

COMMUTATOR DEVICE

This invention relates to commutator devices for electric motors.

Problems arise in the connection of lead wires to commutator devices, particularly in connection with small electric motors. As we shall explain below with reference to Figs. 1 to 3 of the accompanying drawings, a number of proposals have been made with a view to solving these problems, though none of these prior proposals is in our view entirely satisfactory. The present invention has arisen from our work seeking to improve the way in which connection is made between the lead wires and the commutator.

In accordance with a first aspect of the present invention, there is provided for an electric motor, a commutator device having a plurality of electrically conductive commutator pieces mounted in position on an insulating cylinder formed with a first cylindrical section of relatively small diameter and a second cylindrical section of relatively larger diameter axially contiguous with the first section; each commutator piece comprising a part cylindrical commutator portion lying on said first cylindrical section and a terminal portion extending from the commutator portion generally at right angles to the generator of the partial cylinder and lying adjacent the axial end face of the said second cylindrical section; and each said terminal portion being connected to a respective lead wire, being bent to receive said lead wire, being pressed against the said second cylindrical section, and crimped to said lead wire at a region of the terminal portion which is narrower in cross sectional area transverse to the longitudinal direction of the terminal portion than other regions thereof, and being welded to said lead wire by resistance welding.

In a second and alternative aspect of this invention, we provide a method of connecting lead wires from the armature windings of an electric motor to respective terminal portions of respective commutator pieces of a commutator device of the kind having a plurality of electrically conductive commutator pieces mounted in position on an insulating cylinder formed with a first cylindrical section of relatively small diameter and a second cylindrical section of relatively larger diameter axially contiguous with the first section, and each comprising a part cylindrical commutator portion lying on said first cylindrical section and a terminal portion extending from the commutator portion at right angles to the generator of the partial cylinder and lying adjacent the axial end face of the said second cylindrical section; the method being characterised in that each lead wire is received at a region of a respective terminal portion which is narrower in cross sectional area transverse to the longitudinal direction of the said terminal portion than other regions thereof, in that the terminal portion is pressed against the said second cylindrical section and crimped to the said lead wire at the said narrow region, and in that the lead wire and the terminal portion are welded together by resistance welding with an electrode pressure and/or a current less than would be necessary were the terminal portion not provided with the said narrow region.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings, in which:-

Fig. 1 illustrates a typical configuration for the commutator device and armature in a small electric motor;

Fig. 2A shows a front elevational view of a previously proposed commutator device as seen in the direction of the arrows A-A of Fig. 1;

Fig. 2B is a side elevational view of the commutator device of Fig. 2A, partly being shown in section along the line B-B of Fig. 2A;

Fig. 2C is a perspective view of a commutator piece of the commutator device of Figs. 2A and 2B;

Fig. 3 is a side elevational and part sectional view similar to that of Fig. 2B of assistance in explaining connection of a lead wire to the commutator piece in one prior proposal;

Fig. 4 is a plan view of a commutator piece for an embodiment of commutator device in accordance with the present invention but illustrated before bending of the terminal portion to extend at right angles to the generator for the commutator portion;

Fig. 5 is a front elevational view similar to that of Fig. 2 for an embodiment of commutator device in accordance with the present invention and employing commutator pieces in accordance with Fig. 4; and

Fig. 6 is a view generally similar to that of Fig. 3 for the embodiment of commutator device in accordance with Fig. 5 showing the connection with a lead wire.

The electric motor of Fig. 1 includes a commutator device generally indicated 1 which is formed by a plurality of commutator pieces 2 each comprising a commutator portion 3 and a terminal portion 4. The motor additionally has an armature generally indicated 5 with armature windings 6 which provide a plurality of lead wires 7 which are coupled to the respective terminal portions 4 of the commutator device 1. The commutator

pieces 2 are mounted on an insulating cylinder 8, the terminal portions 4 being held in place between an insulating flange 9 integral with the cylinder 8 and an insulating washer 10 applied over the cylinder 8 and the commutator portions 3.

As is best shown in Fig. 2C, the commutator portions 3 are part cylindrical in shape and the terminal portion 4 extends from the commutator portion at right angles to the generator of the part cylindrical surface.

A common prior means of connecting armature windings of a small electric motor to respective terminals of the commutator was by wrapping the lead wires about the terminal portions and applying solder.

Though this provides a positive method of connection, we found that in applying this prior connection system to the commutator illustrated in Figs. 2A and 2B, the cylinder 8 on which the commutator pieces 2 is mounted was apt to be deformed due to the heat produced by soldering, the insulating cylinder being made of a thermally vulnerable synthetic resin. As a result dimensional accuracy of the commutator was affected together with the consequent performance of the motor. We have also found that the use of a soldering method is disadvantageous in terms of working efficiency, quality and manufacturing costs in that soldering involves a considerable degree of skill and several working steps. Any splashes of soldering flux may contaminate the inside of the motor. In methods to overcome this problem, a method of fusing involving a type of resistance welding has been suggested for connecting armature windings to commutator pieces.

Fig. 3 is illustrative of what may happen when such a method is applied to the commutator of Figs. 2A and 2B. Fig. 3 shows the lead wire 7 drawn from the armature

winding 6 held in position by crimping the U-bend portion of the terminal portion 4. An electrode (not shown) is pressed from above the terminal portion to apply a voltage across that portion and the commutator portion 3. The voltage supplied causes current to flow in the terminal portion 4. The consequent heat destroys an insulating film on the surface of the lead wire 7 exposing the core wire which becomes welded to the terminal portion 4. Thus the lead wire 7 is by this method both crimped by the terminal portion 4 and electrically connected thereto by welding.

The above described fusing method has the advantage of adaptability to automation, but the electrical connection between the terminal portion 4 and lead wire 7 is less positive as compared with the previously suggested soldering method because of difficulty in bending or crimping the terminal portion 4, so we believe. We found a tendency for poor contact and accordingly poor welding between the lead wire 7 and the terminal portion 4. Though this problem could be eliminated by increasing the level of current flowing in the terminal portion 4 and also the pressure applied, we found that this tended to cause deformation in the insulating cylinder 8 or in the insulating flange 9 integral therewith, and as is suggested in Fig. 3, where an indentation is shown in the flange 9. The use of this technique also tended to produce breakage in the lead wire 7.

There have been a number of attempts to overcome the shortcomings of these prior systems, including seeking to optimise the electrode force on the terminal portion 4 and the current through the terminal portion 4 to achieve best results and of selecting electrodes of different shape. These further attempts have not in our view been wholly satisfactory. They tend to produce rapid electrode

consumption.

We have now found that a very substantial improvement in the efficiency of the connection system can be achieved by the relatively simple expedient of providing a narrowed region on the terminal portion.

Turning now to Figs. 4 to 6, wherein like reference numerals are used for the same parts as in Figs. 1 to 3, a narrowed region 11 is defined on the terminal portion 4 of the commutator piece 2 to produce a reduced width  $b$  as compared with the normal width  $a$  of the terminal portion, so producing a reduced cross sectional area transverse to the longitudinal direction of the terminal portion at the narrowed region 11.

The terminal portion 4 is bent at the position shown by dotted lines in Fig. 4 so as to extend from the commutator portion in a direction at right angles to the generator of the part cylindrical surface of the commutator portion 3, and is further bent into a U-shape at the position of the narrowed portion 11. The configuration of the commutator piece so formed is not unlike that of the commutator piece of Fig. 2C apart from the addition of the narrowed region 11. The commutator device is assembled in a substantially similar fashion to the commutator device of Figs. 2A and 2B. In the embodiment of commutator device shown in Figs. 5 and 6, the lead wire 7 is connected to the terminal portion 4 by being placed into the U-bend of the narrowed region 11 of the terminal portion 4 and by causing current to flow while pushing the terminal portion 4 from the exterior by an electrode (not shown) -- that is: by the fusing method.

We ascribe the improved results which we have obtained to the provision of the narrowed region 11 on the terminal portion 4. We believe that this region causes the electrical resistance value thereat to be increased as compared with the prior arrangement when an electric current

flows in the terminal portion 4 during the aforementioned fusing method. Thus, even when the current employed in the fusing method is set at a value less than that which would have been employed under the previous proposal, satisfactory welding heat can be produced locally at the narrowed region. This results in an improved fusing since the insulating film on the lead wire 7 is readily destroyed, improving electrical contact with the terminal portion 4. The provision of the narrowed region 11 also makes it easier to bend the terminal portion 4 into a U-shape and improves physical contact between the lead wire 7 and the terminal portion 4 as the lead wire 7 is easily received in the narrowed region. Also, by narrowing the terminal portion, the pushing force required to be provided by the electrode bearing against the terminal portion 4, as described above, is reduced. This feature also helps to concentrate the welding heat at the narrowed portion 11 preventing temperature rise in the surrounding regions and thus tending to minimise deformation of the insulating cylinder 8.

The invention is not restricted to the particular arrangement illustrated. Thus, similar effects can be accomplished by forming the narrowed region by partially reducing the thickness of the terminal portion rather than its width, as shown in the illustrated arrangement.

CLAIMS

1. For an electric motor, a commutator device having a plurality of electrically conductive commutator pieces mounted in position on an insulating cylinder formed with a first cylindrical section of relatively small diameter and a second cylindrical section of relatively larger diameter axially contiguous with the first section; each commutator piece comprising a part cylindrical commutator portion lying on said first cylindrical section and a terminal portion extending from the commutator portion generally at right angles to the generator of the partial cylinder and lying adjacent the axial end face of the said second cylindrical section; and each said terminal portion being connected to a respective lead wire, being bent to receive said lead wire, being pressed against the said second cylindrical section, and crimped to said lead wire at a region of the terminal portion which is narrower in cross sectional area transverse to the longitudinal direction of the terminal portion than other regions thereof, and being welded to said lead wire by resistance welding.
2. A commutator device according to Claim 1, wherein the respective narrow regions are formed by partially reducing the width of the terminal portion in a direction transverse to the longitudinal direction thereof.
3. A commutator device according to Claim 1, wherein the respective narrow regions are formed by partially reducing the thickness of the terminal portion.
4. For an electric motor, a commutator device substantially as hereinbefore described with reference to and as shown in Figs. 4 to 6 of the accompanying drawings.
5. An electric motor provided with a commutator device according to any preceding Claim mounted upon its rotary shaft and a plurality of armature windings each forming a lead wire for a said terminal portion.

(19)



6. A method of connecting lead wires from the armature windings of an electric motor to respective terminal portions of respective commutator pieces of a commutator device of the kind having a plurality of electrically  
5 conductive commutator pieces mounted in position on an insulating cylinder formed with a first cylindrical section of relatively small diameter and a second cylindrical section of relatively larger diameter axially contiguous with the first section, and each comprising a  
10 part cylindrical commutator portion lying on said first cylindrical section and a terminal portion extending from the commutator portion at right angles to the generator of the partial cylinder and lying adjacent the axial end face of the said second cylindrical section; the method being  
15 characterised in that each lead wire is received at a region of a respective terminal portion which is narrower in cross sectional area transverse to the longitudinal direction of the said terminal portion than other regions thereof, in that the terminal portion is pressed against  
20 the said second cylindrical section and crimped to the said lead wire at the said narrow region, and in that the lead wire and the terminal portion are welded together by resistance welding with an electrode pressure and/or a current less than would be necessary were the terminal  
25 portion not provided with the said narrow region.

---