

[54] **ELECTRICALLY DRIVEN MOTOR**

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[51] Int. Cl.H02p 3/02

[58] Field of Search.....318/382, 466

[56]

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[57]

ABSTRACT

An electrically driven motor that can be rapidly rotated and stopped at a predetermined position about its own axis of rotation. To this end, the motor is provided with a rotational shaft rigidly mounted with a rotary magnet in coaxial relation to the rotor, said rotary magnet being adapted to be magnetized in one predetermined direction to produce a magnetic force acting on the rotor so as to stop said rotor at a predetermined position about its own axis of rotation.

4 Claims, 19 Drawing Figures

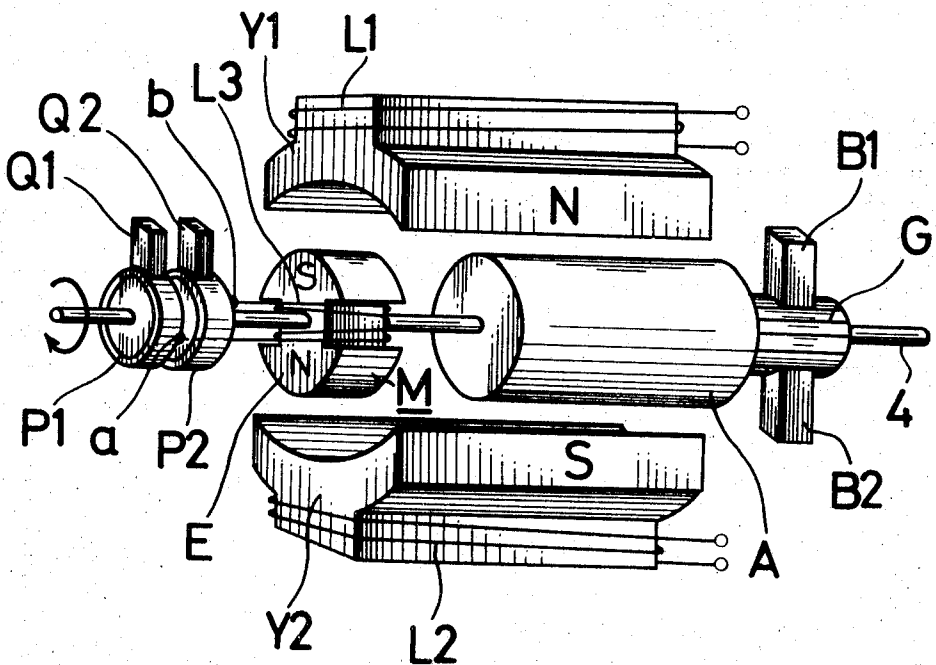


FIG. 1

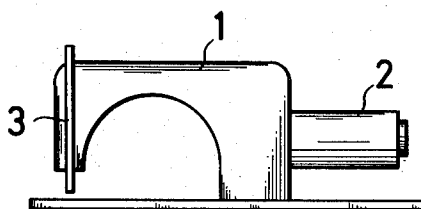
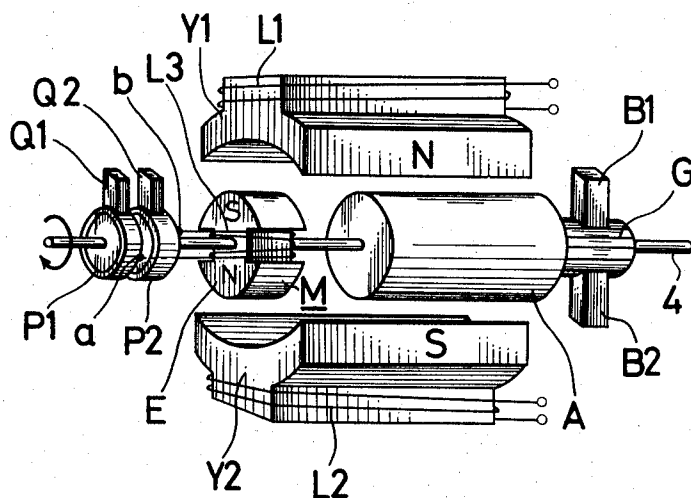


FIG. 2



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ATTORNEYS

FIG. 3

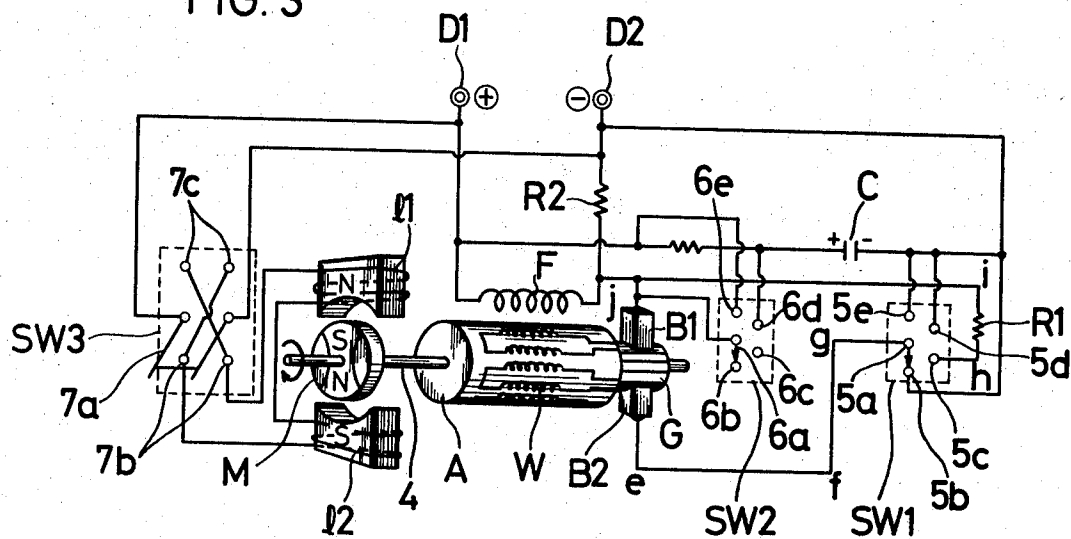


FIG. 4

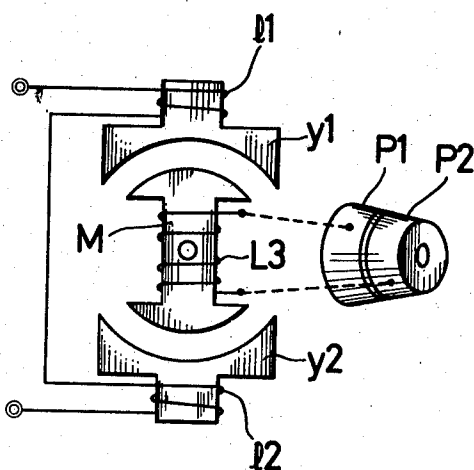


FIG. 5

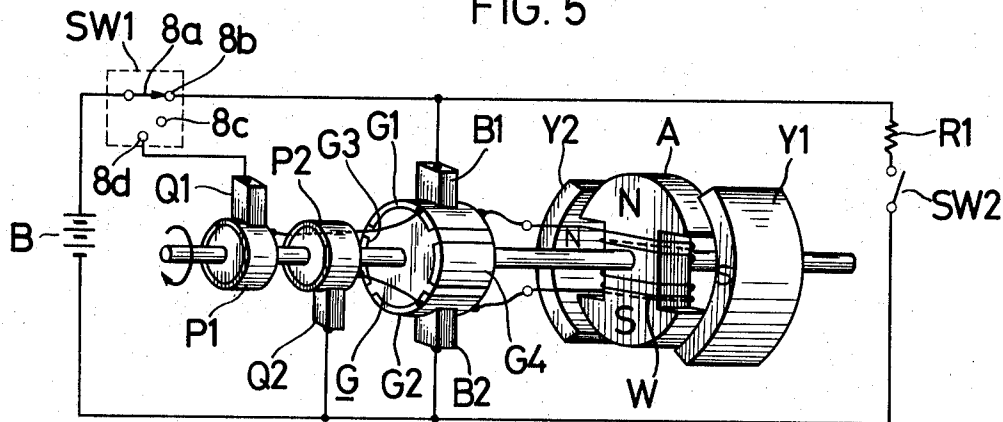
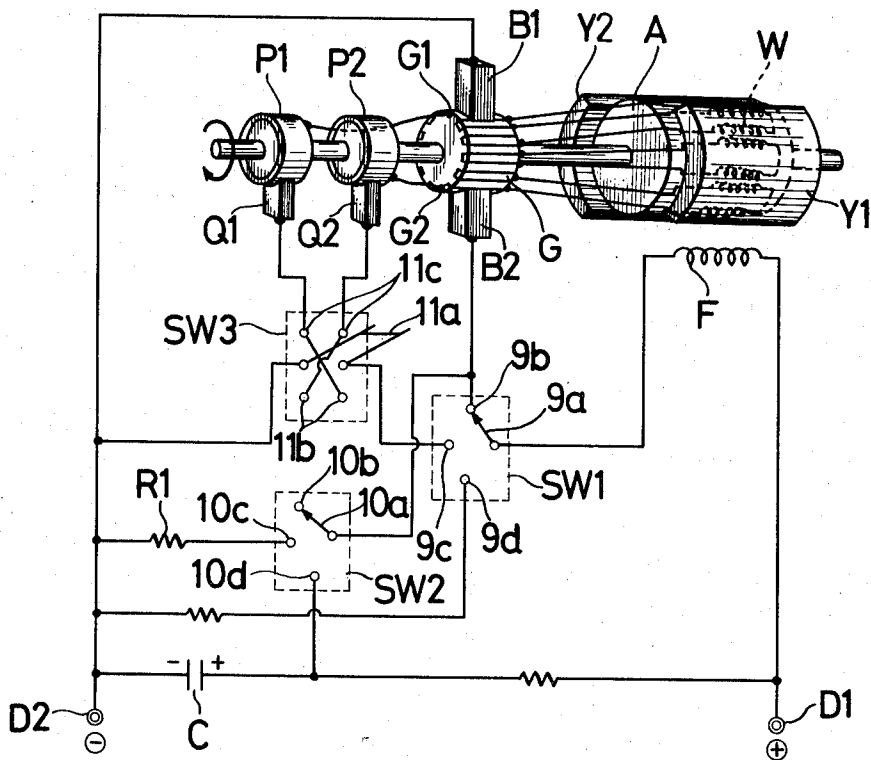


FIG. 6



BY

FIG. 7

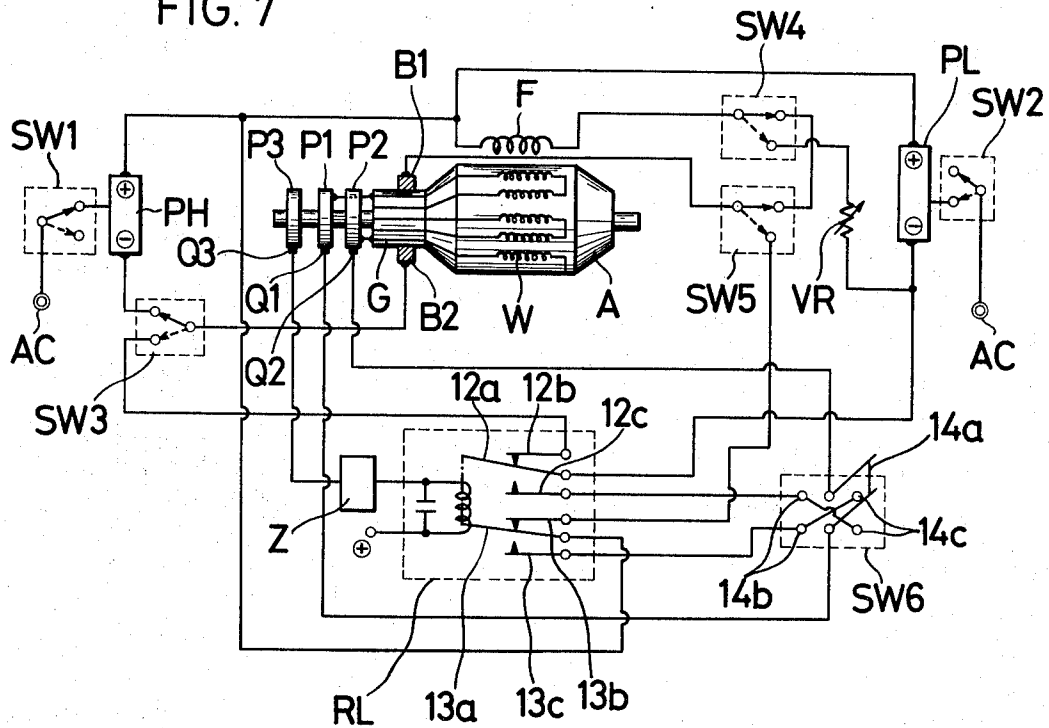


FIG. 8

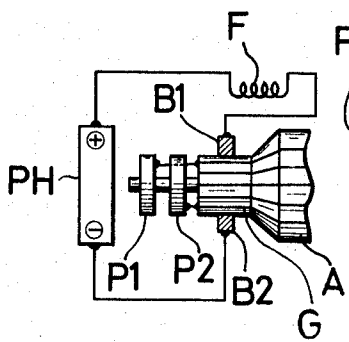


FIG. 9

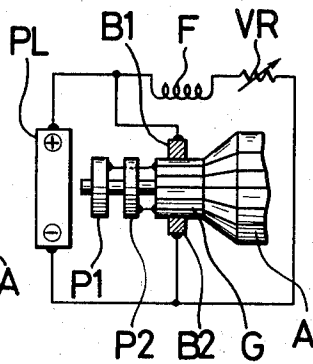


FIG.10

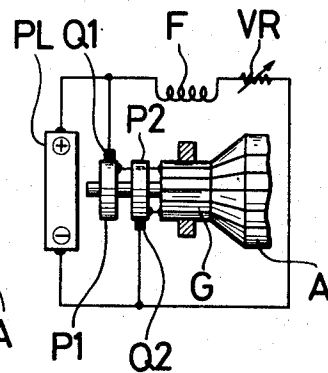


FIG. 11

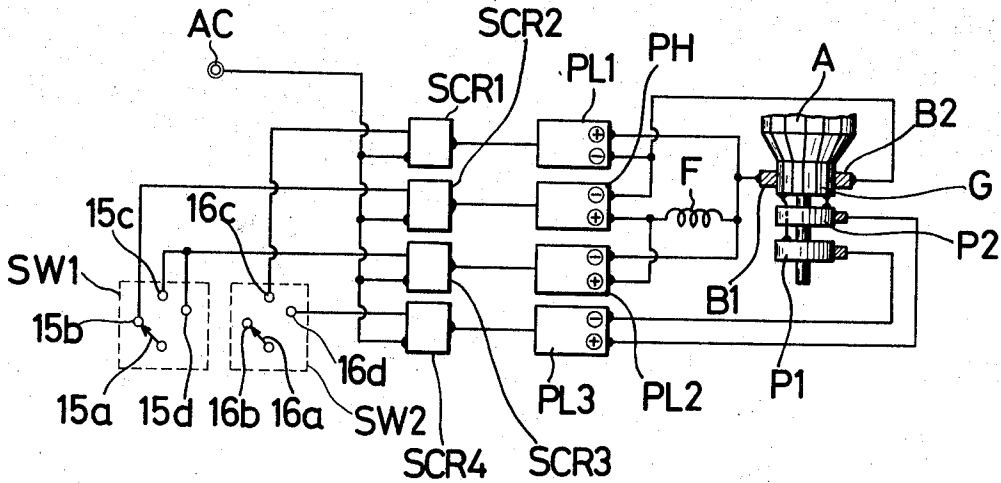
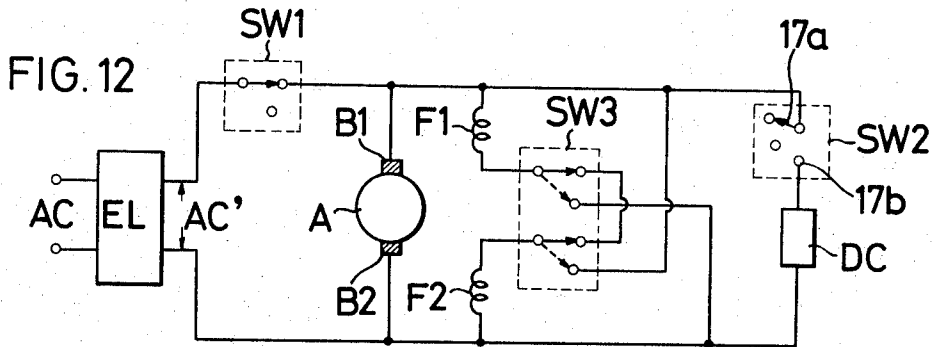


FIG. 13

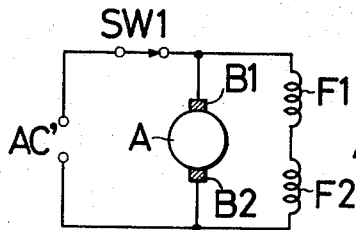
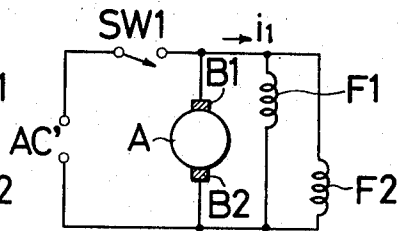


FIG. 14



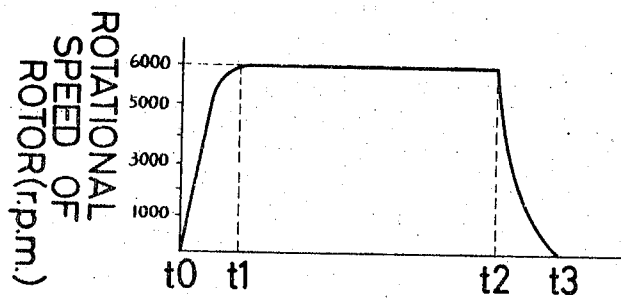


FIG. 15A

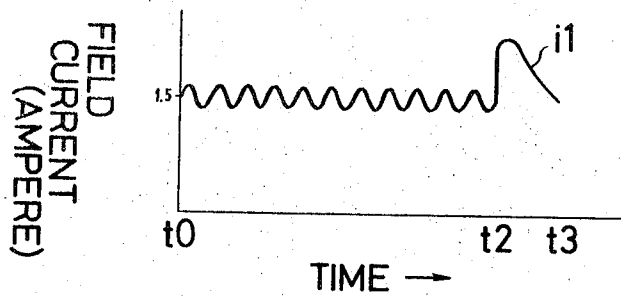


FIG. 15B

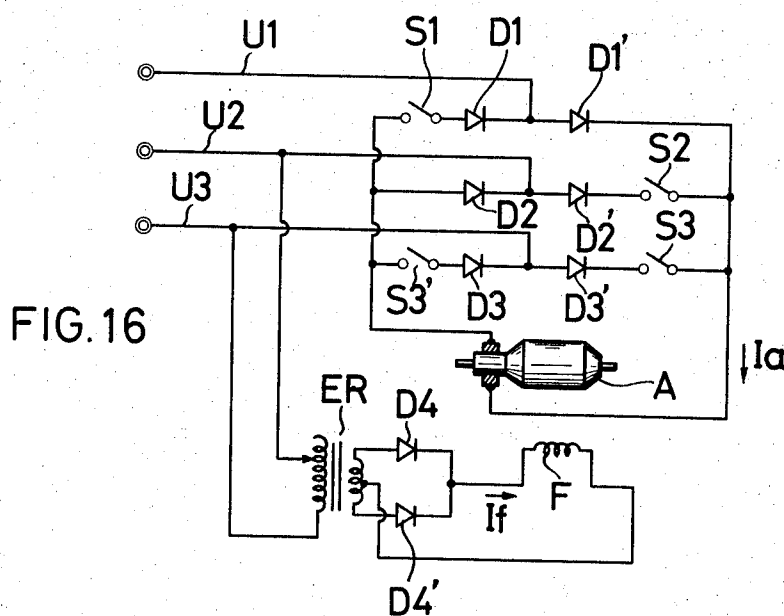


FIG. 16

FIG. 17

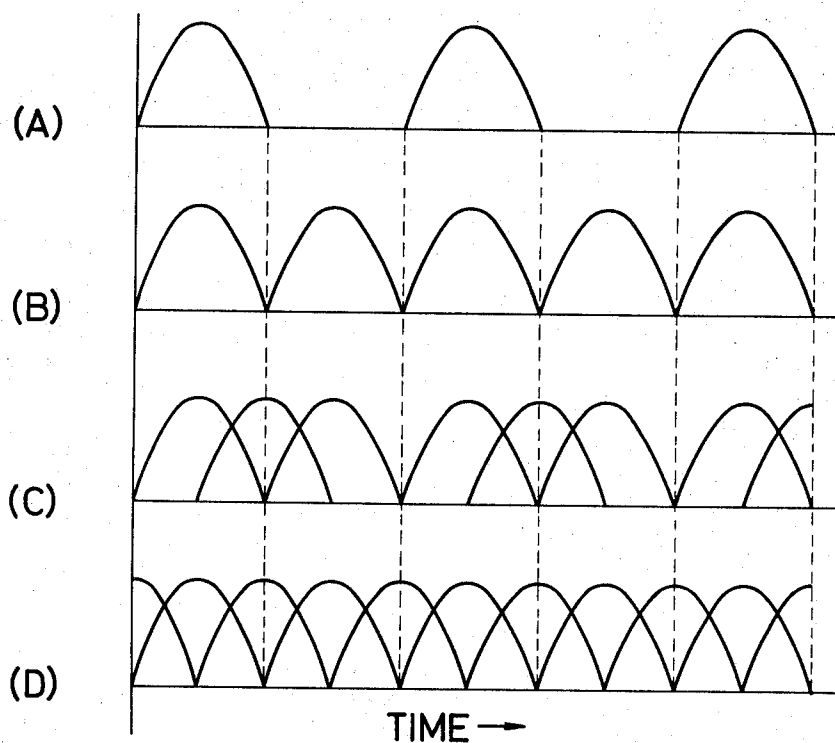
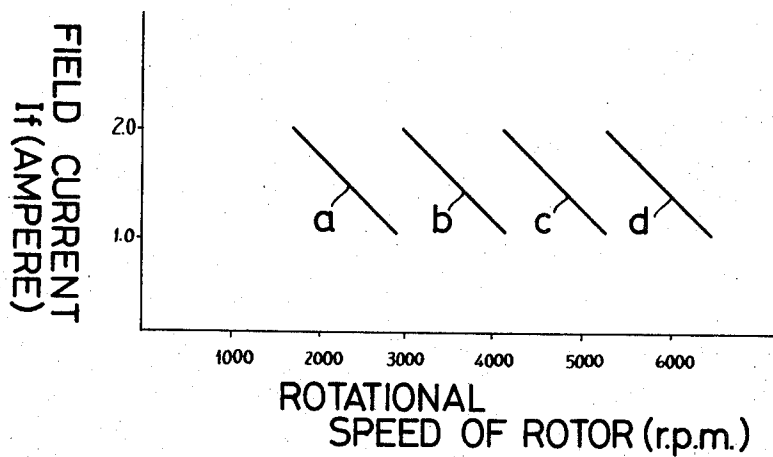


FIG. 18



ELECTRICALLY DRIVEN MOTOR**BACKGROUND OF THE INVENTION**

The present invention relates to an electrically driven motor and, more particularly, to an electrically driven motor capable of being suddenly rotated and stopped at a predetermined position about its own axis of rotation during each rotation thereof.

In an electric sewing machine for industrial use, an electric motor for driving the sewing machine should be such that the motor can be suddenly rotated and stopped at a predetermined position about its own axis of rotation so that the efficiency in sewing clothes can be improved. Furthermore, when the motor is to be stopped, the design of the motor should be such that a needle bar of the sewing machine to which a needle is fitted can be stopped at the upwardly shifted position or the downwardly shifted position as desired during each stroke of movement of said needle bar.

However, according to the prior art, since such a motor has not yet been developed, a mechanical or electrical control device has been interposed between the sewing machine and its needle bar to effect the stoppage of the needle bar at a desired position. However, in such a device, the sewing machine becomes complicated in its structure and manipulation thereof is also complicated.

BRIEF SUMMARY OF THE INVENTION

Accordingly, the present invention has been made in view to eliminating the disadvantages inherent in the conventional electrically operated sewing machines and has for its object to provide an electrically driven motor of simplified construction capable of being suddenly rotated and stopped at a predetermined position about its own axis of rotation.

Another object of the present invention is to provide an electrically driven motor having a rotatable rotor which can be stopped at a predetermined position about its own axis of rotation during each rotation thereof.

A further object of the present invention is to provide an electrically driven motor having a rotatable rotor which can be stopped at a predetermined position about its own axis of rotation half a rotation apart from the position in which the rotor has been initially stopped.

A still further object of the present invention is to provide an electrically driven motor which can be stopped at a desired position during the half rotation of the rotor.

DETAILED DESCRIPTION OF THE INVENTION

For better understanding of the present invention, the present invention will be hereinafter fully described with reference to the attached drawings in conjunction with preferred embodiments taken only for the purpose of illustration thereof, in which;

FIG. 1 is a schematic front view of a sewing machine to which a drive motor embodying the present invention is fitted,

FIG. 2 is a schematic perspective view of an essential portion of the drive motor showing an inner structure thereof,

FIG. 3 is an electric circuit diagram for operating the drive motor in another preferred embodiment of the present invention,

FIG. 4 is a schematic electric circuit diagram employed in a portion of means for stopping a rotational shaft mounted with a rotor at a predetermined position about its own axis of rotation,

FIG. 5 is a schematic perspective view of the inner structure of an AC and DC versatile drive motor and its associated electric circuit in another embodiment of the present invention,

FIG. 6 is a schematic perspective view of the inner structure of the drive motor shown in FIG. 5 in a modified form,

FIG. 7 is a motor circuit diagram according to the present invention,

FIG. 8 through FIG. 10 are electric circuit diagrams shown in series in connection with the operation of the motor shown in FIG. 7,

FIG. 11 is an electric circuit diagram showing a circuitry between a power source and the motor according to the present invention,

FIG. 12 is an electric circuit diagram showing a circuitry associated with field coils employed in the motor according to the present invention,

FIG. 13 and FIG. 14 are electric circuit diagrams shown in series in connection with the operation of the motor shown in FIG. 12,

FIG. 15(A) and (B) are performance characteristic curves shown for better understanding of the principle of operation of the circuit shown in FIG. 12,

FIG. 16 is an electric circuit diagram showing a circuitry employed for controlling the drive motor of the present invention with the use of a three-phase power source,

FIG. 17 is a diagram showing various wave forms of current past the field coil shown in FIG. 16, and

FIG. 18 is a diagram showing the relationship between the rotational number of the rotor shown in FIG. 16 and the value of current past the field coil.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a sewing machine 1 adapted to be driven by an electric drive motor 2 constructed in accordance with the teachings of the present invention. This drive motor 2 is usually fitted to the sewing machine body so as to reciprocate a needle bar 3, adapted to support a needle, in a conventionally known manner.

The drive motor 2 is, as shown in FIG. 2, provided with a rotor A rigidly mounted on a rotational shaft 4, a commutator G having a plurality of commutator segments and also rigidly mounted on the shaft 4, an electromagnetic iron core E rigidly mounted on the shaft 4 and a pair of slip rings P1 and P2 rigidly mounted on the shaft 4. The iron core E is wound with a winding L3 having a pair of terminal ends which are in turn connected with said slip rings P1 and P2, respectively, as indicated by a and b in FIG. 2.

Surrounding around the electromagnetic iron core E and the rotor A is a pair of electromagnetic yokes Y1 and Y2 respectively wound with coils L1 and L2 which are in turn connected with a common DC power source (not shown) to magnetize the respective yokes Y1 and Y2 into the north pole and the south pole as shown.

The commutator G has, as hereinbefore described, a plurality of commutator segments each in slidably contact with a pair of brushes B1 and B2 through which current can be supplied to the rotor A. Also provided in slidably contact with the peripheral surfaces of the slip rings P1 and P2 is a pair of respective brushes Q1 and Q2 through which DC current can be supplied to the winding L3 so that a pair of segments of the iron core E can be respectively magnetized into the north pole and the south pole as shown.

If DC current is supplied to the coils L1 and L2 to magnetize the respective yokes Y1 and Y2 into the north and south poles as shown and the same is also supplied to the rotor A through the brushes B1 and B2 both in contact with the peripheral surfaces of the segments of the commutator G, the rotor A commences to rotate in one direction. This mechanism of the rotation is well known in the art and is substantially the same as that of a conventional DC motor.

However, when the current that has been supplied to the rotor A through the pair of brushes B1 and B2 is cut off and DC current is then supplied to the winding L3 through the pair of brushes Q1 and Q2 normally contacted to the respective slip rings P1 and P2, the electromagnetic iron core E can be magnetized such that one segment of said iron core E establishes the north pole and the other segment thereof establishes the south pole, resulting in that an electromagnetic braking force can be generated between the pair of the yokes Y1 and Y2 and the iron core E. Accordingly, it will be clearly understood that a rotary electromagnet M composed of the iron core E and the winding L3 can be stopped in such a manner, as shown in FIG. 2, that the south pole of the iron core E is in register with the north pole of the yoke Y1 while the north pole of the iron core E is in register with the south pole of the yoke Y2.

While in this condition as shown in FIG. 2, it is assumed that the needle bar 3 of the sewing machine 1 is moved to the uppermost position. If the direction of flow of current supplied to the winding L3 through the pair of brushes Q1 and Q2 is subsequently reversed, the polarity of the rotary electromagnet M is then reversed resulting in that the rotary electromagnet M is rotated half a rotation until the south and north poles thereof are respectively mated with the north and south poles of the both yokes Y1 and Y2. Accordingly, the needle bar 3 of the sewing machine 1 is at this time moved to the lowermost position.

In the foregoing description, although the yokes Y1 and Y2 are respectively wound with the coils L1 and L2 adapted to magnetize said yokes upon application of current thereto, it is to be noted that a pair of permanent magnet may be employed in place of such yokes.

Referring now to FIG. 3, it is shown an electric circuit which may be employed in connection with the drive motor shown in FIG. 2. However, for the sake of brevity, the rotary electromagnet M in FIG. 2 is respectively replaced by a permanent magnet in FIG. 3.

While the circuit is in the condition as shown in FIG. 3, current from a positive terminal D1 of the DC power source is adapted to flow to a negative terminal D2 of the same power source in order through a field coil F, the brush B1, the commutator G, the winding W of the

rotor A, the brush B2 and a pair of closed contacts 5a and 5b of a switch SW1. Accordingly, since an electromotive force of a great value can be generated when the current from the power source flows through the field coil F, the rotor A can be rapidly rotated in one direction about its own axis of rotation.

In order to stop the rotating rotor A, it is only necessary to engage a movable contact 5a of the switch SW1 from its fixed contact 5b to its fixed contact 5c. When the movable contact 5a is engaged with the fixed contact 5c, a closed circuit can be established between the pair of the brushes B1 and B2 through a resistor R1, this closed circuit being indicated by *e-f-g-h-i-j* in series. However, a movable contact 6a of a switch SW2 is at this time switched over from its fixed contact 6b to its fixed contact 6c so that no current flows through the winding W of the rotor A from the power source. However, since the current from the positive terminal D1 of the power source passing through the field coil F is fed back to the negative terminal D2 through a resistor R2, the field coil F is excited. Accordingly, when the supply of current to the winding W of the rotor A ceases and the rotor A is still rotating under the influence of an inertia force, an electromotive force can be produced in the winding W of the rotor A by the excitation of the field coil F, resulting in that the drive motor acts as a power generator. The electromotive power thus produced is in turn applied to the closed circuit *e-f-g-h-i-j* and wasted by the load resistor R1 disposed in said closed circuit, whereby a braking force in proportion to the amount of the electromotive power thus wasted acts on the rotor A so as to rapidly reduce the rotational speed of said rotor A.

If a pair of movable contacts 7a of a switch SW3 is engaged with a pair of its fixed contacts 7a while the rotor A is decelerated, a pair of coils l_1 and l_2 are respectively excited to establish the north and south poles as shown in FIG. 3 and, therefore, the rotary magnet M can be attracted thereby as shown resulting in that the rotor A can be stopped at a predetermined position about its own axis of rotation.

In the case where the rotor A is desired to be rotated half a rotation about its own axis of rotation from the condition in which said rotor A is stopped as hereinbefore described, it is only necessary to disengage the pair of movable contacts 7a of the switch SW3 from its pair of fixed contacts 7b thereby to cut off the supply of the DC current to the both coils l_1 and l_2 and also to connect the movable contacts 5a and 6a of the switches SW1 and SW2 to the fixed contacts 5d and 6d, respectively thereby to supply a load, that has been charged in a condenser C, to the commutator G through the respective brushes B1 and B2. Accordingly, it will be clearly understood that the rotor A commences to rotate in the direction as indicated by the arrow.

Thereafter, when the directions of magnetization of the coils l_1 and l_2 are respectively reversed with respect to each other by connecting the movable contacts 7a of the switch SW3 to its fixed contacts 7c and the movable contacts 5a and 6a of the respective switches SW1 and SW2 are at the same time instantaneously engaged with the fixed contacts 5e and 6e, respectively, the current from the positive terminal D1 flows to the negative terminal D2 through the winding W of the rotor A. Accordingly, it will be clearly understood that the rotor A

can be stopped at a predetermined position after half a rotation.

FIG. 4 shows the rotary magnet M, yokes y_1 and y_2 for respective field windings which are employed in the form of electromagnets. The advantages obtainable from the circuit shown in FIG. 4 resides in that no electromotive power can be generated in the windings I_1 , I_2 and L_3 even during the rotation of the rotor A.

FIG. 5 shows an electric circuit associated with a two phase motor which can be driven by either DC or AC current. In this instance, the winding W formed in the rotor A which is surrounded by a pair of the yokes Y1 and Y2 respectively magnetized into the north and south poles has a pair of terminals which are in turn connected with a pair of segments of the commutator G, respectively, as indicated by G1 and G2. The segment G1 is also connected with the slip ring P1 while the other segment G2 is connected with the slip ring P2. In this arrangement, the current is adapted to be fed to the winding W of the rotor A through the pair of brushes B1 and B2 and also through the pair of brushes Q1 and Q2, each of the former being in contact with the corresponding segments G1 and G2 and each of the latter being in contact with the corresponding slip rings P1 and P2.

In this circuit as shown in FIG. 5, if the movable contact 8a of the switch SW1 is engaged with its fixed contact 8b while the switch SW2 is opened, current from the power source B can be supplied to the winding W of the rotor A through the pair of brushes B1 and B2 resulting in that the rotor A commences to rotate in one direction about its own axis of rotation.

If the switch SW1 is subsequently operated to engage the movable contact 8a to the fixed contact 8c then to cease the supply of the current to the winding W of the rotor A while the switch SW2 is closed, an electromotive power generated in the winding W of the rotor A that is rotating under the influence of an inertia force can be impressed on the resistor R1. As the electromotive power is impressed on the resistor R1, the rotating rotor A can be affected with a braking force of the value proportional to the amount of electric power wasted by said resistor R1 with the result that the rotor A can be rapidly decelerated.

When the movable contact 8a of the switch SW1 is engaged to the fixed contact 8d during the deceleration of the rotor A, the current from the power source B can be supplied to the winding W of the rotor A in order through the brush Q1, the slip ring P1 and the segment G1 of the commutator G and then fed back in order through the segment G2 of the commutator G, the slip ring P2 and the brush Q2 thereby to establish a closed circuit connecting these elements. Accordingly, the current flowing through the winding W of the rotor A acts to from the north and south poles in the rotor A and the rotor A undergoes one-fourth rotation exactly until the north pole of the rotor A is attracted by the south pole of the yoke Y1 while the south pole of the rotor A is attracted by the north pole of the yoke Y2, the condition of the rotor A with respect to the yokes Y1 and Y2 prior to such one-fourth rotation being shown in FIG. 5.

While the rotor A is stopped as hereinbefore described, the winding W of the rotor A is still excited by the current from the power source B flowing

therethrough via the pair of brushes Q1 and Q2 in contact with the respective slip rings P1 and P2. Accordingly, no change in the direction of magnetization of the rotor A takes place and, therefore, the rotor A maintains in its stopped condition.

In order to cause the rotor A to re-rotate, it is only necessary to open the switch SW2 and concurrently to engage the movable contact 8a to the fixed contact 8b of the switch SW1.

In FIG. 6, a modification of the circuit shown in FIG. 5 is shown wherein the yokes Y1 and Y2 are adapted to be magnetized by current flowing through the field coil F and the winding W of the rotor A has a pair of terminals each connected with the commutator G. One of the segments G1 of the commutator G is, in the instance as shown in FIG. 6, connected with the slip ring P1 and another one of the segments G2 thereof is connected with the slip ring P2.

While in this arrangement, if the movable contact 9a of the switch SW1 is connected with its fixed contact 9b, current from the positive terminal D1 of the power source can flow to the negative terminal D2 thereof in order through the field coil F, the switch SW1, the brush B2, the commutator G and the brush B1 so that the rotor A can be rotated in one direction about its own axis of rotation.

If the movable contacts 9a and 10a of the respective switches SW1 and SW2 are engaged to the fixed contacts 9c and 10c, respectively, while the movable contact 11a of the switch SW3 is engaged to its fixed contact 11b, no current is supplied to the commutator G through the brush B1, but the winding W of the rotor A can be excited by the current flowing therethrough via the pair of the brushes Q1 and Q2 in contact with the respective slip rings P1 and P2. For this reason, the motor acts as a generator motor in such a manner as hereinbefore described in connection with that shown in FIG. 5. In other words, an electromotive power produced in the winding W of the rotor A can be impressed on the closed circuit including the commutator G, the brush B1, the resistor R1, the contacts 10c and 10a of the switch SW2 and the brush B2. As a result thereof, the rotor A that has been rotated under the influence of an inertia force can be electromagnetically braked so that the rotor A can be rapidly decelerated. However, even during the deceleration of the rotor A, current flows through the winding W of the rotor A through the slip rings P1 and P2 so that the rotor A can be, by the same principle as hereinbefore described with reference to FIG. 5, rotated about its own axis of rotation at a predetermined angle of the rotation under the electromagnetic attraction exerted by the yokes Y1 and Y2 and subsequently stopped at a predetermined position where the winding W is parallel to the magnetic lines of force exerted between the yokes Y1 and Y2.

If the movable contact 11a of the switch SW3 is subsequently engaged to the fixed contact 11c thereof while the movable contacts 9a and 10a of the switches SW1 and SW2 are instantaneously engaged to the fixed contacts 9d and 10d thereof, respectively, a load that has been charge in the condenser C can be supplied to the winding W of the rotor A across the switch SW2 of which the contacts 10d and 10a are instantaneously engaged to each other as hereinbefore described, result-

ing in that the rotor A undergoes half a rotation. However, when the movable contacts 9a and 10a of the switches SW1 and SW2 are respectively re-engaged to the contacts 9c and 10c, the current can be reversely applied to the winding W of the rotor A through the slip rings P1 and P2 so that the polarity of the rotor A can be reversed.

Accordingly, it will be clearly understood that the rotor A can be stopped at a predetermined position about its own axis of rotation.

In FIG. 7, it is shown an electric circuit associated with the motor for rapidly rotating the rotor A and rapidly stopping the latter exactly at a predetermined position about its own axis of rotation.

Referring now to FIG. 7, reference characters PH and PL designate a high voltage circuit and a low voltage circuit, respectively. In the circuit as shown, when the switches SW1, SW2, SW3, SW4, SW5 and SW6 are maintained in the respective conditions as shown, a closed circuit including the field coil F, the switches SW4 and SW5, the brush B1, the commutator G, the winding W, the brush B2 and the switch SW3 in specified order can be completed. This closed circuit can be possibly expressed as shown in FIG. 8. The closed circuit of FIG. 8 represents a series motor circuit wherein an electromotive power of a greater value can be obtained so that the rotor A can be rapidly rotated in a short time. By way of example, if 200 volt current is supplied from a power source or the high voltage circuit PH, the rotational number of the rotor A reaches at the value of 6,000 r.p.m. in one-tenth second.

When the switches SW1 through SW5 are operated to establish the respective conditions as indicated by the dotted lines in FIG. 7 during a period in which the rotor A is rapidly rotated, a closed circuit including the field coil F and the switch SW4 can be completed between the both terminals of the low voltage circuit PL and also a closed circuit including the mutually engaged contacts 13a and 13b of a relay RL, the switch SW5, the brush B1, the commutator G, the winding W of the rotor A, the brush B2, the switch SW3 and the mutually engaged contacts 12b and 12a of the relay RL in specified order can be completed between the both terminals of the low voltage circuit PL. These two closed circuits can be expressed as shown in FIG. 9. As can be understood from FIG. 9, these two closed circuits has the common low voltage circuit PL from which power can be supplied thereto. Accordingly, when the circuit as shown in FIG. 9 is established by operating the switches SW1 through SW5 (FIG. 7) as hereinbefore described, the rotational number of the rotor A can be rapidly reduced. However, since the circuit of the motor is switched over to a shunt circuit, no great variation in the rotational number of the rotor A takes place with respect to variations in the load in the circuit. By way of example, in FIG. 9, 20 volt current is applied from the low voltage circuit PL to the motor, the rotational number of the rotor A can be rapidly reduced from 6,000 r.p.m. to 200-300 r.p.m. in one-tenth second.

While the rotor A is thus rotated at low speed, a command signal for stopping the rotor A can be fed to a control circuit Z from a command signal generating ring P3, rigidly mounted on the shaft, through the brush Q3 in contact with said ring P3. Upon application of

such command signal to the control circuit Z, the relay RL is operated so as to cause the pair of movable contacts 12a and 13a to be engaged by the contacts 12c and 13c, respectively. As a result thereof, and so long as a movable contact 14a of the switch SW6 is engaged to its fixed contact 14b, a closed circuit including the mutually engaged contacts 13c and 13a of the relay RL, the switch SW6, the brush Q1, the slip ring P1, the winding W, the slip ring P2, the brush Q2, the switch SW6, and the mutually engaged contacts 12c and 12a of the relay RL in specified order can be completed between the both terminals of the low voltage circuit PL. This closed circuit can be expressed as shown in FIG. 10.

As the closed circuit shown in FIG. 10 is established, current from the low voltage circuit PL can be fed to the winding W of the rotor A through the pair of the slip rings P1 and P2 so that the rotor A can be magnetized in one particular direction to brake the rotor A at a predetermined position about its own axis of rotation. If half a rotation is effected to the rotor A, it is only necessary to engage the movable contact 14a of the switch SW6 to the fixed contact 14c thereof.

It is to be noted that means for feeding the command signal from the command signal generating ring P3 to the control circuit Z, which means being designated by P3, Q3, is composed of such element as microswitch, lead switch or hole element.

A modification of the circuit shown in FIG. 7 is shown in FIG. 11 wherein the switches SW1 and SW2 are adapted to transmit control signals therefrom to corresponding gate terminals of thyristors SCR1, SCR2, SCR3 and SCR4 so as to fire the thyristors. If these switches SW1 and SW2 are maintained in the respective conditions as shown in FIG. 11, the thyristor SCR2 can be ignited and, therefor, the output current from the high voltage power source PH can be fed to the commutator G of a series motor, resulting in that the rotor A can be rapidly rotated at high speed.

However, when the switch SW1 and SW2 are operated to shift their movable contacts 15a and 16a from the fixed contacts 15b and 16b to the other fixed contacts 15c and 16c, respectively, the thyristors SCR1 and SCR3 are concurrently ignited so that current can be applied to the field coil F and the commutator G from the low voltage power source PL1 and PL2, respectively. As a result thereof, the motor circuit can be switched over to a shunt circuit whereby the rotor A can be rotated at low speed.

When the movable contact 15a and 16a of the switch SW1 and SW2 are subsequently engaged to the fixed contacts 15d and 16d, respectively, current flows to the field coil F through the thyristor SCR3 and concurrently current flows to the slip rings P1 and P2 through the thyristor SCR4 whereby the rotor A can be stopped exactly at a predetermined position about its own axis of rotation.

FIG. 12 shows a motor circuit for rapidly rotating and stopping the rotor A by selectively changing the connection of a pair of field coils F1 and F2 to a power source. In this circuit shown in FIG. 12, if the switches SW1, SW2 and SW3 are maintained in the respective conditions as illustrated therein, voltage from the AC power source AC can be applied to the rotor A through a voltage control EL and the switch SW1 by means of

the brushes B1 and B2. On the other hand, the pair of the field coils F1 and F2 are connected in series through the switch SW1 as shown in FIG. 13. Accordingly, the motor circuit can be switched over to a shunt circuit shown in FIG. 13, the operation characteristic of this circuit being shown in FIG. 15(A). As can be understood from the characteristic curve of FIG. 15(A), when the circuit of FIG. 13 is in operation, the rotational number of the rotor A can be rapidly increased. In this circuit, the feature resides in that, even if variations may take place in the load during the rotation of the rotor A, the rotational number of the rotor will not be affected so much.

In other words, with reference to FIG. 15(A), when the switch SW1 is closed at a time t_0 (See FIG. 12 and FIG. 13), the rotational speed of the rotor A reaches to the value of 6,000 r.p.m. after a lapse of time which is represented by the difference $(t_1 - t_0)$ and thereafter the rotor A can be constantly rotated at the rate of 6,000 r.p.m. until the time t_2 .

If it is assumed that, at the time the rotor A is constantly rotated, the composite inductance of the field coils F1 and F2 connected in series with each other is about 0.4 henry and the DC resistance is 40 ohms, then, the composite impedance of the series connected field coils F1 and F2 will be about 130 ohms. In the case where the AC voltage from the power source AC' is assumed to be 200 volts, the exciting current flowing through the series connected field coils F1 and F2 will be about 1.5 amp. (See, FIG. 15(B)).

On the other hand, when the switch SW1 is opened and the switch SW3 is brought into the condition as indicated by the dotted line in FIG. 12, the field coils F1 and F2 can be connected as illustrated in FIG. 14. In other words, the field coils F1 and F2 are connected in parallel to each other so that the total amount of current flowing across the both field coils F1 and F2 reach to the value as indicated by i_1 in FIG. 15(B) between the time t_2 and the time t_3 . Accordingly, it will be clearly understood that the motor acts as a generator so that the rotor A can be stopped rapidly at the time t_3 .

More particularly, in the circuit shown in FIG. 13 wherein the field coils F1 and F2 are connected in series with each other, the composite DC resistance of the field coils F1 and F2 when the switch SW1 is opened is 40 ohms and, therefore, in the case where the rotor A generates voltage of the value of 160 volts, the field current will become 4 amps. Accordingly, the rotor A will not stop until one-third second elapses.

However, in the circuit shown in FIG. 14 wherein the both field coils F1 and F2 are connected in parallel to each other, the composite DC resistance of the field coils F1 and F2 when the switch SW1 is opened is 10 ohms and, therefore, in the case where the rotor A rotating under the influence of an inertia force generates voltage of the value of 160 volts, the field current will become 16 amps. Accordingly, the rotor A can be stopped in a short time, say, in one-tenth second, the value of which being represented in FIG. 15(A) by the difference $(t_3 - t_2)$.

If the movable contact 17a of the switch SW2 is engaged to the fixed contact 17b thereof shortly before or after the rotation of the rotor A ceases, voltage of low value can be supplied to the motor from the DC low voltage power source DC so that the rotor A can be

rotated at low speed with a relatively high value of horsepower.

It is to be noted that, in FIG. 12, although a pair of the field coils F1 and F2 are employed, more than the two field coils may be provided and that, instead of the AC power source, a DC power source may be employed.

FIG. 16 shows a motor circuit for operating the motor according to the present invention with the application of a three-phase power source.

Referring now to FIG. 16, reference characters U1, U2, and U3 designates respective power lines from a three-phase power source, D1 through D3 and D1' through D3' designate respective diodes, S1 through S3 and S3' designate respective switches, ER designates a variable transformer, D4 and D4' designate respective diodes, A designates the rotor and F designates a field coil of the motor.

In the circuit shown in FIG. 16, if all of the switches S1 through S3 and S3' are respectively opened, the armature current I_a flowing through the rotor A will give such wave form as shown in FIG. 17(A). The rotational number of the rotor A will vary in accordance with the field current I_f flowing through the field coil F decrease in a range indicated by a line a in FIG. 18.

If the switches S1 and S2 are subsequently closed, the armature current I_a flowing through the rotor A will give such wave form as shown in FIG. 17(B) and the rotational number of the rotor A will vary in accordance with the field current I_f flowing through the field coil F in a range indicated by a line b in FIG. 18.

When the switches S1 through S3 are closed, the armature current I_a flowing through the rotor A will give such wave form as shown in FIG. 17(C) and the rotational number of the rotor A will vary in a range indicated by a line c in FIG. 18.

However, when all of the switches S1, S2, S3 and S3' are concurrently closed, the armature current I_a flowing through the rotor A will give such wave form as shown in FIG. 17(D) and the rotational number of the rotor A will vary in a range indicated by a line d in FIG. 18.

Accordingly, with the circuit shown in FIG. 16 the rotation of the motor driven by the three-phase power can be easily controlled in a simple manner.

Although the present invention has been fully described by way of its preferred embodiments with reference to the accompanying drawings, it is to be noted that the present invention is not to be limited thereby, but various modification and change are apparent to those skilled in the art. Therefore, such modification and change are to be construed as included in the following scope and claim of the present invention.

What is claimed is:

1. An electrically driven motor comprising a rotor wound with a winding, means for producing a magnetic field surrounding said rotor, said magnetic field producing means comprising a plurality of field coils and further including means for connecting said field coils in series with each other during a period beginning from the commencement of rotation of said rotor until the termination of high-speed rotation of said rotor and connecting said field coils in parallel to each other when the supply of current to said winding of said rotor

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and said field coils is cut off whereby an electromotive power produced by said rotor that has been rotated under the influence of an inertia force is permitted to flow to said field coils connected in parallel to each other, means for feeding current to the winding of said rotor so as to continuously rotate said rotor in one direction, a rotary magnet rigidly mounted on a rotational shaft of said rotor in a spaced relation with respect to said rotor and normally magnetized one predetermined direction and means for stopping said rotor, that has been rotated, at a predetermined position about its own axis of rotation in cooperation with said rotary magnet emanating a magnetically-attracting force acting on said rotor.

2. An electrically driven motor according to claim 1,

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wherein said rotary magnet comprises an electromagnet adapted to receive current from a power source through a plurality of slip rings coaxially mounted on the rotational shaft of the rotor.

3. An electrically driven motor according to claim 2, wherein said rotary magnet is integrally formed with rotor.

4. An electrically driven motor according to claim 1, wherein said motor further includes means for dissipating an electromotive power produced in the winding of the rotor rotating under the influence of an inertia force after the current to the winding of the rotor is cut off thereby to rapidly stop the rotation of the rotor.

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