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ELECTRIC MOTORS

This invention relates to electric motors, and particularly to miniature electric motors of the kind used as drive units in tape recorders and other audio equipment. It is especially concerned with the prevention of electrical noise caused by commutating sparks leaking to the outside of the motor.

Electrical noise is small and particularly in what are known as miniature electric motors has been a major problem in audio equipment where the quality of the reproduced or transmitted sound is such as to render any extraneous sounds audible to an extent that it adversely affects the performance of the equipment. This noise can be reduced by effectively enclosing the motor in a conductor shield. Where the motor housing is electrically conductive and has an open end the open end may be closed by a conductive cover plate. However, electrical noise remains a potential problem unless good electrical contact is assured between the cover plate and the motor housing.

The present invention addresses the above problem, and seeks to provide a motor design in which an electrically conductive housing is maintained in good and electrical contact with a cover plate to form an effective shield. To this end, according to the invention the components of an electric motor are installed in an housing comprising a tubular metallic body with one open end and an opposite substantially closed end, which open end is closed by a metallic plate received within the body

wall, the outer dimensions of the plate being at least equal to the inside dimensions of the body wall to ensure a tight fit of the plate in the body, and ridges being formed on at least one of the outer periphery of the plate and the inner surface of the body at said one end thereof to ensure electrically conductive engagement therebetween. Normally, the ridges are formed on the outer peripheral surface of the plate, and may extend continuously or intermittently around the outer peripheral surface of the plate.

In preferred embodiments of the invention, the plate is fitted to the body such that the open end of the body wall extends beyond the plate. The protruding wall at the open end of the body may be the body wall at the open end being staked so that at least part of the body wall is pressed into the plate. The body is conveniently the motor case itself, but may be a shield case extending over the outside surface of the housing so as to envelop the housing. In either form, the cover plate may be a press fit into the body, normally against a lip or shoulder formed within the body.

As discussed above, motors of the invention can function excellently to prevent electrical noise from leaking with a simple construction. Not only can the leakage of electrical noise be reduced or even eliminated, but also the strength of the joint between the cover plate and the housing is enhanced.

In preferred embodiments of the invention, minute ridges are provided on the outside circumferential surface

of the cover plate, which cut into the inside circumferential surface of the body as the cover plate is press-fit into the body, ensuring a positive electrical contact therebetween.

The invention will now be described by way of example and with reference to the accompanying drawing wherein:

Figure 1 is a perspective view of the principle components of an embodiment of the invention;

Figure 2 is an enlarged perspective view of the portion A of Figure 1; and

Figure 3 is a longitudinal section through a known miniature electric motor, showing the principle components thereof.

Miniature motors of the conventional type will first be described with reference to Figure 3. This motor has an housing made of an electrically conductive metallic material and formed into a bottomed, hollow cylindrical shape with an opening at one end thereof. A stator 2 and a rotor 3 are installed in the housing, and a cover 4 made of an electrically conductive material and formed into a disc shape is fixedly fitted to the opening to close the open end of the housing. Brushes 5 are mounted on the cover 4 and make sliding contact with a commutator 7.

In the miniature motor of Figure 3 a problem exists in the electrical noise caused by the commutating sparks generated during sliding contact between the brushes 5 and

the commutator 7 leaking to the outside of the motor. This is because the cover 4 is simply engaged with the open end face of the housing 1, and there is insufficient electrical contact between both. To ensure positive electrical contact between the housing 1 and the cover 4, therefore, various means of increasing the axial contact length between the housing 1 and the cover 4 have been proposed, which include increasing the thickness of the cover 4 and employing draw forming. These proposals, however, involve increased material consumption, increased motor weight, and increased manufacturing costs due to the additional fabricating steps.

Figure 1 is a perspective view of an embodiment of this invention in which like parts are indicated by the same reference numerals shown in Figure 3. Figure 1 shows the stage in motor assembly where all components but the cover plate 4 have been installed in the housing 1. A motor control circuit board 8 is visible through the open end of the housing 1. In Figure 1, a plurality of minute ridges 4a are provided on the outside circumferential surface of the cover, as is more clearly seen in the partially enlarged view of Figure 2. The outside dimensions, or outside diameter, of the cover 4 are made at least equal to, or slightly larger than the inside circumferential dimensions, or inside diameter, of the opening 1a of the housing 1.

When the housing 1 and the cover plate 4 are constructed in the abovementioned fashion, the cover 4 is fitted to the opening 1a of the housing 1, as shown by an

arrow in Figure 1, and press-fitted by a press or any other suitable means into the open housing end. The minute ridges 4a shown in Figure 2 cut into the inside circumferential surface of the opening 1a of the housing 1 and thus, as the cover 4 is press-fitted to the housing 1, electrical contact between them can be positively accomplished. The minute ridges, which are typically of a cog, or knurl shape, or resemble the milled edge of a coin, are continuously provided over the entire outside circumferential surface of the cover 4. Substantially the same effect, however, can be achieved by providing these ridges intermittently or in a distributed fashion over the entire circumference. The shape and press-fit allowance of the minute ridges can be selected appropriately taking into consideration the hardness and other mechanical properties of the metallic materials of the cover and housing.

It is of course necessary to maintain a sufficient axial length of the housing to receive the cover in the opening of the housing. However, the housing and the cover can be fitted even more firmly by forming the edge or wall of the housing in such a manner as to slightly protrude from the upper surface of the cover after the cover is fitted, and staking partly or entirely the edge of the housing to ensure a firm grip on the cover.

The embodiment of the invention just described has no other motor components on the cover. However, the same effect can also be achieved in a miniature motor in which bearings and other motor components are provided

integrally with the cover.

The cross-section of the housing and the planar shape of the cover plate may be other than circular, for example polygonal. Moreover, electrical noise can also be reduced even in a construction in which an entire motor is enveloped in a hollow cylindrical body with a cover plate generally as described above, with both made of a shielding material, such as aluminum or an aluminum alloy for example. Thus, the abovementioned housing may be either a motor case that is in close contact with the stator 2, or a shield case provided over the motor case in such a manner as to envelop the motor case. The shield case used in this variant has almost the same shape as the motor case.

With the embodiment of the invention just described, the following benefits can be obtained:

- (1) The thickness of the metallic material of which the cover plate is made can be reduced, and the axial size of the motor can also be reduced because no drawing operation is needed. This results in a saving in material cost and a compact motor size.
- (2) The minute ridges provided on the edge of the cover can be formed simultaneously with the forming of the cover, leading to improved machining accuracy.
- (3) Since the minute ridges provided on the edge of the cover plate slightly cut into the

inside circumferential surface of the housing, electrical contact between the housing and the cover plate can be maintained even if a plating film, oxidized film, foreign matter or any other electrically non-conductive substance adheres to the inside circumferential surface of the housing. Thus, variations in motor characteristics can be substantially reduced, and quality can be materially improved.

- (4) In connection with (3) above, process control and production control can be facilitated, and productivity can be improved since there is no need for a cleaning process to remove the aforementioned electrically non-conductive substances.

CLAIMS:

1. An electric motor in which motor components are installed in an housing comprising a tubular metallic body with one open end and an opposite substantially closed end, which open end is closed by a metallic plate received within the body wall, the outer dimensions of the plate being at least equal to the inside dimensions of the body wall to ensure a tight fit of the plate in the body, and ridges being formed on at least one of the outer periphery of the plate and the inner surface of the body at said one end thereof to ensure electrically conductive engagement therebetween.
2. An electric motor according to Claim 1 wherein said ridges are formed on the outer peripheral surface of the plate.
3. An electric motor according to Claim 2 wherein said ridges are formed over the entire outer peripheral surface of the plate.
4. An electric motor according to Claim 2 wherein said ridges are formed intermittently over the outer peripheral surface of the plate in such a manner as to be distributed at two or more locations.
5. An electric motor according to any preceding Claim wherein the plate is fitted to the body such that the open end of the body wall extends beyond the plate, the body wall at the open end being staked so that at least part of the body wall is pressed into the plate.
6. An electric motor according to any preceding Claim wherein the body is a motor case.



7. An electric motor according to any of Claims 1 to 5 wherein the body is a shield case extending over the outside surface of the housing so as to envelop the housing.

8. An electric motor substantially as described herein with reference to Figures 1 and 2 of the accompanying drawing.

