

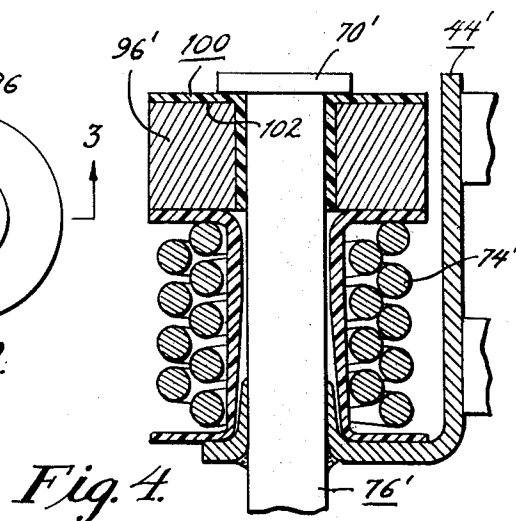
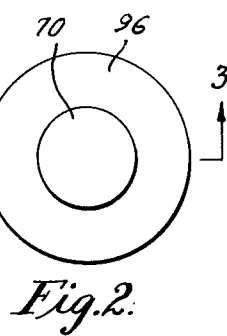
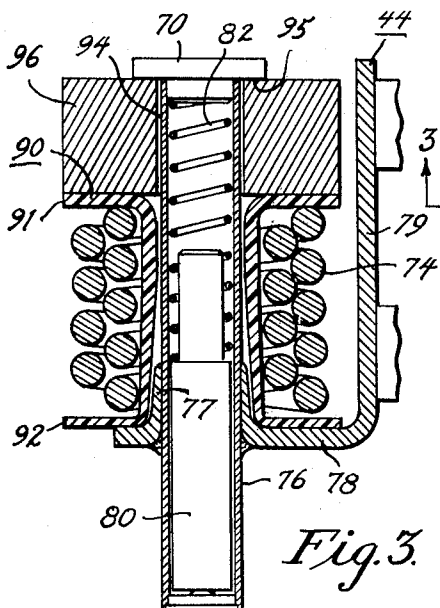
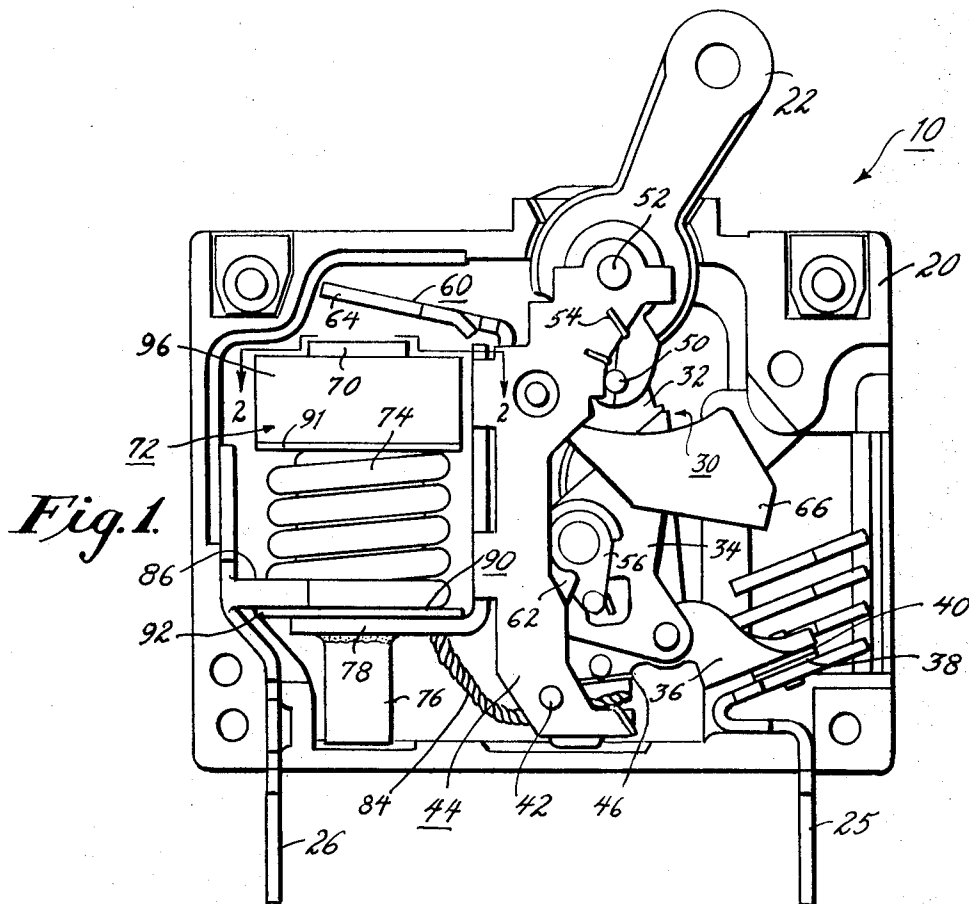
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ELECTROMAGNETIC DEVICE HAVING A SHORT CIRCUITED TURN

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1

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ELECTROMAGNETIC DEVICE HAVING A SHORT CIRCUITED TURN

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13 Claims

ABSTRACT OF THE DISCLOSURE

An electromagnetic device comprising a solenoid coil, an armature actuatable by the coil and a magnetizable frame carrying the coil. A tube of non-magnetic material within which is a movable magnetizable core, the tube having a pole piece at one end toward which the armature is attracted on predetermined overload conditions, the core being biased toward the end of the tube away from the pole piece. A short circuited turn or ring of electrically conductive, but non-magnetizable material, is associated with the coil, so that the current in the coil required to overcome the bias on the armature with substantially no time delay, when the gap between the core and the pole piece is at its maximum, is substantially higher than the current required for a similar device, but which omits the short circuited ring.

BACKGROUND OF THE INVENTION

This invention relates to electromagnetic devices and, in particular, to circuit breakers and relays in which overload sensing is accomplished electromagnetically by a device which permits the circuit breaker or relay to actuate after a time delay period at certain overloads and with substantially no time delay at other overloads. Such devices are illustrated, for example, in U.S. Pat. No. 2,360,922, issued to Kurt W. Wilckens, and U.S. Pat. No. 3,329,913, issued to William W. Camp.

These prior patents relate to an electromagnetic sensing device including a solenoid coil, a time delay tube housing a movable core of magnetizable material movable against the retarding action of a liquid and a pivotal, spring biased, armature to provide a time delay upon the occurrence of an overload which, if below a certain value and if it does not persist for a predetermined time, will not cause the tripping by the armature of the circuit breaker's operating mechanism and will not open the circuit breaker contacts, thereby avoiding nuisance tripping. In this type of circuit breaker, if the overload current is sufficiently high, the resulting magnetic flux will substantially instantaneously cause the pivotal armature to pivot and trip the circuit breaker operating mechanism and will open the circuit breaker contacts substantially instantaneously, i.e., with no intentional time delay.

However, certain electrical loads may safely accept a very high current, usually an inrush current and a substantially momentary current, i.e., of very short duration, so that at such currents no tripping of the circuit breaker may be desired.

Several attempts have previously been made to modify this known type of electromagnetic device to permit the flow through the circuit breaker or relay of higher inrush currents, of short durations, without tripping the circuit breakers or the relays, as disclosed in U.S. Pat. No. 3,307,130, issued to William W. Camp, and U.S. Pat. No. 3,272,934, issued to Normal J. Schwartz et al. It is an object of this invention to provide another arrangement whereby the electromagnetic device will permit the flow

2

therethrough of high inrush currents, of short durations, without tripping the circuit breakers or the relays.

BRIEF SUMMARY OF THE INVENTION

This invention is embodied in an electrical circuit breaker having separable contacts actuatable by a toggle linkage. The toggle linkage, on predetermined current conditions, is tripped by a pivotal armature. The armature forms part of the electromagnetic device which further comprises a frame and a solenoid coil. The solenoid coil partially surrounds a tube housing a core of magnetizable material which is biased toward one end, the rear end, of the tube. The other, or forward, end of the tube includes a magnetizable pole piece toward which the core moves upon sufficient energization of the coil, and the armature is biased away from the pole piece. Adjacent the armature and the pole piece is placed a short circuited turn or ring in which a current is induced by the coil when the current in the coil varies. The induced current produces a magnetic flux which delays actuation of the armature, thus more electrical current will be required to produce a sufficient flux (in the gap between the pole piece and the armature) to attract the armature, i.e., the current level at which the armature will be actuated substantially instantaneously has been raised, relative to a similar device without a short circuited ring, permitting inrush currents of short duration to flow through the coil without causing tripping of the circuit breaker.

Short circuited turns or rings have been previously disclosed in D.C. relays, to provide a time delay, but, so far as I know, have not heretofore been used in combination with a circuit breaker or relay having a tube with a movable core intended to provide a time delay at certain overloads.

Also, in a D.C. use, a current is induced in the short circuited turn at the instant the circuit is closed or opened, but not during steady state conditions. However, for A.C. applications, a current is induced in the short circuited turn at all times. Although short circuited turns or shading coils, i.e., slugs or rings, have been previously used in A.C. relays to quiet their operation, one writer, at least, had thought that they could not be successfully used to provide a time delay in an A.C. circuit breaker or relay, as it is stated in "Relay Engineering" by Charles A. Packard, Second Edition, at page 116, as follows:

"Slugs may only be used for D-C operation. Where the relay coil operates on alternating current, they would be a tremendous transfer of energy from the coil to the slug which would act as a short circuited secondary on a transformer. Even if this fact is ignored as it might be on applications where the relay is only energized for extremely brief intervals, the performance of the slug would be erratic when operating on an A-C relay. This is so because it would merely act to delay the decay of flux—and the flux through the magnetic parts of an A-C relay varies continuously depending on the instantaneous value of the current flowing through the operating coil."

In the device which I have invented, the high inrush current usually exists for a very short period of time, a few milliseconds, and, thus, the transfer of energy to the short circuited turn takes place at the high level of the inrush current for only a very brief time period. Further, should the high inrush current exceed the level at which the circuit breaker or relay will trip, or last for a long enough period of time for the flux to build up to the trip level, such as by movement of the core forward, the device will thereafter open and no current will flow through the coil. This is in contrast, for instance, to the normal shaded coil relay, in which the device is normally intended to remain energized with the armature in the attracted position. That is, in the device of this invention, once the armature is attracted, the unit trips open, the

coil deenergizes, and then the armature is returned to its initial position by its spring bias.

Also, in my device, the transfer of energy takes place when the magnetic coupling is poorest, i.e., the magnetizable core is in its rearwardmost position and not coupling the coil and the short circuited turn.

The foregoing and other objects of this invention, the principles of this invention, and the best modes in which I have contemplated applying such principles will more fully appear from the following description and accompanying drawings in illustration thereof.

BRIEF DESCRIPTION OF THE VIEWS

In the drawings,

FIG. 1 is a side elevation, illustrating a circuit breaker incorporating this invention, with a half-case removed to show the general internal arrangement and illustrating the contacts in the closed position;

FIG. 2 is a top view of the solenoid coil and the pole piece taken along the line 2—2 in FIG. 1;

FIG. 3 is an enlarged partial, sectional view of the solenoid coil, tube, pole piece, and frame taken along the line 3—3 in FIG. 2; and

FIG. 4 is a partial sectional view similar to FIG. 3, but showing a modification of this invention.

DESCRIPTION

Referring to the drawings, FIG. 1 illustrates a circuit breaker 10 generally similar to the one disclosed and claimed in U.S. Pat. No. 3,329,913, issued to William W. Camp. For a more complete description of the mechanism of this circuit breaker reference should be made to the aforementioned patent, but for clarity, the circuit breaker may be briefly described as comprising an insulating case 20 formed by abutting half-cases, only one half-case being illustrated in FIG. 1, an operating handle 22, and terminals 25 and 26 for connecting the circuit breaker to a load. Connected to the operating handle 22 is a linkage 30 comprising toggle links 32 and 34 and a movable arm 36. The terminal 25 supports a stationary contact 38 which cooperates with a movable contact 40, the latter being carried by the movable arm 36. The movable arm 36 pivots about a pintle 42, carried by a frame 44, and is biased by a spring 46 to the open position of the contacts.

The toggle link 34 is pivotally connected to the movable arm 36 at one end and to the toggle link 32 at the other end to form the knee of the toggle, the link 32 being pivotally connected at its upper end to the handle 22 by a pintle 50. The handle 22 oscillates about a fixed pintle 52 which is carried by the frame 44 and is biased to the "off" position of the contacts by a reset spring 54, the spring 54 also resetting the toggle linkage upon tripping of the mechanism.

For locking the toggle in the overcenter position during automatic resetting, the toggle link 32 engages a latch 56 carried by the link 34.

The latch 56 is tripped by a pivotal armature 60 having three arms, namely an unlatching member 62, an attracted end 64 and a balance portion 66. The unlatching member 62 engages the latch 56 and turns it to unlatch the toggle, thereby allowing the toggle to collapse under the bias of the spring 46, when the armature arm 64 is attracted (upon sufficient overload), toward the pole piece 70 of an electromagnet 72.

The electromagnet 72 comprises a solenoid coil 74 about a tube 76, the latter projecting through a sleeve 77 of a leg 78 of the frame 44 whose other leg 79 extends longitudinally along the coil, as shown. The tube 76 is of non-magnetic material and houses a movable core 80 of magnetizable material biased by a spring 82 toward the lower end of the tube and is retarded in its upward movement by a liquid, preferably a silicone oil, within the tube 76 to provide a time delay below certain overload currents before tripping of the circuit breaker takes place. The coil 74 has one end connected to the movable arm 36 by a flexible conductor 84 and the other end connected

by a conductor 86 to the terminal. Thus, an electromagnetic tripping device or sensing element is formed by the coil 74, tube 76, movable core 80, and armature 60 for tripping the circuit breaker after a time delay period at certain overloads or substantially instantaneously at other, higher overloads.

The coil 74 is formed by turns of insulated wire wound around an insulator bobbin 90 having a central, axial hole through which the tube 76 extends. As illustrated, the bobbin 90 has upper and lower flanges 91 and 92 and the lower flange 92 may rest upon the leg 78. The tube 76 may also be soldered to the leg 78.

The tube 76 extends, at its upper end, as viewed in FIGS. 1 and 3, above the upper flange 91 and the pole piece 70 may extend radially beyond the outer, cylindrical wall 94 of the tube to define an annular space between the surface 95 of the pole piece 70 and the upper surface of the flange 91 within which is placed a short circuited turn or ring 96 of non-magnetizable, but electrically conductive material, such as copper.

It is preferred that the ring 96 extend from the cylindrical wall 94 of the tube 70 to the frame leg 79 with a suitable clearance with the cylindrical wall 94 and with the frame leg 79.

Referring to FIG. 4, it has been found that the instantaneous trip point of a circuit breaker may be further increased if the short circuited turn or ring 96' is electrically isolated from the tube 76' and the frame 44'. It is suspected that since one end of the coil 74' is connected to the movable arm by the flexible conductor and, since the frame 44' and the tube 76' are thus at essentially the same electrical potential as one end of the coil 74', if the turn or ring 96' is not electrically isolated from the tube 76' and the frame 44' an autotransformer effect would be produced which is not as effective as an isolated secondary turn. Thus, the ring 96' is isolated from the tube 76' by an insulator sleeve 100 which is placed around the tube 76' between the tube 76' and the pole piece 70', the sleeve 100 having a flange 102 extending radially between the lower surface of the pole piece 70' and the upper surface of the ring 96'. As in the previous embodiment, the ring 96' is maintained spaced from the frame 44'.

It has also been found that as the thickness of the short circuited turn or ring increases, i.e., as the mass of the ring increases, the instantaneous trip point is also raised to a greater extent than would be expected from merely reducing the length of the coil, i.e., by merely providing a gap between the upper end of the coil and the pole piece. It is, of course, assumed that the unit remains otherwise the same, except that the size of the wire for the coil is reduced.

To facilitate commercial production, it may be desired to form the short circuited turn or ring by a stacked array of washer-like discs. This would provide a convenient method of providing a short circuited turn of different thicknesses for different requirements with only one stock part.

Further, while the short circuited turn or ring has been shown as occupying substantially all of the available radial space between the tube and the frame, so as to provide as large a volume as possible for any given thickness, it will be understood that the ring need not extend the entire distance between the tube and the frame to increase to some extent the instantaneous trip point.

Also, while the short circuited turn or ring has been shown as positioned between the pole piece and the coil, it will be understood that it could be placed above the pole piece or extending in part through the pole piece, although such arrangements would increase the instantaneous trip point to a lesser extent than if placed as shown in the drawings. Further, while the short circuited member has been shown in the shape of a ring it is understood that it need not be restricted to a ring shape to have some influence on raising the instantaneous trip point.

Although a frame has been shown in the drawings having a sleeve 77 extending part way into the coil, it will be understood that this invention is applicable even where this sleeve is omitted.

Further, this invention has been incorporated in A.C. devices and in D.C. devices which have been successfully tested.

Having described this invention, what I claim is:

1. An electromagnetic device comprising a solenoid coil, an armature actuatable by said coil, a magnetizable frame about said coil, a tube of non-magnetic material surrounded, at least in part, by said coil, a movable and magnetizable core within said tube, means for retarding movement of said core and biasing said core toward one end of said tube, a magnetizable pole piece secured to the end of said tube opposite to the end toward which said core is biased and toward which said armature is movable, said pole piece defining with said core a magnetic gap, said pole piece defining with said armature another magnetic gap, said core being movable by said coil toward said pole piece, further means biasing said armature away from said pole piece, and non-magnetizable, electrically conductive means inductively associated with said coil and positioned adjacent said armature for producing a magnetic flux tending to delay actuation of said armature, so that the current in the coil required to overcome the armature bias with substantially no time delay, at any particular gap between said armature and pole piece, when the gap between the core and the pole piece is at its maximum, is substantially higher than the current required for a similar device but which omits said conductive means.

2. The structure recited in claim 1 and further including a pair of separable contacts, and operating means associated with said armature for automatically opening said contacts on predetermined overloads.

3. The structure recited in claim 2 wherein said conductive means is short circuited.

4. The structure recited in claim 3 wherein said conductive means consists of a ring.

5. The structure recited in claim 3 wherein said conductive means comprises a plurality of stacked washer-like discs.

6. The structure recited in claim 2 and further including insulation electrically isolating said conductive means from said tube, pole piece and frame.

7. The structure recited in claim 2 wherein said conductive means is concentric with said tube and placed between said pole piece and said coil at the end portion of said coil adjacent said armature.

8. The structure recited in claim 7 wherein said conductive means extends radially from said tube to the outer portion of said coil.

9. An electromagnetic device for operating a pair of separable contacts controlled by an operating mechanism comprising a solenoid coil, a magnetizable frame associated with said coil, an armature attractable by said coil, said armature being pivotally carried by said frame, a tube surrounded, at least in part, by said coil, said tube being of non-magnetic material, a pole piece of magnetizable material secured to the end portion of said tube toward which said armature moves, a core of magnetizable material within said tube, a spring biasing said core away from said pole piece and defining a gap, a liquid within said tube for retarding the movement of said core, said

magnetizable core being movable by the magnetic field of said coil along the longitudinal axis of said coil toward said pole piece, a further spring biasing said armature away from said pole piece and defining with said pole piece another gap, short circuited non-magnetic ring means inductively coupled to said coil, and positioned intermediate said pole piece and said coil and adjacent said armature for conducting a current in the direction to generate a magnetic field opposing the magnetic field of said coil as the current in the coil varies, whereby the varying current in the coil required to overcome the spring bias on the armature with substantially no time delay, when the gap between the core and the pole piece is at its maximum, is substantially higher than the varying current required to overcome the spring bias on the armature in a similar device but which omits said ring means.

10. The structure recited in claim 9 and further including insulation for electrically isolating said short circuited ring means from said tube, pole piece and frame.

11. The structure recited in claim 9 wherein said short circuited ring means spaces said coil from said pole piece axially along said tube.

12. The structure in claim 11 wherein said frame has two legs one along the length of the coil and the other at an angle thereto and through which said tube extends, said coil being disposed between the frame leg through which said tube extends and said short circuited ring means.

13. An electromagnetic device comprising a solenoid coil, an armature actuatable by said coil, a magnetizable frame about said coil, a tube of non-magnetic material surrounded, at least in part, by said coil, a movable and magnetizable core within said tube, means for retarding movement of said core and biasing said core toward one end of said tube, a magnetizable pole piece secured to the end of said tube opposite to the end toward which said core is biased and toward which said armature is movable, said pole piece defining with said core a magnetic gap, said pole piece defining with said armature another magnetic gap, said core being movable by said coil toward said pole piece, further means biasing said armature away from said pole piece, and non-magnetizable, electrically conductive means inductively associated with said coil and positioned around said tube for producing a magnetic flux tending to delay actuation of said armature, so that the current in the coil required to overcome the armature bias with substantially no time delay, at any particular gap between said armature and pole piece, when the gap between the core and the pole piece is at its maximum, is substantially higher than the current required for a similar device but which omits said conductive means.

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