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ELECTRICAL SWITCH APPARATUS

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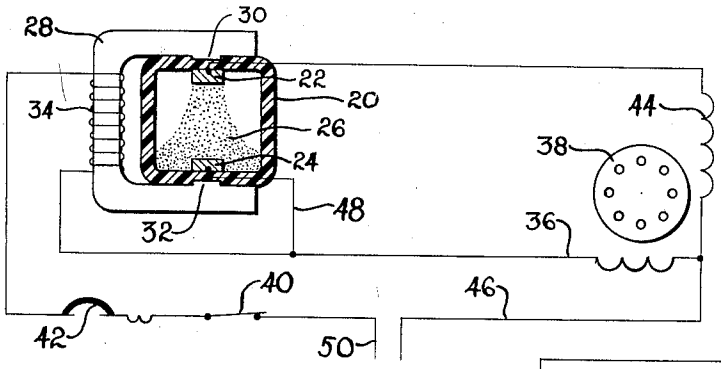
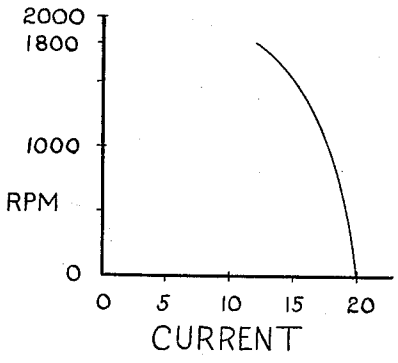


Fig. 1

Fig. 4



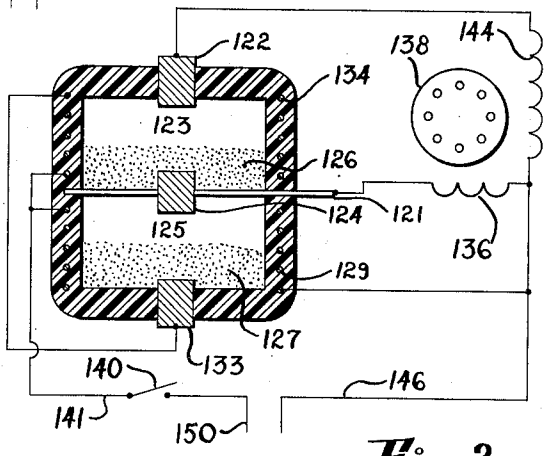


Fig. 2

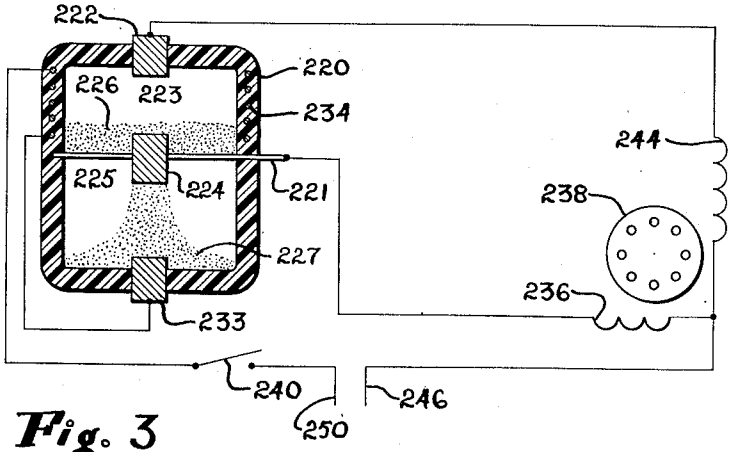


Fig. 3

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ELECTRICAL SWITCH APPARATUS

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4 Claims. (Cl. 200—88)

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This invention relates to electrical apparatus and more particularly to electric switches and relays.

It is an object of my invention to provide a simple, reliable, low cost switch using a minimum of strategic materials.

It is another object of my invention to provide a switch in which there are no parts to wear and in which there is an absence of contact difficulties.

It is another object of my invention to provide a relay which is simple, reliable and low in cost.

It is another object of my invention to provide a relay in which there are no contact difficulties and no parts to wear.

To attain these objects I provide a sealed enclosure containing a suitable non-conducting gas such as hydrogen. Separated electrical terminals are exposed within the interior of the enclosure. In one form of the invention an electromagnet, when energized, provides an electromagnetic field between the poles causing particles within the enclosure to bridge the gap between the terminals to allow current to flow. In a modified form, the particles may be permanently magnetized and have a low Curie point for use as a thermal current overload.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view partly in section of a relay switch embodying one form of my invention connected to a wiring diagram for a split phase motor;

Fig. 2 is a sectional view of another form of my improved relay switch which includes both a starting relay switch and a thermal overload switch connected to a wiring diagram of a split phase motor circuit;

Fig. 3 is a sectional view of a third form of my invention likewise connected to a split phase motor circuit; and

Fig. 4 is a main winding current speed diagram of an electric motor.

In the drawings, the switch is shown used as the starting relay for a split phase motor. Starting relays are used in great quantity and have been of many different designs. They are ordinarily controlled either by motor speed or by the motor current. All types seem to be subject to some difficulties. To overcome difficulties found in such starting relays, I provide a sealed enclosure

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20 preferably of some suitably insulating material such as a thermo-plastic, for example, phenol formaldehyde resin. This sealed enclosure is provided with an upper electrical terminal 22 and a lower electrical terminal 24. These terminals should be larger in size than conventional contact terminals. Preferably they are of a paramagnetic or ferromagnetic material, for example, very soft iron which may be silver plated. The sealed enclosure is also provided with a multitude of ferromagnetic particles such as soft iron. These particles may be copper or silver plated to increase their electrical conductivity. The area of the terminals and the quantity of the particles should be in proportion to the amount of current it is desired to carry with the maximum allowable contact resistance. The sealed enclosure 20 is preferably completely evacuated and charged with a suitable gas such as hydrogen under pressure.

To cause the particles 26 to bridge the gap between the terminals 22 and 24 there is provided a U-shaped electromagnet 28 provided with pole pieces 30 and 32 directly adjacent the nearest terminals 22 and 24. The U-shaped magnet 28 is provided with an energizing winding 34 connected in the supply circuit of the main winding 36 and the starting winding 44 of the electric motor 38. The supply circuit includes a control switch 40 and a thermal overload control 42 in series with the motor winding circuits. The motor 38 is also provided with a starting winding 44 which has one terminal connected to the adjacent terminal of the main winding 36 and to the supply conductor 46. The other terminal of the starting winding 44 is connected to the upper contact terminal 22 while the lower contact terminal 24 is connected by the conductor 48 to the main winding circuit.

When the switch 40 is closed, the current first flows from the supply conductor 46 through the main winding 36 and the electromagnet coil 34. the overload protector switch 42, and the switch 40 to the supply conductor 50. In a typical motor this current may be as high as 20 amperes as shown in Fig. 4. This current flowing through the electromagnet coil 34 is sufficient to set up a magnetic field between the pole pieces of the electromagnet 28 which will cause the magnetic particles 26 to arrange themselves in this magnetic field between the terminals 22 and 24. This bridges the contacts 22 and 24 and causes the current to flow through the conductor 48 to the lower contact 24, the magnetic particles 26, to the contact 22 and thence through the starting

winding 44 to the supply conductor 46. This causes the motor 38 to start. As the motor picks up in speed according to Fig. 4, the main winding current falls and when the current is reduced to about 15 amperes, the electromagnetic field is insufficient to hold the particles 26 as a bridge between the terminals 22 and 24 so that they fall with the bottom of the sealed enclosure 20, thereby breaking the bridge and stopping the current flow between the terminals 22 and 24. The current falls to 15 amperes at about 15 to 1600 R. P. M. which is a desirable switching speed.

In Fig. 2 there is shown another form of the invention in which there is provided a sealed container 120 of a suitable thermo-plastic material such as phenol formaldehyde resin. Molded into this sealed container 120 is a dividing plate 121 which divides the interior of the container 120 into an upper compartment 123 and a lower compartment 125. The conductor plate 121 is provided with a dual contact terminal 124 in its center portion which projects upwardly and downwardly into the spaces 123 and 125. Coaxial with the container 120 and the terminal 124 is an upper terminal 122 mounted in the center of the top wall of the sealed container 120. The space 123 is filled with a sufficient quantity of soft iron particles 126 to bridge the gap between the terminals 122 and 124 in sufficient quantity to carry the starting winding current.

To cause these particles 126 to bridge the gap between the terminals 122 and 124, there is embedded in the walls of the chamber portion 123 an electromagnet coil 134 which is connected between the control switch 140 and a lower terminal 133 provided coaxially with the terminals 122 and 124 in the bottom wall of the sealed container 120. This sealed chamber 125 contains particles 127 having a low Curie point. These particles 127 as well as the particles 126 and the terminals 122, 124 and 133 may be silver plated to provide increased electrical conductivity.

The particles 127 in the chamber 125 may, for example, be of a 29.5% nickel, 70.5% iron alloy which has a Curie point of about 130° F. The purpose of providing particles with a low Curie point is to employ this chamber 125 as a thermal overload protector. The quantity of particles 127 and the area of the terminals 124 and 133 are so limited that upon excessive current flow the particles 127 will be heated above their Curie point, thereby losing their magnetic properties so that they fall to the bottom of the chamber 225 to break the bridge across the terminals 124 and 133. The alloy may be varied to change the Curie point. For example, if it is desired to use particles having a Curie point of about 300° F. a 31% nickel, 69% iron alloy may be used. Also nickel silicon, nickel molybdenum, and nickel zinc, and nickel copper alloys may be used for example. To obtain a Curie temperature of about 300° a 2½% silicon, 97½% nickel alloy may be used. A 300° Curie temperature may also be obtained by a 6% molybdenum, 94% nickel alloy or a 12½% zinc, 87½% nickel alloy, or a 19% copper, 81% nickel alloy.

To cause these particles 127 to bridge the gap between the terminals 133 and 124 there is embedded in the wall of the chamber 125 an electromagnet coil 129 which has one terminal connected to the supply conductor 141 under the control of the control switch 140 while the other terminal of the coil 129 is connected to the supply conductor 146. This arrangement acts as a low voltage protector, since whenever the supply voltage is too low for proper operation, the magnetic field provided by the energization of the coil 129 will not be strong enough to cause the particles 127 to arrange themselves across the gap between the terminals 133 and 124 or to hold them in bridging arrangement. When the supply voltage is adequate, the magnetic field between the terminals 133 and 124 will be strong enough to cause the particles to arrange themselves across the gap and bridge the terminals 133 and 124. The central electrical divider plate 121 is connected to the main winding 136 of the electrical motor 138. The starting winding 144 of the motor 138 has one end connected to a common connection with the supply conductor 146 while the other end is connected to the upper terminal 122.

When the switch 140 is closed, current will first flow through the supply conductor 146 and the electromagnet coil 129 to the supply conductor 141. This will set up a magnetic field between the terminals 124 and 133 causing the particles 127 to bridge the gap between these terminals 124 and 133. When this bridge is established current will flow from the main winding 136 through the plate 121 to the terminal 124 and across the bridge of the particles 127 to the terminal 133 and thence through the starting electromagnet coil 134 to the supply conductor 141. The energization of the coil 134 will provide an electromagnetic field between the terminals 122 and 124 thereby causing the particles 126 to bridge the gap between these terminals and close the starting winding circuit. Both windings of the motor 138 are thereby energized. In accordance with the current diagram in Fig. 4, the main winding current will reduce as the motor speed increases and at a desirable switching speed this current will be reduced sufficiently that the electromagnetic coil 134 will not provide a field which is strong enough to hold the particles 126 across the terminals 122 and 124 so that they will fall to the bottom of the chamber 123. This will deenergize the starting winding 144.

The quantity of the particles 127 and the area of the terminals 124 and 133 are limited to the extent that upon excessive current flow to the motor 138, the particles 127 will be heated above their Curie point, thereby losing their magnetic properties so that they fall to the bottom of the chamber 125 to break the bridge across the terminals 133 and 124 which conducted the motor current. As soon as the particles 127 are cooled below their Curie range, they will gradually recover their magnetic properties. The coil 129 remains energized. Therefore when the particles 127 have sufficiently recovered their magnetic properties, they will again return to the magnetic field and bridge the gap between the terminals 133 and 124 to reclose the motor circuit. Thus automatic reclosing thermal overload and low voltage protection are provided.

In Fig. 3 the portion above the dividing plate 221 is similar to that shown in Fig. 2 and includes a terminal 224 projecting into the upper chamber 223 and the lower chamber 225 within the sealed enclosure 220. The upper contact 222 is connected to the starting winding 244 while the dividing plate 221 is connected to the main winding 236 of the motor 238. As in Fig. 2 the sealed enclosure 220 may contain an atmosphere of a suitable gas such as hydrogen under pressure. The chamber 223 contains an adequate quantity of soft iron particles 226 which may be silver plated to increase their conductivity. The chamber 223 is surrounded by an electromagnet coil

234 embedded in the wall of the sealed enclosure 220. One terminal of this coil 234 is connected to the control switch 240 while the other terminal is connected to the terminal 233 provided in the bottom of the sealed enclosure 234 coaxially with the enclosure and the contacts 222 and 224. This circuit differs from Fig. 2 in that there is no electromagnetic winding for surrounding the bottom chamber 225 but one or both the terminals 233 and 224 are permanently magnetized. The chamber 225 also contains an adequate quantity of permanently magnetized particles 227 having a relatively low Curie point such as between 130° and 300° F. The metallurgic composition of the particles 227 may be the same as the particles 127 of Fig. 2.

With this arrangement, as long as the particles 227 are below their Curie point they will bridge the gap between the terminals 224 and 233. When the switch 240 is closed the current will flow from the supply conductor 246 through the main winding 236 to the plate 221 and the terminal 224. The magnetic particles 227 will carry the current to the bottom terminal 233 from which point the current will flow through the winding 234 and the switch 240 to the other supply conductor 250. The flow of current through the winding 234 will cause the particles 226 to form a bridge between the contacts 222 and 224 thereby permitting current to flow from the terminal 224 through the bridge of particles 226 to the terminal 222 and thence through the starting winding 244.

The motor will have a current characteristic like that shown in Fig. 4 and when the current drops by reason of the acceleration of the motor from a standing start below 15 amperes, the magnetic force provided by coil 234 will be insufficient to maintain the particles 226 in a bridge across the terminals 222 and 224. This will permit the particles to fall to the bottom of the chamber 223 thereby breaking the circuit of the starting winding 244. The motor 238 will then continue to operate until either the switch 240 is opened or the particles 227 are heated above their Curie point by reason of either excessive current flow or high environment temperature. When so heated, the particles 227 will fall to the bottom of the chamber 225 and break the motor circuit. The motor circuit will remain broken until the particles are cooled below their Curie point. After the particles 227 are so cooled, they will recover their magnetic properties and again arrange themselves as a bridge across the terminals 224 and 233 to reclose the circuit of the motor 238. In all modifications, the contact terminals should be adequate in area and the particles sufficient in quantity to provide the necessary current carrying capacity. Both terminals and particles may be plated with silver, copper or other good electrical conductor to improve the electrical conductivity.

While I have shown the switch as used for a starting relay and current overload protector for a split phase motor, there is evidence that this is merely one of many practical applications of the invention and the invention may be used wherever it is desired to start and stop the energization of any electric circuit.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. A switch including a sealed enclosure provided with two spaced electrical terminals, at least one of said terminals being of a permanent magnetic material and being located above the other, said sealed enclosure containing a sufficient quantity of magnetized particles having a low Curie point to bridge the gap between the terminals when the particles are below the Curie point temperature, said terminals having a sufficiently limited exposed area and being spaced sufficiently far apart and said quantity of particles being so limited that an excessive current flow through the particles across the gap will heat the particles above their Curie point to demagnetize the particles to break the bridge.

2. A switch including a sealed enclosure provided with two spaced electrical terminals, at least one of said terminals being of a permanent magnetic material and being located above the other, said sealed enclosure containing a sufficient quantity of magnetized particles having a low Curie point to bridge the gap between the terminals when the particles are below the Curie point temperature, the quantity of particles and the rate of heat dissipation being proportioned to provide resistance heating of the particles under an excessive current flow sufficient to raise the temperature of the particles above the Curie point to break the circuit between the terminals.

3. A switch including a sealed enclosure provided with two spaced electrical terminals and means for creating a magnetic field between the terminals, said sealed enclosure containing a sufficient quantity of magnetized particles having a low Curie point to bridge the gap between the terminals when the particles are below the Curie point temperature, the quantity of particles and the rate of heat dissipation being proportioned to provide resistance heating of the particles under an excessive current flow sufficient to raise the temperature of the particles above the Curie point to break the circuit between the terminals.

4. A switch including a sealed enclosure enclosing a chamber, an electromagnet winding encircling said chamber, a wall extending across said chamber dividing said chamber into two sub-chambers, said wall being provided with an electrical terminal extending into each of said sub-chambers, each of said sub-chambers being provided with a second electrical terminal separated from said first mentioned terminal, each of said sub-chambers being provided with paramagnetic particles, the particles in one of said sub-chambers having a sufficiently low Curie point that an excessive current flow between the terminals through the particles will cause the particles to be heated above their Curie point to disperse the particles and break the current flow.

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