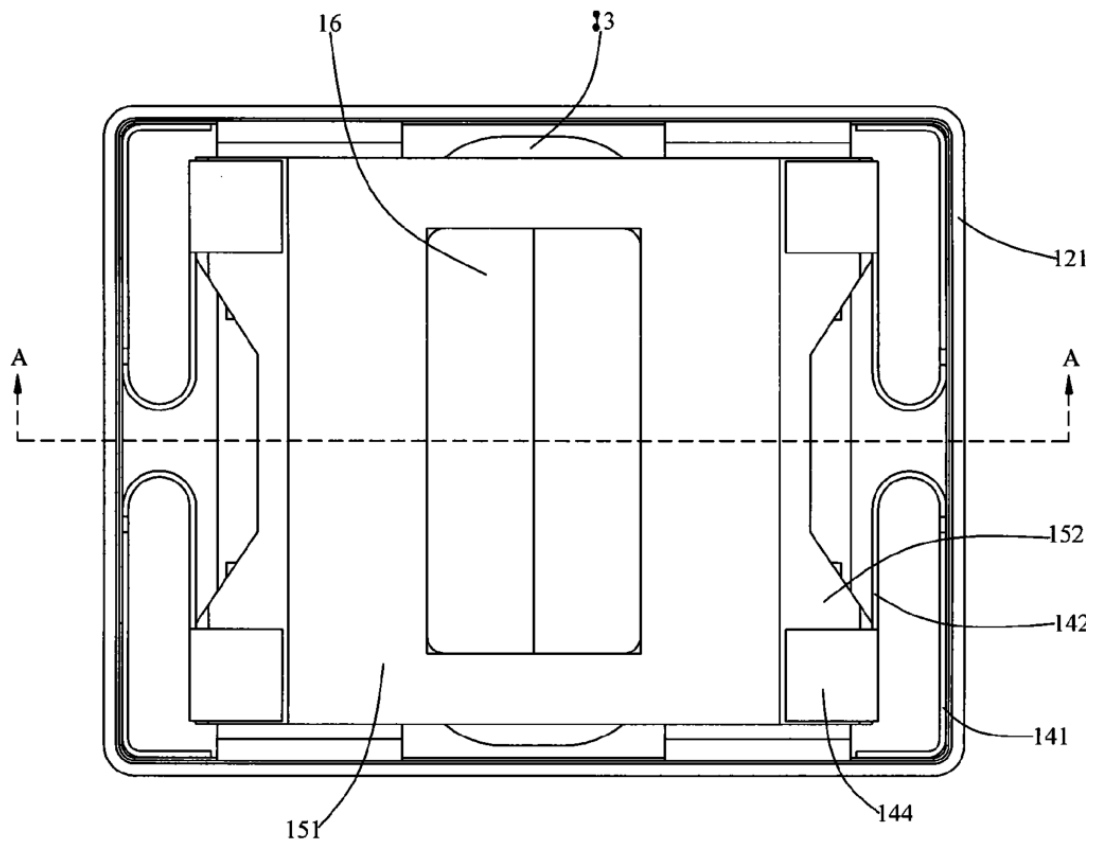


FIG. 3

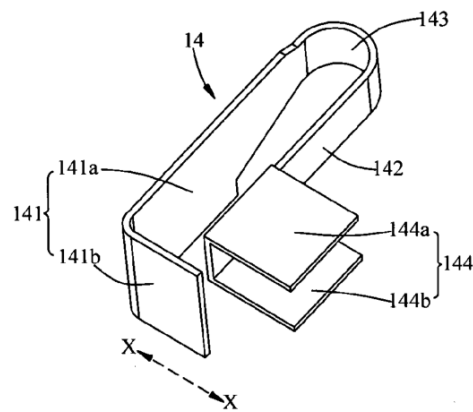


FIG. 4

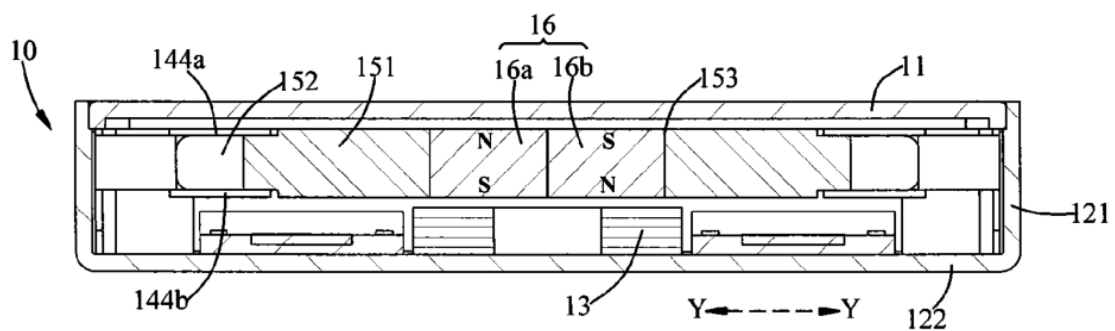


FIG. 5

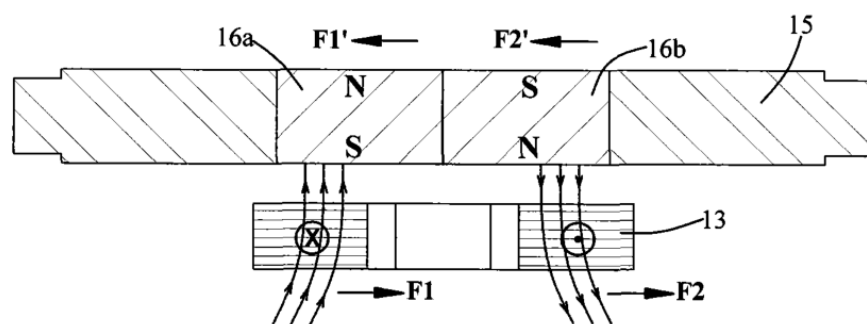


FIG. 6

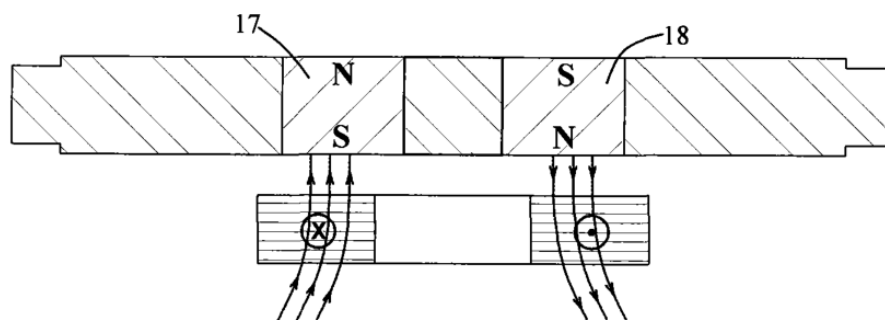


FIG. 7