United States Patent

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[72] Inventor **Josef Lindner**
Nurnberg, Germany

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[73] Assignee **Paul Weiss**
Nurnberg, Germany

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[54] **MINIATURE DIRECT-CURRENT MOTOR**
3 Claims, 2 Drawing Figs.

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[51] **Int. Cl.** **H02k 27/22,** H02p 5/08
[50] **Field of Search** 318/325, 346, 439

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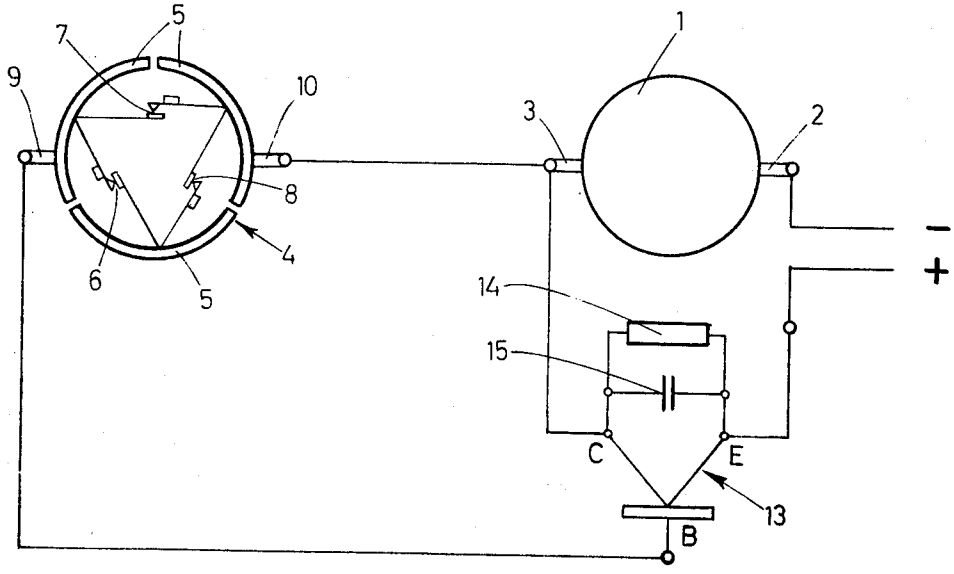
Primary Examiner—Oris L. Rader
Assistant Examiner—Thomas Langer
Attorney—Richards and Geier

ABSTRACT: A miniature DC motor the speed of which is controlled in response to centrifugal force and which has two commutators, one of which is provided for supplying the current to the rotor winding, while the other has three segments and two diametrically opposite brushes for electrically connecting two adjacent of these three segments to each other by at least two and preferably three centrifugal contactors.



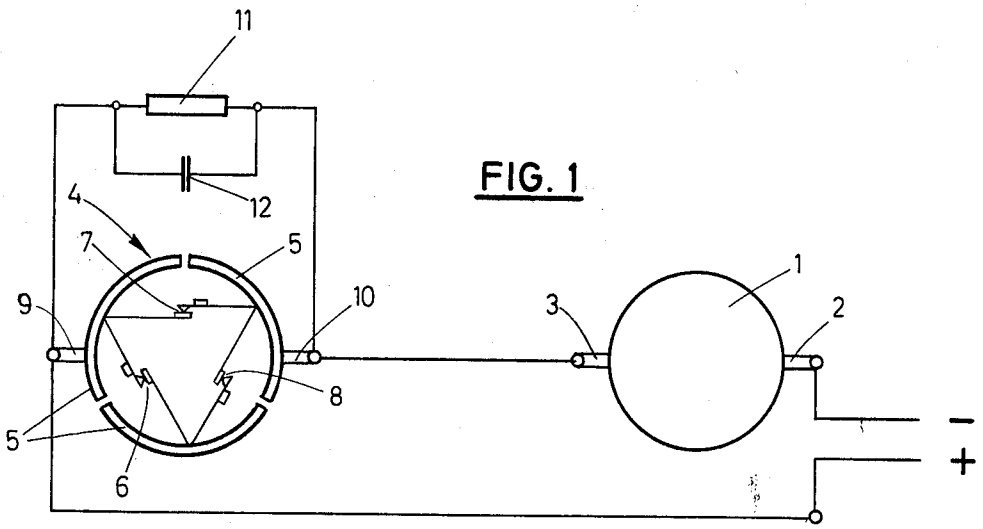


FIG. 1

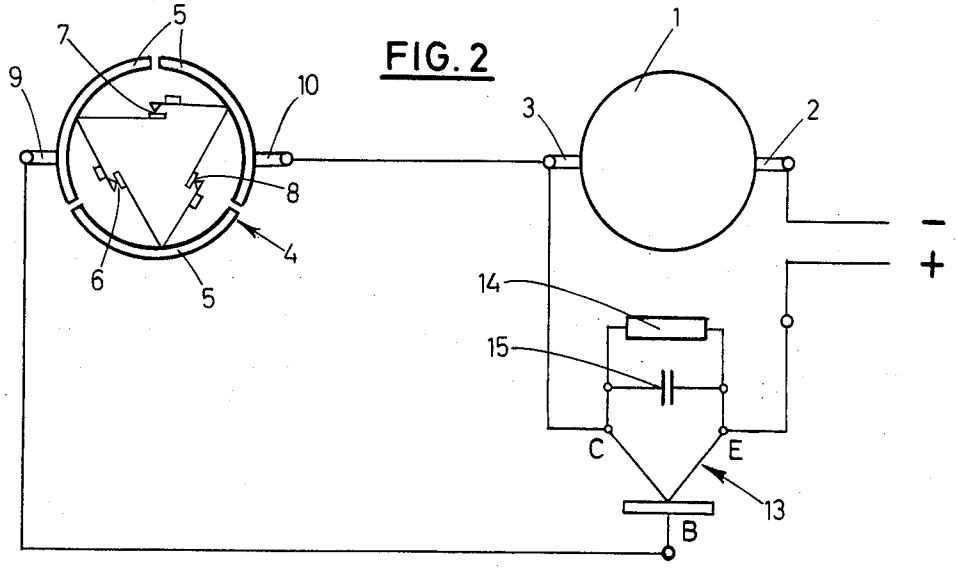


FIG. 2

INVENTOR: J. Lindner

By Richards & Geier

ATTORNEYS

MINIATURE DIRECT-CURRENT MOTOR

The present invention relates to a miniature direct-current motor the speed of which is controlled in response to centrifugal force.

For maintaining the speed of a miniature direct-current motor at a constant rate, a centrifugal contactor is often employed each contact of which is electrically connected to a separate slip ring. In order to subject the contacts of the centrifugal contactor and the brushes which engage upon the slip rings only to the load of the smallest possible current so as to protect them as much as possible, a transistor has already been employed the collector-emitter line of which is connected in series with the motor and the base circuit of which contains the centrifugal contactor. This known miniature direct-current motor has the disadvantage that the unchanging polarity of the contacts of the centrifugal contactor results in a flow of material on these contacts and that, in addition, films of foreign substances are formed on these contacts which result in a change of the transition resistance between the contacts which, in turn, interferes with the proper running of the motor. It has also been found that at very small currents and therefore low voltages between the contacts the films of foreign substances are especially disadvantageous and that especially at higher voltages and stronger currents the flow of material leads to serious interferences. For eliminating the flow of material, the prior art already discloses a miniature direct-current motor in which, aside from the commutator for supplying the current to the rotor winding, a second commutator is provided which has two diametrically opposite brushes and two segments which are electrically connected to each other by a centrifugal contactor. Since a continuous change in the polarity of the contacts of the two centrifugal contactors is hereby attained, the flow of material is eliminated.

The present invention relates to a miniature direct-current motor of the type as mentioned above, the speed of which is controlled in response to centrifugal force and which is provided with a commutator for supplying the current to the rotor winding and with at least one centrifugal contactor, and in addition with a second commutator which is provided with diametrically opposite brushes and with at least two segments which are electrically connected to each other by the centrifugal contactor. Although in such a known type of a miniature direct-current motor the flow of material is eliminated by a continuous reversal of polarity of the contacts of the centrifugal contactor, it has the disadvantage that films of foreign substances are formed on the contacts of the centrifugal contactor and that, in addition, every time when its second commutator is located in a position in which the ends of the segments of this second commutator are electrically connected to each other by the diametrically opposite brushes and the open centrifugal contactor is therefore short circuited, the maximum current will flow through the brushes and through the commutator segments, which occurs twice at each revolution and increases the speed of this motor beyond its rated speed.

It is an object of the present invention to overcome these disadvantages of forming films of foreign substances on the contacts of the centrifugal contactor and of increasing the speed of this motor beyond its rated speed.

For attaining this object, the present invention consists in providing the second commutator with three segments and in connecting these three segments electrically to each other by means of two centrifugal contactors.

These new features of the present invention have the result that, when the motor reaches its rated speed, the pairs of contacts of the two centrifugal contactors will open so that at any position of the second commutator the circuit between the two brushes of this commutator will always be interrupted. The speed of the miniature direct-current motor according to the invention can therefore never increase beyond the rated speed. It has further been found that films of foreign substances will practically never occur on the contacts of the centrifugal contactors of this miniature motor and that it will therefore always run without interference.

According to a further embodiment of the invention, the new miniature direct-current motor may also be provided with three centrifugal contactors each of which is electrically connected to two adjacent segments. These three centrifugal contactors do not have to be adjusted precisely to the rated speed but may differ therefrom by very small amounts. Assuming that the motor according to the invention operates with a normal torque, two centrifugal contactors will then be open, while only the third contactor will be in operation. This centrifugal contactor then connects two adjacent segments to each other each of which has a angular length of almost 120°. A flow of current through the second commutator will then be impossible along a length of more than twice 120°. The load upon the centrifugal contactor which is in operation will therefore be considerably relieved since the number of contactor operations decreases considerably per unit of time. Therefore, the second commutator practically serves also for regulating the speed.

The miniature direct-current motor according to the invention may operate either together with or without a transistor. Such a transistor is unnecessary if at a maximum load the current is kept within relatively small limits. When employing a transistor, the collector-emitter line of the transistor is connected in a manner known as such in series with the commutator which supplies the current to the rotor winding, while the two brushes of the second commutator are connected into the base circuit of the transistor.

The features and advantages of the present invention will become further apparent from the following detailed description thereof which is to be read with reference to the accompanying diagrammatic drawings, in which

FIG. 1 shows the circuit diagram of a miniature direct-current motor according to the invention without a transistor; while

FIG. 2 shows a circuit diagram similar to that according to that of FIG. 1 but with a transistor.

The miniature direct-current motor as illustrated in FIG. 1 comprises a commutator 1 which is adapted to supply the current to the rotor winding, not shown. Upon the commutator 1 pair of brushes 2 and 3 are applied. Connected in series with the commutator 1 and the brushes 2 and 3 is a second commutator 4 which is provided with three segments 5. Each of these segments is electrically connected to each adjacent segment by means of a centrifugal contactor 6, 7, or 8, respectively. Upon this commutator 4 are applied the brushes 9 and 10 which are disposed at an angle of 180° to each other and are bridged by a resistor 11 and a condenser 12. Brush 9 is connected to the positive terminal and brush 2 of the commutator 1 to the negative terminal of a direct-current source.

In the circuit of the miniature motor as illustrated in FIG. 2, the collector-emitter line of the transistor 13 is connected in series with the commutator 1, while the commutator 4 is connected by the brushes 9 and 10 to the base circuit of the transistor 13. The collector C and the emitter E of the transistor 13 are bridged by a resistor 14 and a condenser 15.

Actually, only two of the three centrifugal contactors are required, for example, the contactors 6 and 7, while the third centrifugal contactor, for example, the contactor 8, serves for relieving the load on the two other contactors. When all three centrifugal contactors 6, 7, and 8 are opened, the circuit between the two brushes 9 and 10 will always be interrupted in any position of the second commutator 4 so that the rated speed can never be exceeded.

It is evident that the three centrifugal contactors 6 to 8 cannot be adjusted precisely to the same speed. Assuming that the motor operates with the normal torque, two of the centrifugal contactors will then be open and only one contactor will be in operation. This contactor then always connects two adjacent segments 5 to each other. It is therefore impossible that along an angle of rotation of twice 180° a flow of current will occur through the second commutator 4. The centrifugal contactor

which is in operation will therefore be considerably relieved since the number of contactor operation decreases considerably per unit of time. Therefore, the additional commutator **4** then also serves as a speed governor. At a low voltage and an unexpected maximum load, for example, the centrifugal contractor **7** will operate, while the centrifugal contactor **6** will be closed and the contactor **8** will be open. The centrifugal contactor **8** then serves as a reserve contactor and will not be necessary for the normal operation.

Series of tests with the miniature direct-current motor according to the invention have shown that it operates very properly and that the centrifugal contactors cause no interferences. This miniature motor has especially the advantage that, although operating correctly, it is of a very simple and inexpensive construction. Such a correct operation of a miniature direct-current motor has hitherto been impossible, except by the use of expensive and complicated electronic circuits.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. A miniature direct-current motor, comprising a rotor having a winding and a shaft, a first commutator fixed upon the rotor shaft and supplying current to the rotor winding, said commutator having two fixed diametrically opposed brushes, a second commutator fixed upon the rotor shaft and having two fixed diametrically opposed brushes, three segments, and at least two centrifugal contactors interconnecting electrically the three segments, means electrically connecting one brush of the first-mentioned commutator with one brush of the second commutator, a source of direct current and means connecting one pole of said source to the other brush of the first-mentioned commutator and connecting the other pole of said source to the other brush of the second-mentioned commutator.

2. A miniature direct-current motor as defined in claim **1**, in which three centrifugal contactors are provided each of which is adapted to connect two adjacent of said three segments electrically to each other.

3. A miniature direct-current motor as defined in claim **1**, further comprising a transistor, the collector-emitter line of said transistor being connected in series with said first commutator, said two brushes of said second commutator being connected into the base circuit of said transistor.