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Kruszynski

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[54] **ELECTRIC DRIVING APPARATUS**

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[51] **Int. Cl.** **H02k 13/00**

[58] **Field of Search** 310/128, 133; 318/242, 243, 265, 369, 373, 437, 439, 466, 491, 541

[56] **References Cited**

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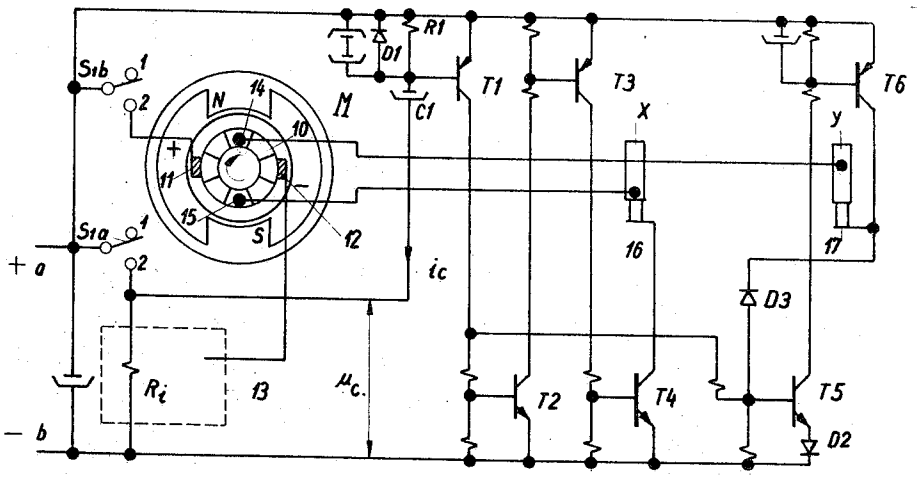
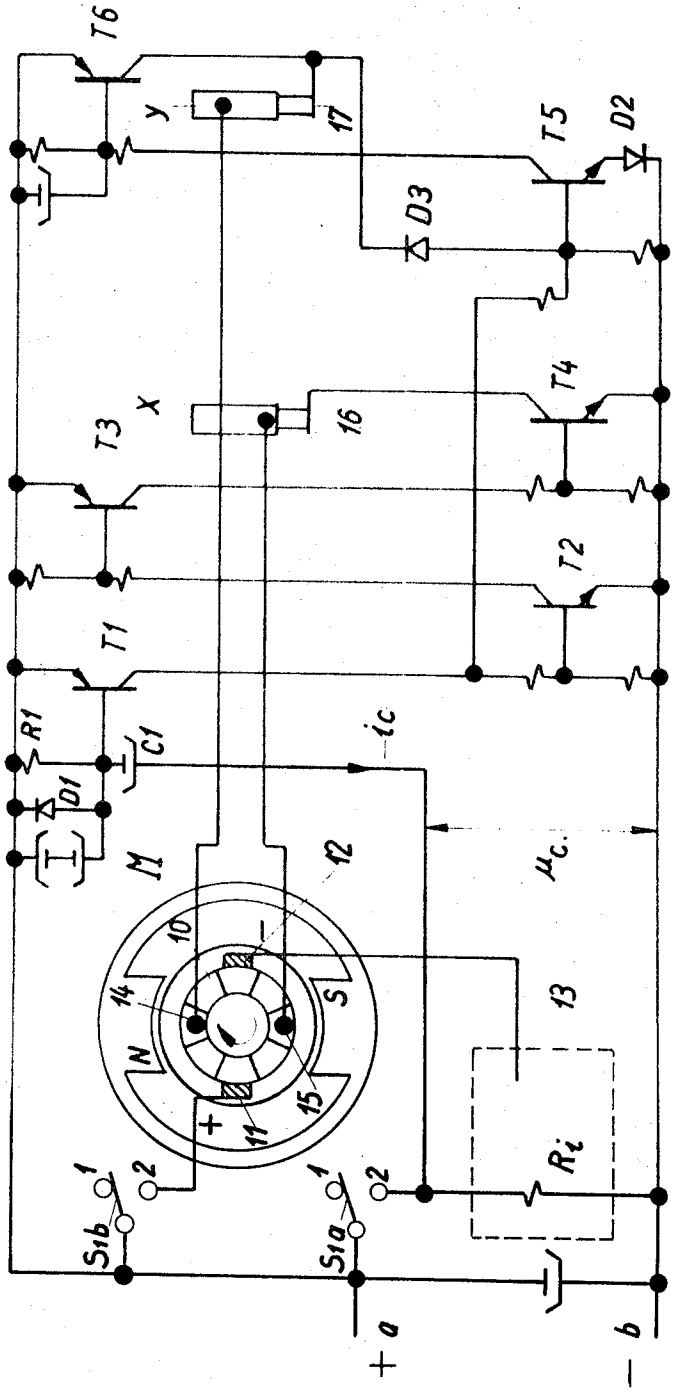
Attorney—Edward Dreyfus

[57] **ABSTRACT**

An electric motor drive having a rotor that is brought to a stop in a predetermined angular position whenever the mechanism ceases to move. The motor includes a segment type commutator as well as a slip ring and means of applying a blocking voltage to the slip ring to produce a rotor induced magnetic field of fixed orientation in relation to the rotor. Means are also provided to control application of stopping current only when the rotor is in a stable stopping position.

4 Claims, 6 Drawing Figures




T6
y
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x
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12
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14
S
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15
11
13
Ri
1
2
S1b
S1a
+ a
– b

Fig. 1

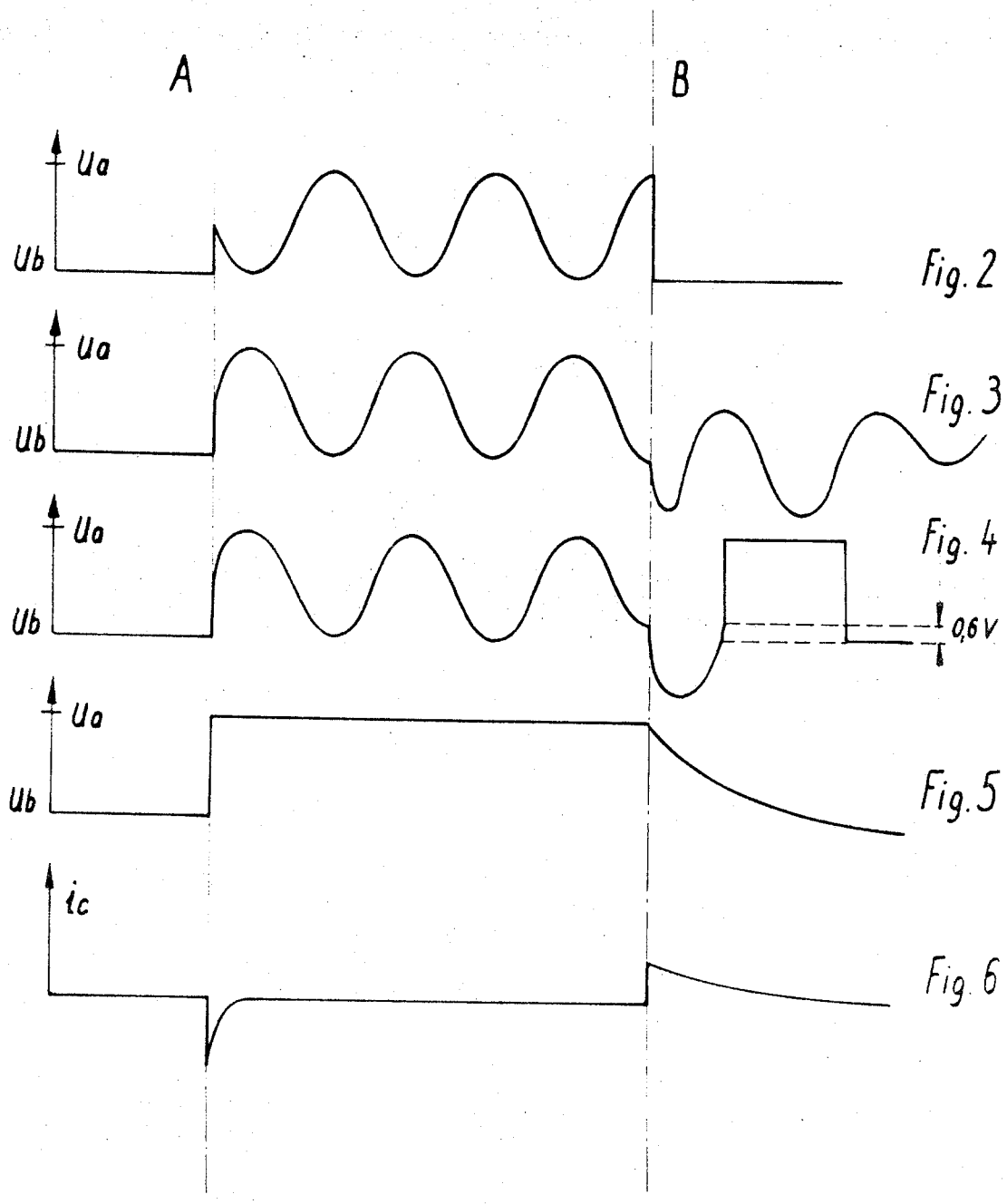
A
B
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Fig. 2
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Fig. 3
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Fig. 4
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Fig. 5
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Fig. 6

ELECTRIC DRIVING APPARATUS

FIELD OF INVENTION

The present invention relates to an electric driving apparatus and more particularly to a motor the rotor of which can be stopped in a predetermined angular position.

BACKGROUND

It is often desirable for the driving motors of various machines to stop in determined angular position. This is particularly necessary in the case of cine-cameras, because the shutter must be closed when the mechanism stops moving. With prior known cameras, this is usually acheived by employing a mechanical device which is relatively costly. Furthermore, these devices are known to deteriorate as the result of wear and tear or as the result of an error in manipulation.

SUMMARY OF THE INVENTION

The present invention overcomes these problems by providing the electrical drive motor with a segment type commutator and a slip ring and also a means of applying a blocking voltage (when the movement ceases) through the slip ring current collector to produce a rotor induced magnetic field constantly orientated in relation to the rotor. This magnetic field cooperates with the permanent magnetic field to stop the rotor in a predetermined position.

In order that the invention may be more fully understood one embodiment and one variation of the objective according to the invention, are described below, purely by way of illustrative but non-limiting example, with reference to the accompanying schematic drawing in which:

FIG. 1 shows the electrical lay-out of the driving mechanism of the motor.

FIG. 2 to 6 represent the electric signals read at various points on the circuit shown in FIG. 1.

DETAILED DESCRIPTION

With reference to FIG. 1, motor M comprises two permanent magnetic poles N and S. The motor also comprises a commutator 10 for the supply of current to the rotor by way of the brushes 11 and 12. Thus, brush 11 is connected to the pole as of a power supply by a switch S_{1b} of which a second pole S_{1a} controls the stepping up of voltage of standard and known electronic device 13 controlling the supply voltage proportionally to the desired speed of rotation of the motor. This device is connected between the brush 12 and the terminal b of the power supply.

Two segments 14 and 15 of the commutator 10 are connected respectively to two slip rings *x* and *y* which have been depicted outside the motor in order to simplify the drawing, but which physically are mounted on the shaft of the motor. The ring *x* is connected by a brush 16 to the collector of a transistor T_4, while the ring *y* is connected by a brush 17 to the collector of a transistor T_6. When the two transistors T_4 and T_6 are turned on, the rings *x* and *y* are connected respectively to the terminals *b* and *a* of the power supply; thus a current goes thorugh the rotor which gives it a transversal magnetisation stationary in relation to the rotor itself.

Under the influence of this magnetisation, the motor always stops in a predetermined angular position in which the magnetic north and south poles of the rotor

are opposite the south and north poles of the stator. If, when the current is applied to to the rings *x* and *y*, the rotor is in a position other than the predetermined stopping position, it is brought to this position by mangetisation unless it happens to be exactly in the unstable position of equilibrium in which the north and south poles of the rotor are opposite the north and south poles respectively of the stator.

A circuit comprising the transistors T_1, T_2, T_3, Tj_5 controls the two transistors T_4 and T_6 which are turned on simultaneously for a predetermined length of time provided that the angular position of the rotor enables such turn on at that instant as described below.

The control of the transistors T_4 and T_6 is carried out by a charging current from condenser C_1 which is connected between the resistance R_i of the device 13 and the base of the transistor T_1. The terminal of the condenser C_1 which is connected to the resistance R_i is connected to the contact stud 2 of the switch S_{1a}. The charging current of the condenser C_1 causes current to flow in the transistor T_1 which turns on the transistors T_5 and T_6 on the one hand and the transistors T_2, T_3 and T_4 on the other. However, the conduction of the transistor T_5 cannot be achieved unless a voltage negative in relation to its threshold level is applied to its base by means of the diode D_3 connected between its base and the brush 17.

The operation of the drive motor is illustrated by the curves in FIG. 2 to 6 in which the supply to the motor M is represented between the interrupted lines A and B. This interval is preceded by an interruption in the flow of current of an unlimited length of time which is represented on the left of line A and it is followed by another period without current which is represented on the right of line B.

FIG. 5 shows the voltage at the terminals of the resistance R_i. After a sufficient interruption the voltage at the terminals of the condenser C_1 is equal to that of the supply. When the switch S_{1a}, S_{1b} is "on" the condenser C_1 discharges through the diode D_1. This produces a peak in the current (see FIG. 6) during which the transistor base T_1 reaches a positive potential in relation to its emitter. The transistor T_1 is therefore turned off and in consequence all the transistors T_2 to T_6 remain nonconductive. When the switch S_{1a}, S_{1b} is "off" the supply voltage is again applied to the condensers C_1 through the resistance R_i and the transistor T_1 and the condenser C_1 is recharged. The charging current activates the transistor T_1, which inturn in turn a voltage to the bases of the transistors T_2 to T_5, thus activating them. In each case the transistors T_2, T_3 and T_4 are activated simultaneously with the transistor T_1. However, the voltage at the base of the transistor T_5 is determined not only by the current from the collector of the transistor T_1, but also by the voltage of the slip ring y which when negative forward biases and is applied through D_3.

The voltage of the slip rings *x* and *y* are represented by the curves in FIGS. 2 and 3, respectively. When the motor is connected to the supply, these two voltages vary in an appreciably sinusoidal manner between the terminals, *a* and *b*, respectively of the supply. When the current is interrupted, the transistor T_4 is turned on and it can be seen that the voltage of slip ring *x* then becomes equal to the potential of the terminal *b*.

FIG. 3 shows the voltage which would be collected on the slip ring *y* if the brush 17 were no longer con-

nected to the rest of the circuit. It is seen that when the current is interrupted the voltage at the slip ring *y* describes an alternating curve going from one side to the other of the potential of the terminal *b*. The result of this is that when the voltage of the bursh **17** is less than, +0.6 volts, the transistor T_5 cannot be activated in spite of the current from the collector of transistor T_1. This case is shown in FIG. **4** where it can be seen that the potential at the terminal *a* of the battery cannot be applied to the slip ring *y* during the period in which the latter has a negative potential. As soon as the potential in the slip ring *y* becomes greater than +0.6 volts, the base of the transistor T_5 is no longer affected by the voltage in slip ring *y*, and the transistor T_5 is turned on by the current flowing from the transistor T_1. The current from the transistor T_5 activates the transistor T_6 so that the potential terminal a of the supply is applied to the slip ring *y*. Accordingly, it is possible to bring the motor to rest in a predetermined stable position by controlling the application of the blocking voltage.

It should be noted that because the negative voltage occurring in slip ring *y* is applied to the base of the transistor T_5 through the diode D_3, the blocking current transmitted to the slip rings *x* and *y* cannot flow when the rotor is in the vicinity of its unstable stopping position mentioned above.

Other and further modifications can be made to the present invention without departing from the spirit or scope thereof. For example, the slip rings *x* and *y* may not be connected to the segments **14** and **15** of the commutator **10**, but instead are connected to an independant supplementary winding on the rotor intended only for stopping the rotor. Also, the unstable stopping position of the rotor could be detected by other means than by the occurrence of a voltage on a collector. For example, a contact may be operated by a fixed cam on the motor shaft which would in turn operate the contact at each rotation thus preventing the application of the blocking current at least in coincidence with a given angular position of the rotor. In certain cases it might be unnecessary to provide a means of preventing the application of the blocking current if the unstable stopping position were governed by the mechanism driven by the motor.

What is claimed is:

1. An electric motor apparatus having (a) a stator, (b) a rotor mounted for operative rotation relative to said stator, (c) means for supplying current to drive the rotor relative to said stator, (d) a segment type commutator coupled to the rotor, (e) slip ring means coupled to the rotor, (f) blocking means operable upon interruption of the motor driving current for applying a blocking voltage to the slip ring means to thereby stop said rotor at a predetermined angular position relative to said stator, and (g) control means sensitive to at least one angular position of the rotor relative to the stator for controlling the application of the blocking voltage in predetermined relation to said at least one angular position.

2. An electric motor apparatus as set forth in claim **1**, wherein said control means includes semiconductor means for continuously sensing the voltage in the slip ring means, said voltage in the slip ring means being representative of the angular position of the rotor, and said semiconductor means controlling the application of blocking voltage such that the application is prevented when the slip ring voltage is within certain predetermined values.

3. An electric motor apparatus as set forth in claim **1** wherein said slip ring means comprises a pair of slip rings coupled to rotate with said rotor, said blocking means comprising a pair of switch means for coupling each respective slip ring to a source of blocking voltage, and said control means comprising means for sensing the instantaneous voltage of at least one of said slip rings for applying a control signal to a first one of said switch means when the instantaneous slip ring voltage passes through a predetermined magnitude.

4. An electric motor apparatus as set forth in claim **3** further comprising a drive circuit adapted to be powered by a direct current, the second one of said switch means operative to selectively couple one terminal of a power supply to the drive circuit, and blocking means further including a condenser coupled to the drive circuit such that charging of said condenser, when the second one of said switch means is off, produces a current for a substantial duration, which current controls the second one of said switch means so that the blocking voltage is applied to the slip ring.

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