United States Patent

[11] 3,575,527

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[33] **Japan**
[31] **43/53170, 43,76286, 43/75789, 43/75790, 43,88634, 43/88635, 44/22526, 44/22527, 44/22528, 44/22529, 44/26389, 44/26390 and 43/59888**

[54] **ELECTRIC FAN**
15 Claims, 26 Drawing Figs.

[52] **U.S. Cl.** **416/32,** 416/169, 416/247
[51] **Int. Cl.** **F04d 25/08**
[50] **Field of Search** 416/32, 169, 247

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Primary Examiner—Everette A. Powell, Jr.
Attorney—Stevens, Davis, Miller and Mosher

ABSTRACT: An electric fan with a safety device by which a rotating impeller is stopped at once when a hand gets close to the impeller.

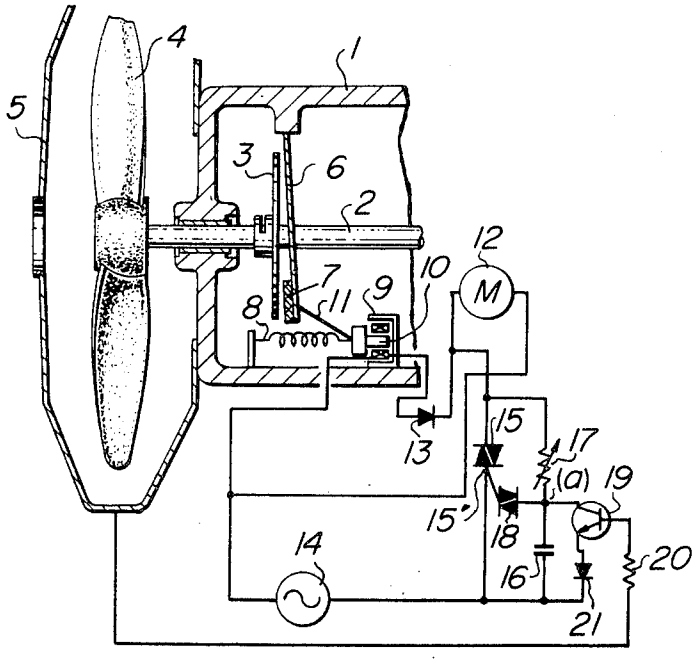


FIG. 2

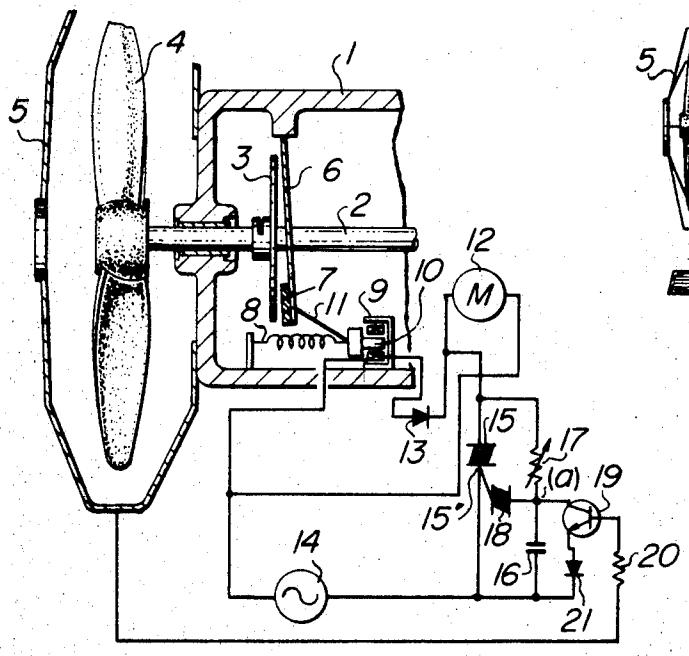


FIG. 1

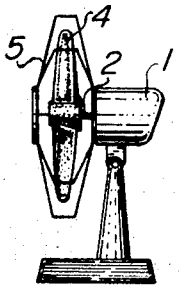
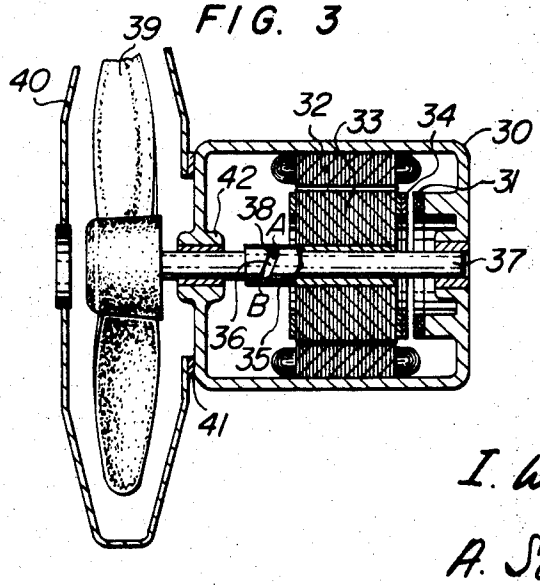


FIG. 3



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INVENTORS

BY Stevens, Davis, Miller & Mosher
ATTORNEYS

FIG. 4

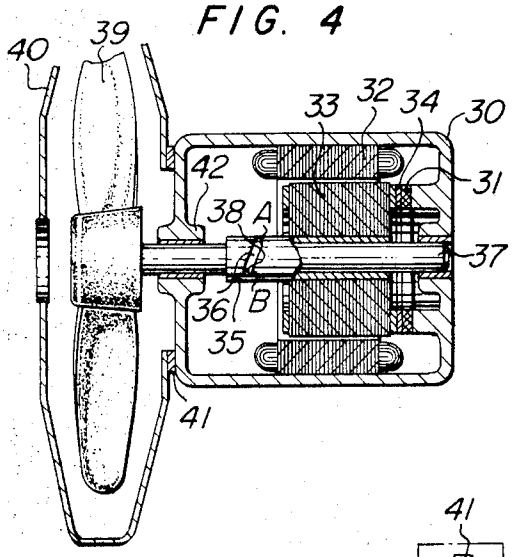


FIG. 5

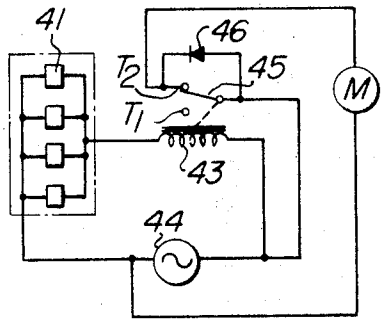


FIG. 6

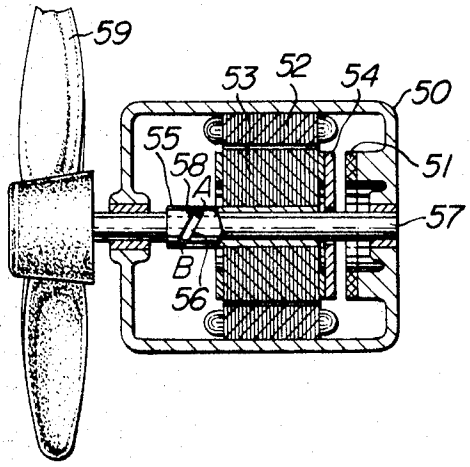


FIG. 7

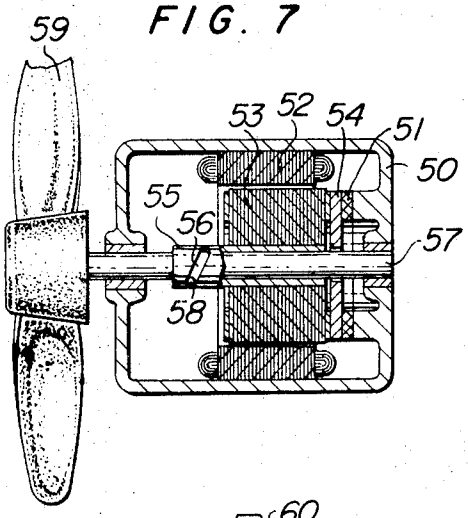


FIG. 8

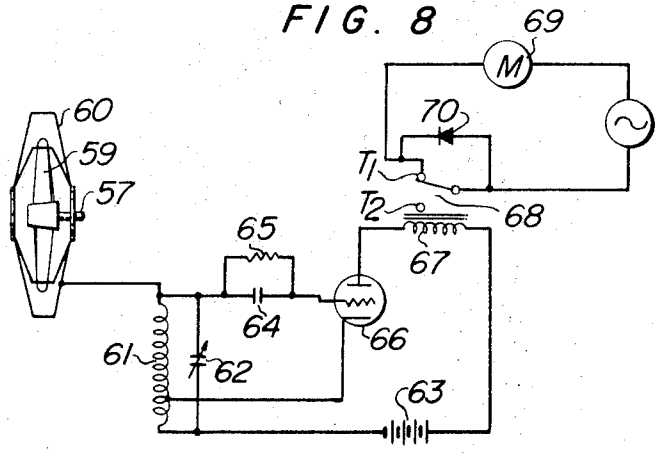


FIG. 9

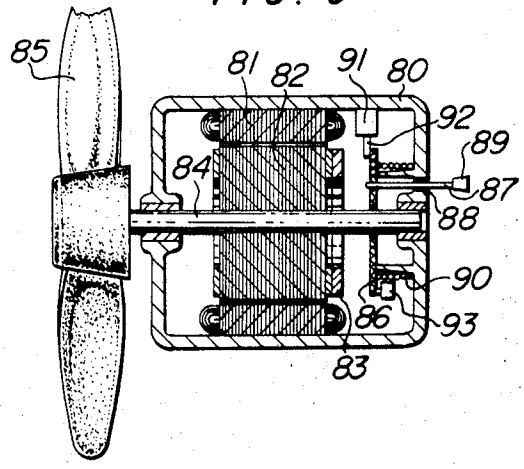


FIG. 10

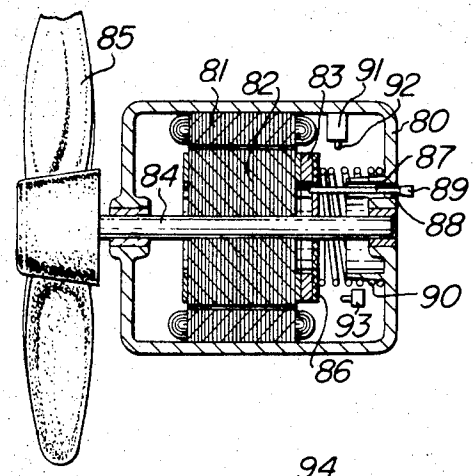


FIG. 11

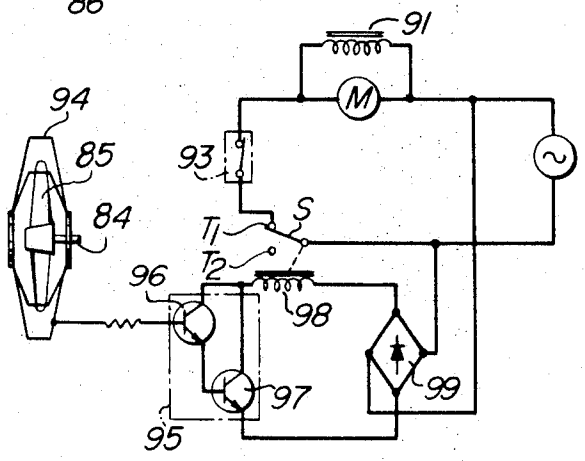


FIG. 12

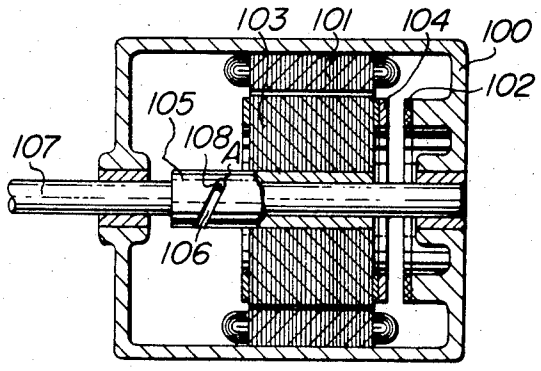


FIG. 13

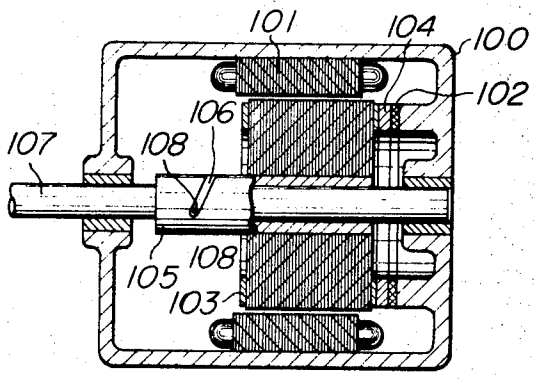

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FIG. 14

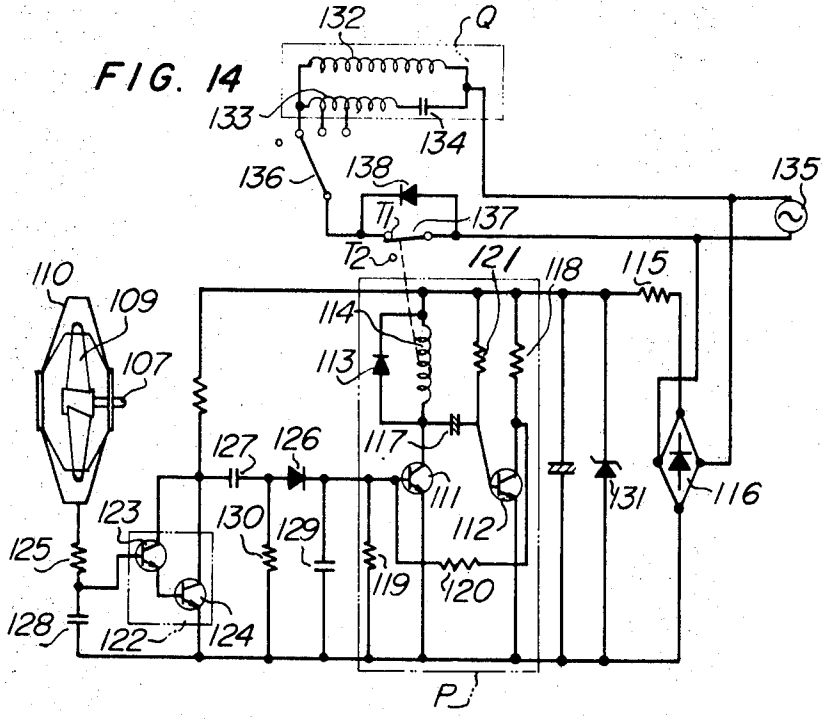

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FIG. 15

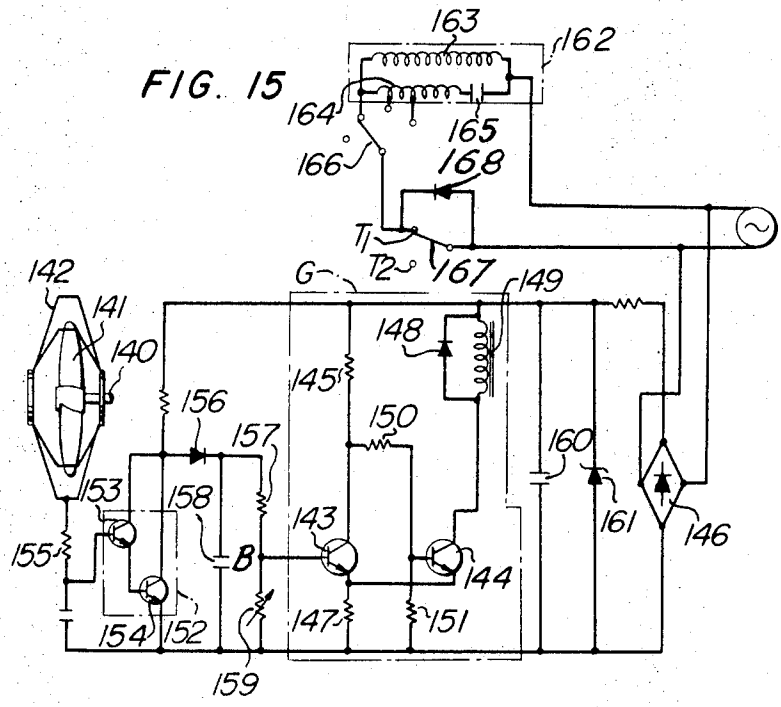

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FIG. 16

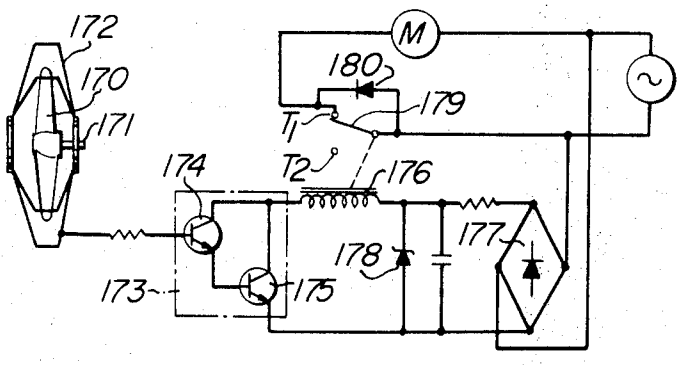

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FIG. 17

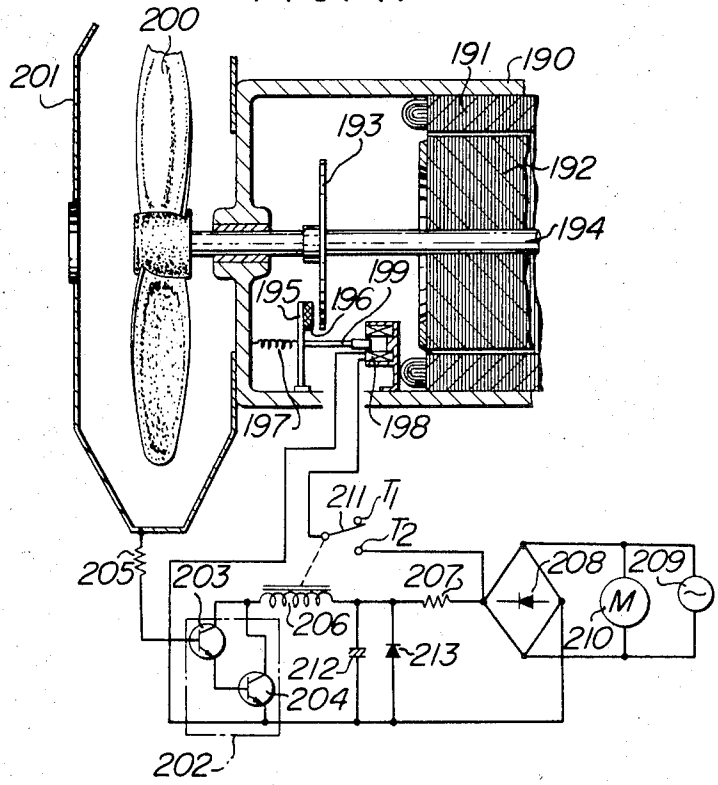

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FIG. 18

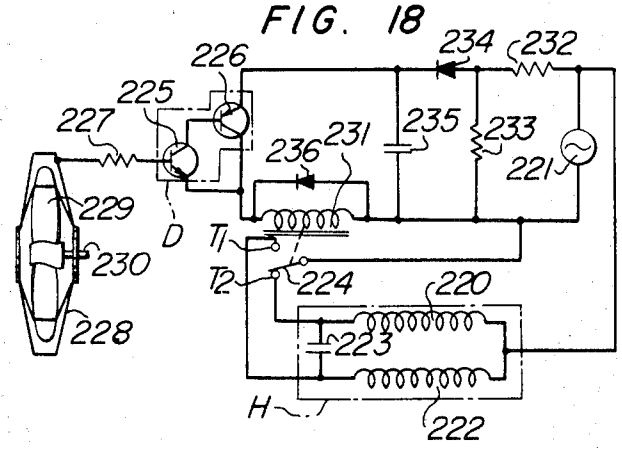

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FIG. 19

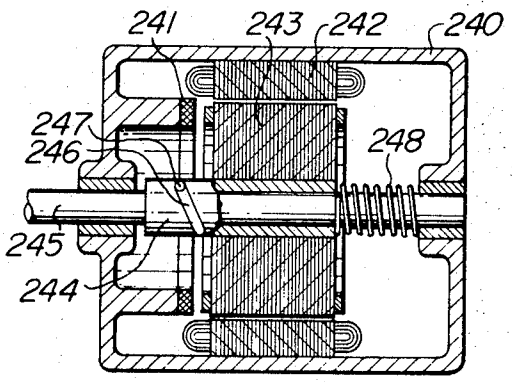


FIG. 20

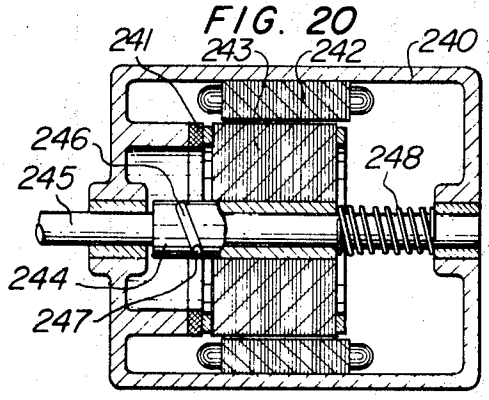


FIG. 21

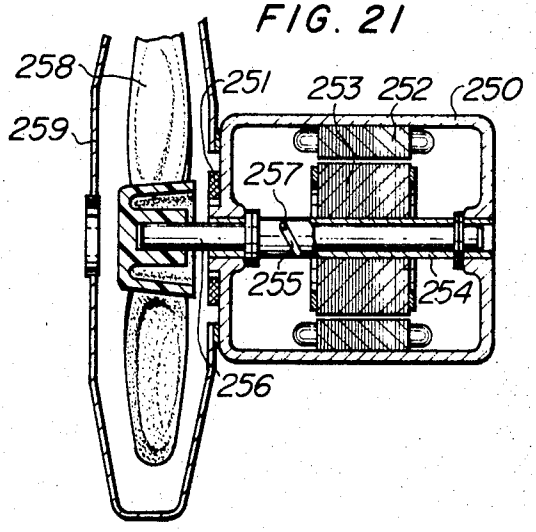


FIG. 22

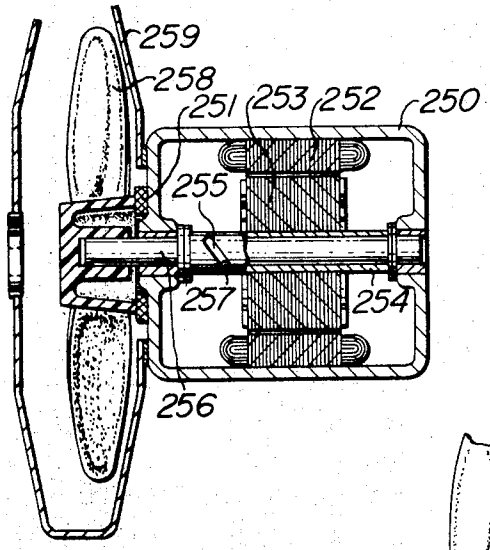


FIG. 23

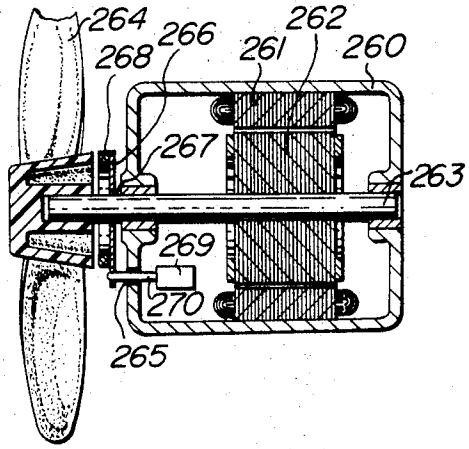


FIG. 24

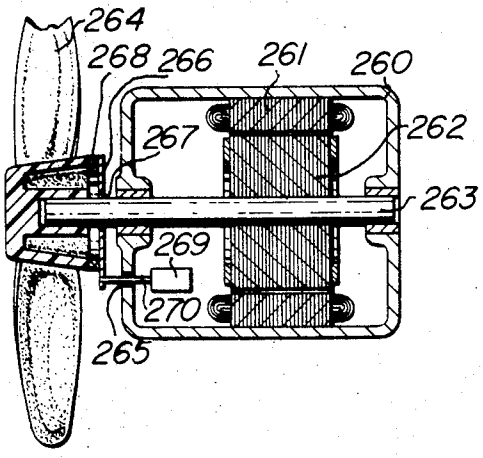


FIG. 25

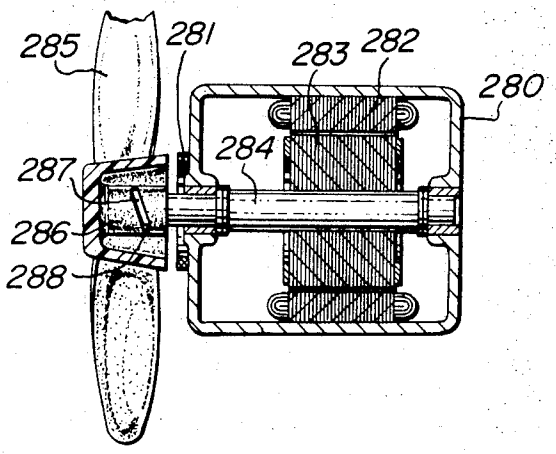
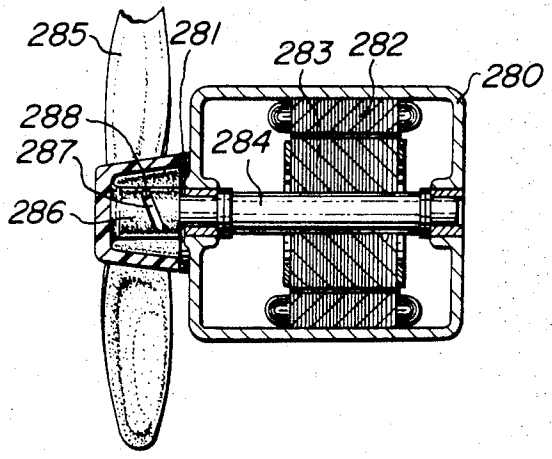

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FIG. 26


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ELECTRIC FAN

The present invention relates to an electric fan with a safety device by which a rotating impeller of the fan is stopped at once when a hand gets close thereto.

With a conventional electric fan, it is quite possible that a hand is injured by an impeller of the fan rotating at a relatively high speed when the user inadvertently gets his hand into the inside of a guard screen of the fan, in an attempt to reset the fan upright after it has fallen down sideways, or when a child gets its finger into the inside of the guard screen. For this reason, an electric fan has been strongly desired which is provided with a safety device by which the impeller is stopped at once under such a dangerous condition.

The present invention proposes an electric fan which comprises a detector adapted to emit a signal upon sensing a portion of the human body getting close to a rotating impeller of the fan and brake means for braking the impeller in response to the signal from said detector. Namely, an object of the invention is to ensure safety of the persons around an electric fan by stopping the rotating impeller of the fan at once when a portion of the human body inadvertently gets close to the impeller and is about to contact the same.

Another object of the invention is to construct the above-mentioned safety device as simple as possible and to brake the impeller positively at any time on occurrence of the dangerous condition described above.

These and other objects, features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevation of an embodiment of the electric fan according to the present invention;

FIG. 2 is a diagram showing the control circuit of the fan;

FIG. 3 is a sectional view of the essential portion of another embodiment of the electric fan according to the invention, showing the position of an electric motor at the time of starting;

FIG. 4 is a sectional view, similar to FIG. 3, showing the position of the electric motor at the time of braking;

FIG. 5 is a control circuit diagram of the electric motor;

FIG. 6 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric motor at the time of starting;

FIG. 7 is a sectional view, similar to FIG. 6, showing the position of the electric motor at the time of braking;

FIG. 8 is a control circuit diagram of the electric motor shown in FIGS. 6 and 7;

FIG. 9 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric motor at the time of starting;

FIG. 10 is a sectional view, similar to FIG. 9, showing the position of the electric motor at the time of braking;

FIG. 11 is a control circuit diagram of the electric motor shown in FIGS. 9 and 10;

FIG. 12 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric motor at the time of starting;

FIG. 13 is a sectional view, similar to FIG. 12, showing the position of the electric motor at the time of braking;

FIG. 14 is a control circuit diagram of the electric motor shown in FIGS. 12 and 13;

FIGS. 15, 16, 17 and 18 are respectively control circuit diagrams of still other embodiments of the electric fan according to the invention;

FIG. 19 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric fan at the time of starting;

FIG. 20 is a sectional view, similar to FIG. 19, showing the position of the electric fan at the time of braking;

FIG. 21 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric fan at the time of starting;

FIG. 22 is a sectional view, similar to FIG. 21, showing the position of the electric fan at the time of braking;

FIG. 23 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric motor at the time of starting;

FIG. 24 is a sectional view, similar to FIG. 23, showing the position of the electric motor at the time of braking;

FIG. 25 is a sectional view of the essential portion of still another embodiment of the electric fan according to the invention, showing the position of an electric motor at the time of starting; and

FIG. 26 is a sectional view, similar to FIG. 25, showing the position of the electric motor at the time of braking.

Referring first to FIGS. 1 and 2, there is shown an embodiment of the electric fan according to the present invention, which comprises an electric motor 12, an impeller 4 fixedly mounted on a drive shaft 2 of said electric motor and a guard screen 5 secured to the front face of a housing 1 of said electric motor and enclosing said impeller 4. Inside of the motor housing 1 are disposed a disc plate 3 which is fixedly mounted on the drive shaft of the motor, and a spring plate 6 which is fixed to the motor housing 1 at one end and provided with a brake lining 7 at the other end for engagement with said disc plate 3. Provided also inside of the motor housing 1 is a solenoid 9. A plunger 10 of the solenoid 9 has one end of a tension spring 8 connected therewith and the other end of said spring 8 is anchored to the motor housing. A connecting rod 11 has one end connected with the spring plate 6 and the other end with the plunger 10. A control circuit of the electric fan is constructed as follows: Namely, a diode 13 is connected with the solenoid 9 at one terminal and with the electric motor 12 at the other terminal. The solenoid 9 is connected with a power source 14 at one terminal thereof. A bidirectional three-terminal thyristor 15 is connected with the motor 12 at one terminal and with the power source 14 at the other terminal thereof. A capacitor 16 is connected in series with a variable resistor 17 and in parallel with the bidirectional three-terminal thyristor 15. A bidirectional two-terminal thyristor 18 is connected at one terminal with the connection between the capacitor 16 and the variable resistor 17, and at the other terminal with the gate electrode 15′ of the bidirectional three-terminal thyristor 15. The variable resistor 17, the capacitor 16, the bidirectional two-terminal thyristor 18 and the bidirectional three-terminal thyristor 15 form an alternating current phase control circuit. A transistor 19 has the base thereof connected to the guard screen 5 through a resistor 20, the collector connected with the connection between the variable resistor 17 and the capacitor 16, and the emitter connected to the power source 14 through a diode 21. Now, when a portion of the human body, e.g. a hand or foot, is brought into contact with the guard screen 5, the base potential of the transistor 19 rises by reason of the potential possessed by the human body, so that when the potential on the collector side of said transistor is positive, the voltage across the collector and the emitter falls and the terminal voltage of the capacitor 16 becomes low. Thus, no current flows to the gate 15′ of the bidirectional three-terminal thyristor 15 through the bidirectional two-terminal thyristor 18. In other words, when the potential at a point *a* is positive, the bidirectional three-terminal thyristor 15 is not energized, with no current flowing therethrough. On the other hand, if the potential at the point *a* is negative, the terminal voltage of the capacitor 16 is high because no current flows through the transistor 19, so that the bidirectional three-terminal thyristor 15 is energized by a current supplied to the gate 15′ thereof through the bidirectional two-terminal thyristor 18. When a portion of the human body, e.g. a hand or foot, is not in contact with the guard screen 5, an alternating current flows

through the electric motor 12 and a half-wave rectified current through the solenoid 9. However, when the guard screen 5 is touched with a portion of the human body, a half-wave rectified current flows through the motor 12 and no current flows through the solenoid 9. Therefore, the motor is subjected to a direct-current braking, while at the same time the solenoid is deenergized and the plunger 10 is pulled by the spring 8. The spring plate 6 is pressed against the disc plate 3 by way of the connecting rod 11 which is connected to said plunger 10, so that the impeller 4 mounted on the drive shaft 2 of the motor is simultaneously brought to a halt due to a frictional force developed between the brake lining 7 and the disc plate 3. Thus, the danger of getting the hand or foot injured on touching the guard screen 5 can be eliminated.

Another embodiment of the present invention will be described with reference to FIGS. 3, 4 and 5 hereunder: According to this embodiment, a braking ring 31 is fitted on the inside face of one end wall of a motor housing 30. Reference numeral 32 designates a stator and 33 designates a rotor which is provided on one side face thereof with a brake lining 34 for engagement with the braking ring 31. A slide collar 35, extending through an axial hole of the rotor 33, is formed with an oblique slot 36 at one end portion thereof, in which is received a pin 38 provided on a drive shaft 37 of the motor, so that said rotor 33 may be displaceable within a predetermined range with respect to the drive shaft 37. Reference numeral 39 designates an impeller fixedly mounted on one end of the drive shaft 37, and 40 designates a guard screen which is secured to the front face of the motor housing 30 in such a manner that it is movable in a small range under a slight external force (to such an extent as will be exerted by the touching of a hand, etc.). Between the guard screen 39 and the front face of the motor housing 30 are disposed a plurality of pressure-sensitive resistors 41 which are arranged along a circle concentric with a bearing member 42 and equally spaced from each other. These pressure-sensitive resistors 41 are connected with each other in parallel, and have one terminals thereof connected with a power source 44 and the other terminals with a solenoid 43 to be described later. The pressure-sensitive resistor 41 is an element whose electric resistance value decreases sharply when a pressure is imposed thereon. A switch 45 is connected in series with a power source circuit of the motor M and is operatively associated with the aforesaid solenoid 43. A diode 46 is connected in parallel with the switch 45. When the motor M is set in motion, the rotor 33 is rotated to transmit its rotational torque to the impeller 39 and the pin 38 mounted on the drive shaft 37 engages an end A of the oblique slot 36 formed in the slide collar 35. Therefore, the brake lining 34 on one side face of the rotor 33 is held away from the braking ring 31, providing for normal operation. When the guard screen 40 is touched with the human body or the electric fan falls down sideways, the pressure-sensitive resistors 41 are subjected to a pressure of the guard screen 40 which is tiltably mounted on the motor housing 30, so that a current is conducted through the solenoid 43 on account of the above-described characteristic of said pressure-sensitive resistors. As a result, the switch 45 in the motor circuit is shifted from a contact T_1 to T_2 and a direct current flows through the motor M via the diode 46, whereby a direct-current brake is applied to the rotor 33. On the other hand, the impeller 39 tends to continue its rotation under inertia, so that the pin 38 on the drive shaft 37 slides in the oblique slot 36 in the slide collar 35 in a direction opposite to that at the time of starting, causing the rotor 33 to move backward. Thus, the brake lining 34 is brought into contact with the braking ring 31 and the impeller 39 is quickly stopped by a braking force created between the brake lining 34, rotating under the inertia force of the impeller 39, and the braking ring 31. Once the impeller 39 has stopped rotating, no rotational torque is developed in the impeller 39 or the rotor 33. By the backward movement of the rotor 33 as described above, the core center of said rotor is displaced with respect to the stator 32. In this case, since a direct current is flowing through the stator 32, the rotor 33 is subjected to a magnetic attraction created by said direct current and returned to the center of the magnetic field of the stator 32. Accordingly, the pin 38 is returned to the end A of the oblique slot 36 in the slide collar 35 and the brake lining 34 is disengaged from the braking ring 31. Therefore, the electric motor operates normally without being subjected to a braking force, when the external force is removed from the guard screen 40.

Still another embodiment of the invention is shown in FIGS. 6, 7 and 8. In this embodiment, a brake lining 51 is fitted on the inside face of the rear end wall of a motor housing 50. Reference numeral 52 designates a stator and 53 designates a rotor which has a brake disc 54 fitted on one side face thereof in confronting relation to the aforesaid brake lining 51. A slide collar 55 having an oblique slot 56 formed at one end portion thereof is fitted into an axial hollow of the rotor 53 and a pin 58 carried on the drive shaft 57 of a motor 69 is received in said oblique slot 56 for sliding movement therein, so as to allow the rotor 53 to be displaced within a predetermined limit with respect to the drive shaft 57. Reference numeral 59 designates an impeller connected to one end of the drive shaft 57 and 60 designates a guard screen covering said impeller, said guard screen 60 being secured to the front face of the motor housing 50. A control circuit diagram of this electric fan is shown in FIG. 8. In FIG. 8, reference numeral 61 designates a coil and 62 designates a capacitor connected in parallel with the coil 61. One terminal of the capacitor 62 is connected to the guard screen 60 and the other terminal to a direct-current power source 63, e.g. a battery. Reference numeral 64 designates a capacitor and 65 designates a resistor connected in parallel with the capacitor 64. One terminal of the resistor 65 is connected with a junction between the coil 61 and the capacitor 62, and the other terminal thereof is connected directly with the grid of an oscillator tube 66. A solenoid 67 is connected with the plate of the oscillator tube 66 at one terminal and with the power source 63 at the other terminal thereof. A switch 68 is provided in series in a circuit of the motor 69 and operatively associated with the solenoid 67. Connected in parallel with the switch 68 is a diode 70. The oscillation circuit including the oscillator tube 66 is oscillating at a frequency determined by the inductance of the coil 61 and the capacity of the capacitor 62. On the other hand, the grid of the oscillator tube 66 is biased negatively by the resistor 65 and the capacitor 64, so that the plate current is small and the solenoid 67 is held inoperative. However, when a person gets close to the guard screen 60, the capacity of the guard screen increases, so that the oscillator tube stops oscillating and the grid voltage becomes zero with the plate current increasing, whereby the solenoid 67 is energized to cause the switch 68 to be shifted from a contact T_1 to T_2. Therefore, a half-wave rectified current flows through the motor 69 via the diode 70 and the rotor 53 of said motor is subjected to a direct-current brake. On the other hand, the impeller 59 tends to continue its rotation under inertia and the pin 58 carried on the drive shaft 57 moves in the oblique slot 56 in the slide collar 55 from a point A to B. Consequently, the brake disc 54 on one side face of the rotor 53 is brought into engagement with the brake lining 51 to create a braking force and thus the impeller 59 is stopped quickly by said braking force. Once the impeller 59 has stopped rotating, no rotational torque is developed in the impeller 59 or the rotor 53. On the other hand, as a result of displacement of the core center of the rotor 53 with respect to the stator 52, a magnetic attraction produced by the half-wave rectified current flowing through said stator, acts on the rotor 53, whereby the rotor 53 is returned to the center of the magnetic field of the stator 52, and simultaneously the pin 58 in the oblique slot 56 is returned to the point A from the point B. Therefore, the engagement between the brake lining 51 and the brake disc 54 is released, providing for normal operation of the motor, under no braking force, when the guard screen 60 is cleared from an influence of the human body.

Still another embodiment of the invention is shown in FIGS. 9, 10 and 11. In FIG. 9, a reference numeral 80 designates a motor housing, 81 a stator and 82 a rotor having a brake lining 83 fitted to one side thereof. Reference numeral 84 designates the drive shaft of a motor M, 85 an impeller connected to one end of the drive shaft 84, 86 a brake disc slidably mounted on the drive shaft 84 for engagement with the brake lining 83 and 87 an operating rod for operating said brake disc 86. The operating rod 87 extends through a hole 88 formed in the motor housing 80 and is connected with the brake disc 86 at one end thereof. The other end of the operating rod 87 is provided with a grip 89. Between the brake disc 86 and the motor housing 80 is disposed a compression spring 90. A control circuit diagram of this electric fan is shown in FIG. 11. As shown, a solenoid 91 is connected in parallel with the motor M and a plunger 92 thereof, in normal operation of the motor M, prevents a forward movement of the brake disc 86 under the biasing force of the spring 90. A switch 93 connected in series with the motor M is designed such that its contact is placed in an ON position when contacted by the brake disc 86. A guard screen 94 covering the impeller 85 is secured to the front face of the motor housing 80. An amplifier 95 is composed of transistors 96 and 97, and the base of the transistor 96 is connected with a portion of the guard screen 94 and the collectors of the transistors 96 and 97 are connected with one terminal of the solenoid 98, the other terminal of which is connected to the negative terminal of a rectifier 99. Another switch S is provided in series in the motor circuit, which is operatively associated with the solenoid 98. With the arrangement described, when a portion of the human body, e.g. a hand or a foot, comes in touch with the guard screen 94, a current is supplied to the base of the transistor 96 due to the potential possessed by the human body, and accordingly a current flows through the collector of said transistor. Further, since the emitter of the transistor 96 is connected with the base of the transistor 97, a current flows through the base and collector of said transistor 97. As a result, the solenoid 98 is energized, whereby the contact of the switch S is shifted from a point T_1 to a point T_2 and current supply to the motor M is interrupted. At the same time, current supply to the solenoid 91, connected in parallel with the motor circuit, is also interrupted and the plunger 92 of said solenoid is retracted upward. Therefore, the brake disc 86 is moved forward under biasing force of the spring 90 and brought into pressure contact with the brake lining 83 on the rotor 82, whereby the rotation of the impeller 85 is quickly stopped. On the other hand, the switch 93 which is normally held in a closed position by the brake disc 86 is opened incident to the forward movement of said brake disc 86. When the guard screen 94 is cleared of the influence of the human body, the solenoid 98 in the motor circuit is deenergized and the contact of the switch S is shifted from the point T_2 to the point T_1. However, since the switch 93 connected in series with the switch S is in an OFF-position, no current is supplied to the motor M. When the operating rod 87 is pulled against the force of spring 90, the brake disc 86 connected with said operating rod is disengaged from the brake lining 83 on the rotor 82 to release the braking force from the rotor 82, and the switch 93 is closed by the brake disc 86, so that the motor circuit is closed again providing for normal operation of the motor under no braking force. The solenoid 91 is also energized to cause the plunger 92 to project downward, whereby the brake disc 86 is held against forward movement even after the tension is removed from the operating rod 87.

FIGS. 12, 13 and 14 show still another embodiment of the present invention. In these FIGS., reference numeral 100 designates a motor housing, 101 a stator, 102 a brake disc fixed interior of the motor housing 100, 103 a rotor having a brake lining 104 fitted to one side face thereof in confronting relation to said brake disc 102, 105 a slide collar formed with an oblique slot 106 at one end portion thereof and fitted into the axial hollow of said rotor 103, 107 and the drive shaft of a motor provided with a pin 108 which is received in said oblique slot 106 to provide for displacement of the rotor 103 in a predetermined range with respect to the drive shaft 107, 109 an impeller connected to one end of the drive shaft 107 and 110 a guard screen covering the impeller 109 and secured to the front face of the motor housing 100. In describing a control circuit of this electric fan with reference to FIG. 14, reference numerals 111 and 112 designate transistors. The collector of the transistor 111 is connected with one terminal of a solenoid 114 which is connected in parallel with a diode 113. The other terminal of the solenoid 114 is connected with a negative terminal of a rectifier 116 through a resistor 115. The emitter of the transistor 111 is connected with another negative terminal of the rectifier 116. The base of the transistor 112 is connected with one terminal of a capacitor 117, the other terminal of which is connected with a junction between the collector of the transistor 111 and the solenoid 114. The collector of the transistor 112 is connected in series with the resistor 115 through a resistor 118 and the emitter thereof is connected with one of the negative terminals of said rectifier 116. Reference numerals 119, 120 and 121 designate resistors, of which the resistor 119 is connected with the base of the transistor 111 and one of the negative terminals of the rectifier 116, and the resistor 120 is connected with the base of the transistor 111 and the collector of the transistor 112. The resistor 121 is connected with the base of the transistor 112 and one terminal of the resistor 115. The above-mentioned elements compose a monostable multivibrator circuit P which is part of the control circuit according to the invention. Transistors 123 and 124 compose an amplifier 122 and the base of the transistor 123 is connected with a portion of the guard screen 110 through a resistor 125, while the collectors of said transistors 123 and 124 are respectively connected with the base of the transistor 111 in the monostable multivibrator circuit P through a diode 126 and a capacitor 127. The emitter of the transistor 124 is connected with one of the negative terminals of the rectifier 116. Reference numerals 128 and 129 designate capacitors, 130 a resistor and 131 a voltage regulated diode connected in parallel with one of the negative terminals of the rectifier 116 through the resistor 115. Reference symbol Q designates a motor circuit according to the invention, which comprises a main winding 132 and an auxiliary winding 133 connected in parallel with said main winding through a capacitor 134. One terminal end of the motor circuit is connected with a power source 135 and the other terminal end thereof with a speed regulating switch 136 for the motor. A switch 137 is provided to be operated by the solenoid 114, and a diode 138 is connected with said switch 137 in parallel. When the motor is set in motion, the rotor 103 is rotated to transmit the rotational torque thereof to the impeller 109, so that the pin 108, carried on the drive shaft 107, slides in the oblique slot 106 in the slide collar 105 and abuts against the terminal end A of said slot. Therefore, the brake lining 104 on one side face of the rotor 103 is completely detached from the brake disc 102 provided on the inside face of the motor housing 100 and the motor operates normally. However, when the guard screen 110 is touched with a portion of the human body, e.g. a hand or a foot, a current flows through the base and collector of the transistor 123, while a direct current flows owing to the diode action between the base of the transistor 123 and the emitter of the transistor 124. Therefore, the emitter and collector currents of the transistor 124 take a form differentiated by the capacitor 127 and the resistor 130, and a pulse on the plug side only is impressed on the base of the transistor 111. Thus the collector voltage of the transistor 111 is lowered and the base voltage of the transistor 112 is lowered accordingly. The collector current of the transistor 112 becomes small as the base voltage drops, whereas the base voltage of the transistor 111 becomes high as the collector voltage of the transistor 112 rises and the transistor 111 is completely energized, while the transistor 112 is deenergized which is normally held in an energized condition. Therefore, the contact of the switch 137 is shifted from a point T_1 to a point T_2 by the action of the

solenoid 114, with the result that a direct-current brake is applied to the rotor 103 via the diode 138. On the other hand, the impeller 109 tends to continue its rotation under inertia, so that the pin 108 carried on the drive shaft 107 is moved in the oblique slot 106 in the slide collar 105 in a direction opposite to that at the time of starting. As a result, the brake lining 104 on one side of the rotor 103 is brought into engagement with the brake disc 102 and thus the impeller 109 is quickly brought to a halt by a braking force created between the contacting surfaces of said brake lining and said brake disc. Once the impeller 109 has been stopped, a rotational torque is no longer generated in the impeller or the rotor 103. As a result of the above operation, the core center of the rotor 103 is displaced relative to the stator 101 and a magnetic attraction generated by the direct current flowing through the stator 101 is exerted on the rotor, whereby the rotor 103 is returned to the center of magnetic field of said stator 101, and thereby the pin 108 is brought into engagement with the terminal end A of the oblique slot 106 in the slide collar 105. Thus, the engagement between the brake lining 104 and the brake disc 102 is completely released. When the guard screen 110 is cleared of the influence of the human body, a capacitor 117 in the monostable multivibrator circuit P discharges the electricity stored therein and when the amount of discharge current becomes small, a current begins to flow through the base of the transistor 112 through the resistor 121 and the collector voltage of the transistor 112 drops, so that the base voltage of the transistor 111 is also lowered, with the collector current thereof decreasing, and as a result the collector voltage of the transistor 111 becomes high. On the other hand, since the collector of the transistor 111 is connected to the base of the transistor 112 through the capacitor 117, the base voltage of said transistor 112 further rises, while the base voltage of the transistor 111 becomes low, and finally the transistor 111 is deenergized and the transistor 112 is energized, with no current flowing through the solenoid 114. Therefore, the contact of the switch 137 is shifted from T_2 to T_1, permitting an alternating current to flow through the motor circuit, and thus the motor resumes its normal operation. The period between the time when the normally deenergized transistor 111 in the monostable multivibrator circuit P is energized and the time when said transistor is deenergized again, is determined by a time constant which in turn is determined by the capacitor 117 and the resistor 121, and during this period the solenoid 114 is held energized through the transistor 111. Therefore, even when the human body is not positively in touch with the guard screen 110, the control circuit operates positively, applying a direct-current brake to the motor to actuate the mechanical brake, and the impeller can be stopped quickly.

Still another embodiment of the invention will be described with reference to FIG. 15. In FIG. 15, reference numeral 140 designates the drive shaft of a motor, 141 an impeller connected to one end of said drive shaft 140, and 142 a guard screen covering said impeller 141. Reference numerals 143 and 144 are transistors and the collector of the transistor 143 is connected to one of the negative terminals of a rectifier 146 through a resistor 145 and the emitter thereof is connected to the other one of the negative terminals of said rectifier 146 through a resistor 147. The collector of the transistor 144 is connected with a terminal of a relay 149 which is connected in parallel with a diode 148 and the other terminal of said relay 149 is connected with one of the negative terminals of the rectifier 146. The emitter of the transistor 144 is connected with the emitter of the transistor 143. Reference numerals 150 and 151 designate resistors connected in series with each other, and one terminal of the resistor 150 is connected with a junction between the resistor 145 and the collector of the transistor 143, while one terminal of the resistor 151 is connected with one of the negative terminals of the rectifier 146. A junction between the resistors 150 and 151 is connected with the base of the transistor 144. Reference character G generally designates a Schmidt trigger circuit, in which the transistor 143 is normally energized and transistor 144 is deenergized. Reference numeral 152 designates an amplifier composed of transistors 153 and 154, and the base of the transistor 153 is connected to a portion of the guard screen 142 through a resistor 155 and the collectors of the transistors 153 and 154 are respectively connected with a diode 156. A capacitor 158 is connected at one terminal thereof with a junction between a resistor 157 and the diode 156 and at the other terminal with one of the negative terminals of the rectifier 146. Reference numeral 159 designates a variable resistor, 160 a capacitor, 161 a voltage regulated diode, 162 a motor circuit, 163 a main winding, 164 an auxiliary winding connected in parallel to said main winding 163 through a capacitor 165, 166 a speed regulating switch, 167 another switch connected in series with said switch 166 and operatively associated with the relay 149, and 168 a diode connected in parallel with said switch 167. With the arrangement described above, when a portion of the human body, e.g. a hand or a foot, gets in touch with the guard screen 142, a current flows through the base of the transistor 153 due to the potential of the human body, with the result that the collector-emitter voltage of the transistor 154 drops and the terminal voltage of the capacitor 158 drops through the diode 156. Accordingly, the voltage at the junction B drops and the normally energized transistor 143 in the Schmidt trigger circuit G is deenergized, whilst the transistor 144 is energized. The relay 149 is actuated and the switch 167 operatively associated with said relay is shifted from the contact T_1 to the contact T_2, so that the motor circuit 162 is supplied with a current rectified by the diode 168 and thus a direct-current brake is applied to the motor. In this case, since the Schmidt trigger circuit G has a hysteresis characteristic, the base current of the transistor 153 in the amplifier 152 decreases slightly (when the contact between the guard screen 142 and the human body is unstable). Therefore, the Schmidt trigger circuit G is not inverted, even with a slight voltage rise at the junction B, so that the relay 149 is held in the energized state and hence the motor is subjected to the direct-current brake.

In FIG. 16 there is shown still another embodiment of the present invention. Referring to FIG. 16, reference numeral 170 designates an impeller connected to one end of a drive shaft 171, 172 a guard screen covering said impeller 170, and 173 an amplifier composed of transistors 174 and 175. The base of the transistor 174 is connected with a portion of the guard screen 172 and the collector terminals of the transistors 174 and 175 are respectively connected with one terminal of a solenoid 176, the other end of said solenoid being connected to a negative terminal of a rectifier 177. The emitter of the transistor 174 is connected with the base of the transistor 175 and the emitter of the transistor 175 is connected with a negative terminal of the rectifier 177. Reference numeral 178 designates a voltage regulated diode connected in parallel with a negative terminal of the rectifier 177, 179 a switch provided in the circuit of a motor M and operated by the solenoid 176, and 180 a diode connected in parallel with the switch 179. When the guard screen 172 is touched with a portion of the human body, e.g. a hand or a foot, a current flows through the base of the transistor 174 in the amplifier 173 due to the potential of the human body, so that a collector current is generated. Further, since the emitter of the transistor 174 is connected with the base of the transistor 175, the current flows through the base of said transistor 175, creating a collector current. As a result, the solenoid 176 is energized, causing the contact of the switch 179 to be shifted from a contact T_1 to a contact T_2. Thus, the motor circuit is supplied with a rectified current through the diode 180 and a direct-current brake is applied to the motor M.

Still another embodiment of the invention is shown in FIG. 17. In FIG. 17, reference numeral 190 designates a motor housing, 191 a stator, 192 a rotor, 193 a brake disc fixedly mounted on the drive shaft 194 of a motor, 195 a supporting member fixedly mounted upright on the inner wall of the

motor housing 190, 196 a brake lining fitted to the top end portion of said supporting member 195, and 197 a tension spring having one end thereof anchored to the inner wall of the motor housing 190 and the other end to the supporting member 195. Reference numeral 198 designates a solenoid and a plunger 199 thereof is connected to the supporting member 195. Reference numeral 200 designates an impeller connected to one end of the drive shaft 194 and 201 designates a guard screen covering the impeller 200, said guard screen being secured to the front face of the motor housing 190. A control circuit of the electric fan comprises an amplifier 202 composed of transistors 203 and 204, the base of said transistor 203 being connected to a portion of the guard screen 201 through a resistor 205, a solenoid 206 connected with the collector terminals of said respective transistors 203 and 204 at one terminal and to a negative terminal of a rectifier 208 through a resistor 207 at the other terminal thereof, a motor 210 connected in parallel with those negative terminals of the rectifier 208 which are connected with a power source 209, a switch 211 to be operated by the solenoid 206, a capacitor 212 and a voltage regulated diode 213, said capacitor and said voltage regulated diode being connected in parallel with the rectifier 208. With the arrangement described above, when the guard screen 201 is touched by a portion of the human body, e.g. a hand or a foot, a current flows through the base and collector of the transistor 203 due to the potential of the human body. Further, since the emitter of the transmitter 203 is connected with the base of the transistor 204, the current flows through the base and collector of said transistor 204. As a result, the solenoid 206 is energized and the switch 211 is shifted from a contact T_1 to a contact T_2, whereby the solenoid 198 is energized. The plunger 199 pulls the supporting member 195 against the tension of the spring 197 and thereby the brake lining 196 carried on the supporting member is brought into pressure contact with the brake disc 193 fixedly mounted on the drive shaft 194 to brake the rotating drive shaft. Thus, the impeller 200 is quickly stopped.

In a further embodiment of the invention shown in FIG. 18, a main winding 220 of a motor is connected at one end thereof with a power source 221, while an auxiliary winding 222 of the same is also connected at one end thereof with the power source 221. A capacitor 223 is connected with the main winding 220 at one terminal and with the auxiliary winding 222 at the other terminal thereof. Further, both terminals of the capacitor 223 are connected with contacts T_1 and T_2 of a switch 224 respectively, so as to form a motor circuit H for rotating the motor in both the normal and reverse directions. An amplifier D is composed of transistors 225 and 226 and the base of the transistor 225 is connected to a portion of a guard screen 228 through a resistor 227, said guard screen being secured to the front face of a motor housing (not shown). An impeller 229 is connected to one end of the drive shaft 230 of the motor. A solenoid 231 has one end thereof connected with the emitter of the transistor 225 and the collector of the transistor 226, and the other end with the power source 221. A resistor 232 is connected with the power source 221 at one terminal and to the emitter of the transistor 226 through a diode 234 at the other terminal thereof. Another resistor 233 is connected with a junction between the resistor 232 and the diode 234 at one terminal and with the power source 221 at the other terminal thereof. A capacitor 235 is connected in parallel with the resistor 233. Another diode 236 is connected in parallel with the solenoid 231. The switch 224 is operatively associated with the solenoid 231. With the arrangement described above, when the guard screen 229 is touched with a portion of the human body, e.g. a hand or a foot, the base potential of the transistor 225 in the amplifier D becomes high due to the potential of the human body, thus causing a base current to flow. In this case, since the collector of the transistor 225 is connected with the base of the transistor 226, the transistor 226 is energized, setting the amplifier D in operation and conducting a current through the solenoid 231. As a result, the switch 224 is shifted, whereby the motor circuit H is set in a position for reverse rotation of the motor and the rotor is stopped quickly by a reverse rotational torque given thereto, and the impeller 229 is also stopped quickly. If the portion of the human body is cleared from the guard screen 228 at this point, the current stops flowing through the amplifier D and accordingly the solenoid 231 is deenergized, so that the switch 224 is restored to permit normal operation of the motor.

Next, the mechanical braking device of the electric fan according to the present invention will be described by way of example hereinafter. According to an embodiment of the braking device shown in FIGS. 19 and 20, a brake lining 241 is fixed inwardly on the front end wall of a motor housing 240, and a slide collar 244 mounted on the drive shaft 245 of a motor and fitted into an axial hole of a rotor 243 is formed with an oblique slot 246 at one end portion thereof. The drive shaft 245 is provided with a pin 247 to be received in the oblique slot 246. A spring 248 is mounted on the drive shaft 245, with one end thereof bearing against the inside wall of the motor housing 240 and the other end against the rear end face of the rotor 243. Reference numeral 242 designates a stator. With the arrangement described above, when the motor circuit is placed in an inoperative position by the function of the various control circuits described previously, the rotor 243 of which the rotational torque has decreased sharply, is urged to the left under the biasing force of the spring 248 and brought into pressure contact with the brake lining 241, so that the rotor 243 is stopped quickly by said brake lining. On the other hand, the impeller (not shown) rigidly connected to the drive shaft 245 tends to continue its rotation due to inertia. Therefore, the pin 247 fixed on the drive shaft moves in the oblique slot 246 to a position opposite to that at which it was located at the time of starting, with the result that the rotor 243 is more strongly pressed against the brake lining 241 and thus the impeller is stopped quickly.

Another embodiment of the braking device will be described with reference to FIGS. 21 and 22. In FIGS. 21 and 22, reference numeral 250 designates a motor housing, 251 a brake lining fitted on the front face of the motor housing, 252 a stator, 253 a rotor, 254 a slide collar having an oblique slot 255 formed in one end portion thereof and fitted into an axial hole of the rotor 253, and 256 a drive shaft slidably received in said slide collar 254. The drive shaft 256 is provided with a pin 257 which is movably received in the oblique slot 255 formed in the slide collar 254. An impeller 258 is rigidly connected to one end of the drive shaft 256 and covered with a guard screen 259. When a direct current is impressed on the motor circuit by the function of the various control circuits described before, the rotor 253 tends to stop rotating while being subjected to a direct-current brake, whereas the impeller 258 tends to continue its rotation due to inertia. As a result, the pin 257 carried on the drive shaft 256 is displaced within the oblique slot 255 in a direction opposite to that at the time of starting, causing the impeller to move backward and thus the rear end face of said impeller 258 is brought into engagement with the brake lining 251 on the front face of the motor housing 250. Therefore, the impeller is braked by the brake lining and stopped quickly.

Still another embodiment of the braking device is shown in FIGS. 23 and 24. Referring to FIGS. 23 and 24, reference numeral 260 designates a motor housing, 261 a stator, 262 a rotor, 263 a rotor shaft and 264 an impeller rigidly connected to one end of the rotor shaft 263. Slidably mounted on the rotor shaft 263 in opposed relation to the rear end face of the impeller 264 is a brake lining mounting member 266 having a plurality of radial arms and a central mounting hole 267, and a brake lining 268 is fitted on the outer ends of said radial arms for engagement with the rear end face of the impeller. Interior of the motor housing 260 is provided a solenoid 269 connected in parallel with the motor circuit and a plunger 270 to be operated by said solenoid extends outwardly through a hole 265 formed in said motor housing and is connected with

the brake lining mounting member 266 at its tip end. Now, when the motor circuit is broken by the function of the control circuits described hereinabove, the solenoid 269 in parallel with said motor circuit is deenergized, whereupon the plunger 270 is retracted, causing the brake lining mounting member 266 to move forward. Therefore, the brake lining 268 carried on the mounting member 266 is brought into pressure contact with the rear end face of the impeller 264, applying a braking force to said impeller. Thus, the impeller 264 and the rotor 262 are stopped quickly.

Finally, a further embodiment of the braking device will be described with reference to FIGS. 25 and 26. In FIGS. 25 and 26, reference numeral 280 designates a motor housing, 281 a brake lining fitted on the front face of said motor housing, 282 a stator, 283 a rotor, 284 a drive shaft, 285 an impeller fitted on the front end of said drive shaft and 287 an oblique slot formed in the boss 286 of said impeller 285. The drive shaft 284 is provided with a pin 288 which is received in the oblique slot 287 formed in the boss 286 of the impeller 285. Now, when a direct current is impressed on the motor circuit by the function of the various control circuits described hereinabove, the rotor 283 tends to stop rotating while being subjected to a direct-current brake, whereas the impeller 285 tends to continue its rotation due to inertia. As a result, the pin 288 on the drive shaft 284 causes the impeller 285 to move backward to bring the end face of said impeller into engagement with the brake lining 281. Thus, the impeller is stopped quickly by a braking force developed between the contacting surfaces of said impeller and said brake lining.

We claim:

1. An electric fan comprising a detector adapted to emit a signal upon sensing a portion of the human body getting close to an impeller of the fan and a braking device for braking the rotating impeller in response to the signal from said detector.

2. An electric fan comprising a detector adapted to emit a signal upon sensing a portion of the human body getting close to an impeller of the fan and an electric braking device for applying an electrical brake to an impeller driving motor in response to the signal from said detector.

3. An electric fan comprising a detector adapted to emit a signal upon sensing a portion of the human body getting close to an impeller of the fan, an electric braking device for applying an electrical brake to an impeller driving motor in response to the signal from said detector and a mechanical braking device for applying a mechanical brake to the rotating impeller simultaneously with said electrical brake. (FIG. 2)

4. An electric fan as defined in claim 1, in which a guard screen covering said impeller is mounted so as to be swingable in a small range and a pressure-sensitive resistor of such a character that its electric resistance value is variable with pressure is provided for cooperation with said guard screen, whereby an external pressure imposed on said guard screen is transmitted to said pressure-sensitive resistor and a change in the resistance value of said resistor is used as a signal for operating said braking device. (FIGS. 3 to 5)

5. An electric fan as defined in claim 1, in which a guard screen covering said impeller is connected with an oscillator and the output of said oscillator is used as a signal for operating said braking device. (FIGS. 6 to 8)

6. An electric fan comprising a brake disc provided for engagement and disengagement with a rotor, a solenoid connected in parallel with a motor of the fan for bringing said brake disc into or out of engagement with said rotor, a switch connected in series with said motor and adapted to be closed by said brake disc, and a control circuit designed to operate in such a manner that when a guard screen covering an impeller of the fan is touched with the human body, said motor is disconnected from a power source, whereby said brake disc is brought into engagement with said rotor by the action of said solenoid. (FIGS. 9 to 11)

7. An electric fan comprising a slide collar formed therein with an oblique slot and fitted into an axial hole of a rotor, said slide collar being slidably mounted on a rotor shaft, a pin fixed on said rotor shaft and received in said oblique slot, a brake disc provided in opposed relation to one end face of said rotor, a monostable multivibrator circuit connected with an amplifier which in turn is electrically connected with a guard screen covering an impeller of the fan, a relay connected with said monostable multivibrator circuit, a switch operatively associated with said relay and connected in series with a motor of the fan, and a rectifier connected in parallel with said switch. (FIGS. 12 to 14)

8. An electric fan comprising an amplifier electrically connected with a guard screen covering an impeller of the fan, a Schmidt circuit of hysteresis characteristic connected with said amplifier, a relay provided in said Schmidt circuit, a switch adapted to be opened and closed by said relay and connecting the motor to a power source therethrough, and a rectifier connected in parallel with said switch. (FIG. 15)

9. An electric fan comprising an amplifier electrically connected with a guard screen covering an impeller of the fan, a relay connected with said amplifier, a switch operatively associated with said relay to be opened and closed thereby and connecting a motor of the fan to a power source therethrough, and a rectifier connected in parallel with said switch. (FIG. 16)

10. An electric fan comprising an amplifier connected at one terminal thereof with a guard screen covering an impeller of the fan, a rectifier connected at one of the negative terminals thereof to the other terminal of said amplifier through a relay, a switch operatively associated with said relay and connected between the negative terminals of said rectifier, and a motor connected between the input terminals of said rectifier. (FIG. 17)

11. An electric fan comprising an amplifier electrically connected with a guard screen covering an impeller of the fan, a relay connected with said amplifier, a switch operatively associated with said relay and a motor circuit which is controlled by said switch from a position to rotate a motor of the fan in the normal direction to a position to rotate the same in a reverse direction or vice versa. (FIG. 18)

12. An electric fan as defined in claim 3, in which a slide collar formed with an oblique slot therein is fitted into an axial hole of a rotor and a drive shaft of the fan is fitted into said slide collar, said drive shaft having a pin fixedly mounted thereon, said pin being received in the oblique slot in said slide collar, said rotor being provided on one end face thereof with a brake lining in opposed relation to a brake disc provided interior of a motor housing, and between said rotor and said motor housing there being provided a spring by which said brake lining is urged to be held in pressure contact with said brake disc. (FIGS. 19 to 20)

13. An electric fan as defined in claim 3, in which a slide collar formed with an oblique slot therein is fitted into an axial hole of a rotor and a drive shaft of the fan is fitted into said slide collar, said drive shaft having an pin fixedly mounted thereon, said pin being received in the oblique slot in said slide collar, and further a brake lining is fitted on the front face of a motor housing in opposed relation to the rear end face of an impeller connected to an end of said drive shaft. (FIGS. 21 to 22)

14. An electric fan as defined in claim 1, in which a brake disc is provided for engagement and disengagement with the boss of the impeller and means is provided for pressing said brake disc against said boss of the impeller. (FIGS. 23 to 24)

15. An electric fan as defined in claim 3, in which said impeller has an oblique slot formed in the boss thereof and is loosely mounted on a drive shaft of the fan, with a pin provided on said drive shaft being received in said oblique slot, and a brake lining is fitted on the front face of a motor housing in opposed relation to said impeller.