

## ARMATURE STRUCTURE FOR FLAT MOTOR

### FIELD OF THE INVENTION

The present invention relates to an armature structure for a flat motor to be applied to a device for transmitting vibration to a human body, and particularly to an armature structure for smoothly restarting at any time an armature composed of one or plural coreless armature coils.

### BACKGROUND OF THE ART

As a device aiming at transmitting vibration to a human body, various devices are known such as a wireless telephone paging device (hereinafter referred to as a pager), a cellular telephone, a massager for displaying a massage effect by giving a slight vibration to a human body, a signal receiver for a visual and auditory handicapped person and the like, each of which has a built-in flat motor having an eccentric armature.

As such a flat motor, for example, a flat-type vibration generator as shown in Figures 14 and 15 is known (Japanese Patent Laid-Open Publication No.Hei6-205,565). The vibration generator 1 is composed of a circular plate-type field magnet 3 fixed on the bottom of a casing 2, a freely turnable armature 4 arranged so as to face this field magnet 3, and a shaft 5 positioned at the pivot of this armature 4. The armature 4 is made by molding three coils 6a, 6b and 6c arranged in the shape of an inversed

fan together with a resin frame 7 into one body. And the armature 4 is provided with commutators 8 to turn together with the coils 6a, 6b and 6c, and these commutators 8 are brought into contact with two electrode brushes 9 extending from the bottom of the casing 2 and thereby the polarities of the three coils 6a, 6b and 6c are alternately switched over, and every switchover of the polarities generates an attractive force and a repulsive force between the armature and the field magnet 3, and therefore the armature 4 continues turning. Particularly in case of using such a flat motor as a vibration generator, since the armature is turned having a great centrifugal force by making the armature 4 itself greatly eccentric as described above, a strong vibration is generated all over the device.

By the way, in recent years miniaturization of a pager, a cellular phone, a massager, a signal receiver for a visual and auditory handicapped person and the like has been more and more advanced, and according to this, miniaturizing and lightening a vibration generator also have been intensely demanded. As described above, however, since a turning force of the armature 4 is generated by repeated alternation of an attractive force and a repulsive force between the coils 6a, 6b and 6c whose polarities are alternately switched over and the field magnet 3, at least three coils 6a, 6b and 6c are necessary. The reason is that as shown in Figure 16, in case that the armature 4 is made of a single coil 6 having a central angle of about 90

degrees of rotation, if when the armature 4 is stopped it comes into one of N and S poles obtained by dividing the magnet 3 into quarters (S pole in Figure 16), a problem occurs that when attempting to start the armature 4 next time the armature 4 is not defined in its turning direction and cannot be smoothly started. This is a phenomenon which appears in case that both side portions 6d and 6e of the coil 6 stay within a domain Z on the magnet 3 corresponding to the winding width of the coil 6.

Thereupon, an object of the present invention is to make it possible to more miniaturize and lighten a flat motor by providing an armature structure in which an armature can be surely and smoothly started to turn even in case that the armature is composed of one or two coils.

Another object of the invention is to simplify the manufacturing process of an armature and reduce its manufacturing cost by decreasing the number of coils to form the armature.

#### DISCLOSURE OF THE INVENTION

An armature structure of a flat motor according to the present invention is characterized by a fact that it comprises an armature of a flat motor having one or plural coreless armature coils provided over a field magnet having alternately N and S poles so as to relatively turn with an axial spacing between the armature and the field magnet, wherein;

the armature is provided with a magnetic material, and when the armature is stopped to turn the coreless armature coil is brought to a starting position by positioning the magnetic material at the boundary between N and S magnetic poles of the field magnet and making the N and S poles of the field magnet and the S and N poles generated in the magnetic material respectively attract each other.

And an armature structure of a flat motor according to the present invention is characterized by a fact that it comprises an armature of a flat motor having one or plural coreless armature coils provided over a field magnet having alternately N and S poles so as to relatively turn with an axial spacing between the armature and the field magnet, wherein;

the armature is provided with a permanent magnet having N and S poles, and when the armature is stopped to turn the coreless armature coil is brought to a starting position by positioning the permanent magnet at the boundary between N and S magnetic poles of the field magnet and making the N and S poles of the field magnet and the S and N poles of the permanent magnet respectively attract each other.

An armature structure of a flat motor according to the present invention is characterized by a fact that the number of said coreless coils is one and a magnetic material or a permanent magnet having N and S poles projects from one side portion of a frame holding the

coreless armature coil.

An armature structure of a flat motor according to the present invention is characterized by a fact that the number of said coreless coils is one and a magnetic material or a permanent magnet having N and S poles is embedded in a frame holding the coreless armature coil.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view showing a first embodiment of an armature structure of a flat motor of the present invention.

Figure 2 is a perspective view showing a main part of said armature.

Figure 3 is a plan view showing a stop position of the armature on a magnet.

Figure 4 is an explanatory figure for showing the principle of rotation of an armature composed of a single coil, said figure showing a state at the time of starting. Figure 5 is an explanatory figure for showing the principle of turning of an armature composed of a single coil, said figure showing a state immediately after starting. Figure 6 is an explanatory figure for showing the principle of turning of an armature composed of a single coil, said figure showing a state of continuing rotation.

Figure 7 is a plan view showing an armature having a magnetic material disposed inside it.

Figure 8 is a plan view showing an armature having a

magnetic material provided at an arm portion opposite to the coil.

Figure 9 is a plan view showing an armature having a magnetic material embedded in a resin frame.

Figure 10 is a plan view of an armature composed of two coils.

Figure 11 is a plan view showing another embodiment of an armature structure of a flat motor of the present invention.

Figure 12 is a perspective view showing a main part of the said embodiment.

Figure 13 is a plan view showing a stop position of the armature over a magnet of the said embodiment.

Figure 14 is a vertical sectional view showing an example of a conventional flat motor.

Figure 15 is a plan view showing an example of an armature used in a conventional flat motor.

Figure 16 is a plan view showing a positional relation when a conventional armature does not start over a magnet.

#### BEST MODE OF EMBODIMENTS IN THE INVENION

Embodiments of an armature structure of a flat motor according to the present invention are described in detail with reference to the drawings in the following.

Figures 1 and 2 show a first embodiment of an armature structure of a flat motor of the present invention.

An armature 10 is formed by arranging a single coreless armature coil 12 inside a resin frame 11 being approximately in the shape of a quadrant and molding both of them into one body. Commutators 14a, 14b, 14c and 14d obtained by dividing a circle into quarters are provided at the pivot portion 13 of the resin frame 11, and an axis hole 15 to be the center of rotation of the armature 10 is made at the center of them. A coreless armature coil 12 is a one-winding coil being in a shape approximately corresponding to the shape of the resin frame 11, and the opening angle 1 between both side edges is about 90 degrees. Among the commutators 14a, 14b, 14c and 14d, one pair of commutators 14a and 14c being diagonally opposite to each other are commonly connected to each other, and the other pair of commutators 14b and 14d being diagonally opposite to each other are commonly connected to each other, and one commutator of the one pair is connected to the inside winding terminal 25 of the coreless armature coil 12 and one commutator of the other pair is connected to the outside winding terminal 26. In case of using the armature 10 as a vibration generating motor, it is preferable to provide a weight 17 in the empty central part 16 of the coreless armature coil 12 (a part of the weight 17 is broken away in the figure). Although the central angle of rotation of the armature 10 of Figure 1 is about 90 degrees, it is not limited to about 90 degrees in particular.

In this embodiment, a magnetic material 20-1 made of

an iron pin and the like projects sideward from one side edge 11a of the resin frame 11. This magnetic material 20-1 is formed into a round bar or cylinder and is slightly inwards curved so as to form a part of an arc. That is to say, the projecting direction of the magnetic material 20-1 is nearly parallel with the direction of rotation or reverse rotation of the armature 10, and is perpendicular to the one side edge 11a. It is easy to make N and S poles at both sides of the magnetic material 20-1 thanks to forming the sectional shape of the magnetic material 20-1 into a circle. Even if the magnetic material 20-1 is not in the shape of a round bar but in the shape of a cylinder, the same effect is obtained. Since the strength of a magnetic force of the magnetic material 20-1 depends upon the length or the sectional area of the magnetic material 20-1, they need to be properly selected. That is to say, it is necessary to consider that while a magnetic force to force the armature 10 to stop at a specified position is required when stopping the armature 10, the magnetic force needs to be to such a degree that it does not impede rotation of the armature 10 when it is rotating. The shape of a magnetic material is not limited to a round bar or a cylinder like the magnetic material 20-1, but the same effect can be obtained also by projecting a small piece in the shape of a flat plate or an ellipsoid.

Figure 3 shows a positional relation at the time of stopping the armature 10 having the above-mentioned

composition by means of a field magnet 21. The field magnet 21 is obtained by dividing a disk into quarters and arranging N and S poles alternately with each other, and rotatably holds the pivot portion 13 of the armature 10 at the center of the field magnet 21. When the armature 10 is turned clockwise or counterclockwise over the field magnet 21 and then a power source to supply power to the coreless armature coil 12 of the armature 10 is turned off, the armature 10 is stopped in a state where the center in the longitudinal direction of the magnetic material 20-1 is located on a border line 22 between N and S poles of the field magnet 21. That is to say, the armature 10 is stopped over the N pole of the field magnet 21 at any time in a state where it is shifted by an angle  $\theta_2$  corresponding to half of the length of the magnetic material 20-1, and comes into a state where one side portion 12a of the coreless armature coil 12 projects to the other side S pole adjacent to it. The reason is that when the armature 10 is stopped the magnetic material 20-1 is influenced by the field magnet 21 to generate a magnetic field around it and both ends of the magnetic material 20-1 come to have the magnetic poles reverse to those of the field magnet 21 (S pole to the N pole of the field magnet and N pole to the S pole), and therefore the magnetic material 20-1 and the field magnet 21 attract each other and overcome a free rotation of the armature 10 and force it to stop at that position. In such a way, since one side portion 12a of the

coreless armature coil 12 projects greatly to the S pole side from a domain Z on the field magnet 21 where the armature 10 is difficult to start, the armature 10 results in starting to smoothly turn.

Next, the principle of rotation of an armature according to the present invention is described with reference to Figures 4 to 6. Two electrode brushes 23 and 24 extend over the field magnet 21 and the head portions of them are brought into contact with commutators 14a, 14b, 14c and 14d of the armature 10. And the electrode brushes 23 and 24 slide and shift on the commutators 14a, 14b, 14c and 14d one after another at intervals of about 90 degrees. Figure 4 shows a state where the armature 10 is at a stop. As described above, at this time the magnetic material 20-1 is located on the boundary line between the N1 pole and the S2 pole of the field magnet 21, and a major portion of the coreless armature coil 12 overlaps the N1 pole of the field magnet 21 and one side portion 12a of the coreless armature coil 12 overlaps the S1 pole of the field magnet 21. When a switch is turned on in this state, an electric current flows through the commutator 14d being in contact with the head portion of the electrode brush 23 and the commutator 14b connected commonly to the commutator 14b from the outside winding terminal 26 of the coreless armature coil 12 into the coreless armature coil 12 and the electric current flows through the commutators 14a and 14c from the inside winding terminal 25 to the electrode brush 24 side,

and thereby a magnetic field is generated in the coreless armature coil 12. At this time, assuming that the polarity of a magnetic field generated at the opposite side of the coreless armature coil 12 to the field magnet 21 is an N pole, this N pole has the same polarity as the N1 pole of the field magnet 21 located directly under this N pole and therefore a repulsive force is generated between them and on the other hand, this N pole and the adjacent pole S1 of the field magnet 21 attract each other, and therefore a rotational force is generated in this direction (in the clockwise direction) to start the armature 10 to turn.

And when the armature 10 turns to a position shown in Figure 5, the contact head portion of one electrode brush 23 comes into the gap between the commutators 14c and 14d, and the contact head portion of the other electrode brush 24 comes into the gap between the commutators 14a and 14b, and therefore the coreless armature coil 12 comes to have no electric current flowing into it and no magnetism, but the armature 10 continues turning as it is thanks to its turning inertia.

Furthermore, when the armature turns to a position shown in Figure 6, contrarily to the case of Figure 4 an electric current supplied from the electrode brush 23 flows through the commutators 14c and 14a from the inside winding terminal 25 into the coreless armature coil 12 and flows out through the commutator 14d from the outside winding terminal 26 to the electrode brush 24. Accordingly, the

coreless armature coil 12 has a reverse pole S generated at the opposite side to the field magnet 21 and this S pole and the pole S1 of the field magnet 21 under it repel each other and therefore the armature 10 is given a turning force in the same direction to continue turning.

In this way, the armature 10 repeats alternately N and S as turning to repeat repulsion and attraction with the field magnet 21, and thereby can continue turning. And by making the armature 10 of a single coreless armature coil 12 as described above and providing a weight 17, a great centrifugal force can be obtained and a great effect can be obtained in case of using it as a vibration generator.

In case of turning the armature 10 in the reverse direction (counterclockwise direction), the turning direction can be easily changed by reversing the direction of supplying current or by reversing the winding direction of the coreless armature coil 12.

In the above-mentioned embodiment, the magnetic material 20-1 projects in a direction nearly perpendicular to one side edge 11a of the resin frame 11, but may project in a direction not necessarily perpendicular to it only if N and S poles can be generated at both sides of the magnetic material 20-1. And it is possible also to provide the magnetic material 20-1 at the other side edge 11b of the resin frame 11 as well as to make it project into the empty central part 16 of the coreless armature coil 12 as

shown in Figure 7. Furthermore, it is possible also to extend an arm portion 30 at the opposite side of the pivot portion 13 to the coreless armature coil 12 and make the magnetic material 20-1 project from the arm portion 30. And as shown in Figure 9, it is acceptable also to make broader in width one side edge 11a of the resin frame molded together with the coreless armature coil 12 into one body and embed a magnetic material 20-1 such as an iron pin and the like into this one side edge 11a. Thanks to such a composition, since the magnetic material 20-1 is more reliably held and can be molded together with the resin frame 11 into one body, the manufacturing process is simplified. In the above-mentioned embodiment, a case that the field magnet 21 is divided into quarters and is alternately given N and S poles has been described, but it is sometimes more proper to divide the field magnet 21 into eight equal parts depending upon relation to the central angle of rotation of the coreless armature coil 12.

Although the above-mentioned embodiment is a case that the armature 10 is composed of a single coreless armature coil 12, a case of two coreless armature coils 12 as shown in Figure 10 has also the same problem with respect to starting the armature 10 to turn. In this case also, similarly to the armature 10 composed of a single coreless armature coil 12 as described above, the armature 10 can be smoothly started to turn by simply making the magnetic material 20-1 project from one side edge 11a of the

resin frame 11 of the coreless armature coil 12.

The above-mentioned embodiment has described a case of applying the invention to a vibration generator, but the invention can be applied also to an ordinary turning motor and a stepping motor.

Figures 11 to 13 show another embodiment of an armature structure of a flat motor of the present invention. In this embodiment, a permanent magnet 20-2 projects sideward from one side edge 11a of the above-mentioned resin frame 11. This permanent magnet 20-2 is formed into the shape of a slender round bar or cylinder and is slightly curved inwards so as to form a part of an arc having an axis hole 15 as the center of rotation. That is to say, the projecting direction of the permanent magnet 20-2 is nearly parallel with the direction of rotation or reverse rotation of the armature 10, and is perpendicular to the one side edge 11a. It becomes easy to form N and S poles at both sides of the permanent magnet 20-2 thanks to making the sectional shape of the permanent magnet 20-2 into the shape of a round bar. It is a matter of course that the permanent magnet 20-2 in the shape of a cylinder also brings the same effect.

Since the strength of a magnetic force of the permanent magnet 20-2 depends upon the length or the sectional area of the permanent magnet 20-2, they need to be properly selected. That is to say, it is necessary to consider that while a magnetic force to force the armature

10 to stop at a specified position is required when stopping it, the magnetic force must be to such a degree that it does not impede rotation of the armature 10 when it is rotating. The shape of a permanent magnet is not limited to a slender round bar or cylinder like the permanent magnet 20-2, but the same effect can be obtained also by projecting a small piece in the shape of a flat plate or an ellipsoid.

Figure 13 shows a positional relation at the time of stopping the armature 10 having the above-mentioned composition by means of a field magnet 21. The field magnet 21 is obtained by dividing a disk into quarters and arranging N and S poles alternately with each other, and rotatably holds the pivot portion 13 of the armature 10 at the center of the field magnet 21. When the armature 10 is turned clockwise or counterclockwise over the field magnet 21 and then a power source to supply power to the coreless armature coil 12 of the armature 10 is turned off, the S and N poles of the permanent magnet 20-2 are respectively attracted to the N and S poles of the field magnet 21 and thereby the armature 10 is stopped in a state where the center in the longitudinal direction of the permanent magnet 20-2 is located on a border line 22 between the N and S poles of the field magnet 21. That is to say, the armature 10 is stopped over the N pole of the field magnet 21 at any time in a state where it is shifted by an angle  $\theta_2$  corresponding to half of the length of the permanent

magnet 20-2, and comes into a state where one side portion 12a of the coreless armature coil 12 projects to the other side S pole adjacent to it. The reason is that when the armature 10 is stopped the N and S poles of the field magnet 21 and the S and N poles of the permanent magnet 20-2 respectively attract each other, and therefore the permanent magnet 20-2 and the field magnet 21 overcome a free rotation of the armature 10 and force it to stop at that position. In such a way, since one side portion 12a of the coreless armature coil 12 projects greatly to the S pole side from a domain Z on the field magnet 21 where the armature 10 is difficult to start, the armature 10 results in starting to smoothly turn.

#### UTILIZABILITY IN INDUSTRY

In an armature structure of a flat motor of the present invention composed in such a manner, since an armature is provided with a magnetic material or a permanent magnet having N and S poles and when the armature is stopped to turn the magnetic material or the permanent magnet is located at the boundary between the N and S poles of the field magnet so that the coreless armature coil comes to a starting position, even an armature composed of one or two coreless armature coils is reliably and smoothly started to turn and as a result the flat motor can be more miniaturized and more lightened, and the invention is more effective to realization of an armature motor composed of

one or two coreless armature coils in a viewpoint of man-hour and cost in a manufacturing process, and as a motor used in a vibration generator, an armature structure of one coreless armature coil having a greater eccentric action brings a greater effect for the purpose of obtaining a greater vibration.



WHAT IS CALIMED IS:

1. An armature structure of a flat motor comprising an armature of a flat motor having one or plural coreless armature coils provided over a field magnet having alternately N and S poles so as to relatively turn with an axial spacing between the armature and the field magnet, wherein;

the armature is provided with a magnetic material and when the armature is stopped to turn the coreless armature coil is brought to a starting position by positioning the magnetic material at the boundary between N and S magnetic poles of the field magnet and making the N and S poles of the field magnet and the S and N poles generated in the magnetic material respectively attract each other.

2. An armature structure of a flat motor comprising an armature of a flat motor having one or plural coreless armature coils provided over a field magnet having alternately N and S poles so as to relatively turn with an axial spacing between the armature and the field magnet, wherein;

the armature is provided with a permanent magnet having N and S poles, and when the armature is stopped to turn the coreless armature coil is brought to a starting position by positioning the permanent magnet at the boundary between N and S magnetic poles of the field magnet and making the N and S poles of the field magnet and the S and N poles of the permanent magnet respectively attract each other.



3. An armature structure of a flat motor according to claim 1 or 2, wherein;

the number of said coreless armature coils is one and a magnetic material a permanent magnet having N and S poles projects from one side portion of a frame holding the coreless armature coil.

4. An armature structure of a flat motor according to claim 1 or 2, wherein;

the number of said coreless armature coils is one and a magnetic material a permanent magnet having N and S poles is embedded in a frame holding the coreless armature coil.