United States Patent

Setone et al.

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[54] **CIRCUIT PROTECTOR**

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[52] **U.S. Cl.**......................................**335/63,** 335/236
[51] **Int. Cl.**..**H01h 7/14**
[58] **Field of Search**.....................335/63, 62, 61, 236

[56] **References Cited**

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[57] **ABSTRACT**

A circuit protector including an electromagnetic device, said device comprising a coil through which circuit current flows and wound on a coil bobbin, a cylinder provided at the center of said bobbin, an oil-dash type plunger provided within said cylinder movably against a compression force of a spring arranged between a cylinder head and the plunger, a yoke integrally connected to said cylinder and the bobbin, and an armature mounted to an end of said yoke in a manner capable of being attracted to the plunger head, said bobbin is provided with a magnetic leakage in the vicinity to the cylinder head.

4 Claims, 7 Drawing Figures

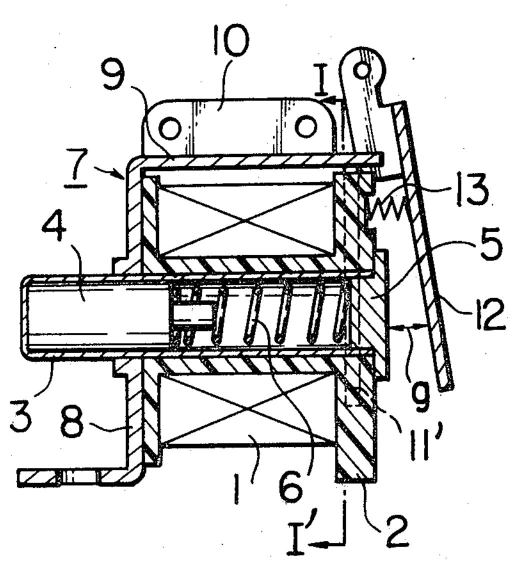

Fig. 1A

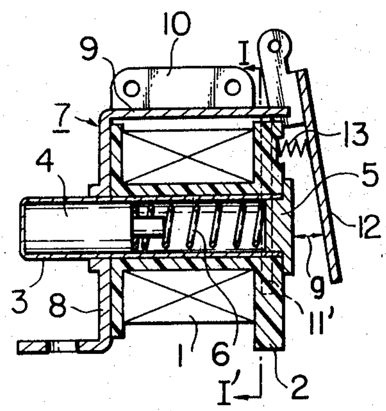

Fig. 1B

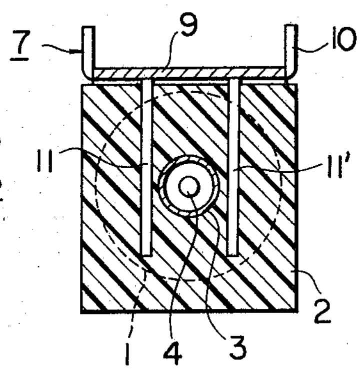

Fig. 2

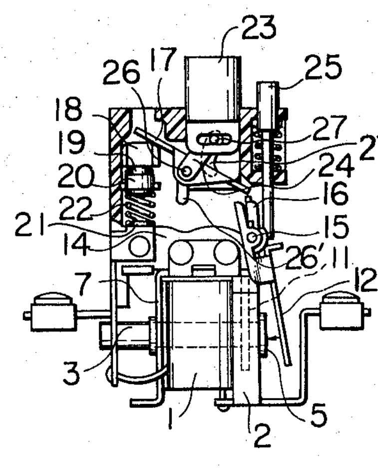

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Fig. 3

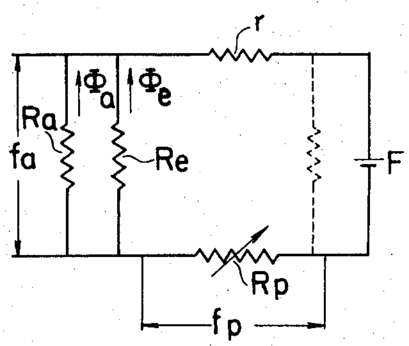


Fig. 4

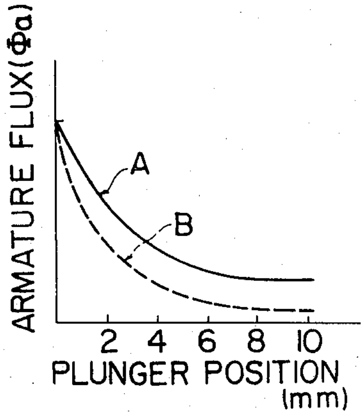


Fig. 5

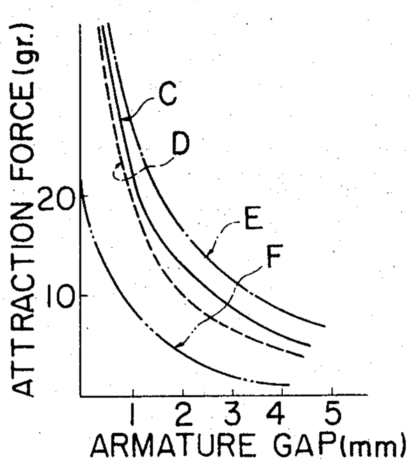
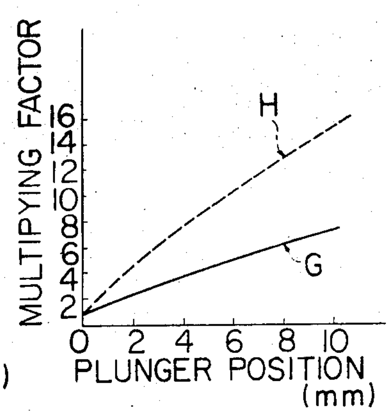


Fig. 6



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CIRCUIT PROTECTOR

This invention relates to a circuit protector.

In general, the transformer or solenoid allows such a great overcurrent as 1,500 – 3,000 percent of rating current to flow temporarily at the starting moment. In a convention circuit breakers or protectors, therefore, there has been such a drawback that the electromagnet device is actuated actuated by electromagnetic force produced only in the coil before the plunger moves due to the attraction and, thus, the circuit breaker itself is apt to operate before such overcurrent reaches stable region (or the starting current disappers).

The present invention has been proposed to remove the above drawback and is so constructed that the circuit protector is not actuated by the starting current but actuated by the overcurrent continuously flowing during operation by increasing magnetic leakage so as to increase attracting ampare turn of the armature and by minimizing the leakage at the time of completion of attraction of the plunger, so that the above problem will be effectively solved.

It is a principal object of the present invention to provide a circuit protector which is not actuated by any temporary overcurrent flowing at the starting moment but actuated by a continuous current flowing during the operation.

Other objects and advantage of the present invention will become clear as the following descriptions set forth with reference to the accompanying drawings, in which;

FIGS. 1A and 1B show the electromagnet device for use in the circuit protector according to the present invention and, in particular, FIG. 1A is a longitudinal cross section of the device and FIG. 1B is a cross sectional view taken along the line I — I' of FIG. 1A;

FIG. 2 is a partially sectioned elevation of the circuit protector according to the present invention, in which the electromagnet device of FIG. 1 is utilized;

FIG. 3 is an equivalent circuit; and

FIGS. 4 to 6 are explanatory diagrams for explaining the characteristics of the present device as compared with the conventional one.

FIGS. 1A and 1B show respectively only electromagnet devices to be used in the circuit protector according to the present invention, and FIG. 1A is a sectional elevation and FIG. 1B is a sectional side view taken along the line I — I' of FIG. 1A.

To begin with, explanation will be made of the structure and operation of the electromagnet with reference to FIGS. 1A and 1B.

In the drawings, a coil **1** is wound around a bobbin **2** made of insulation material within which a cylinder **3** made of nonmagnetic materials such as brass is disposed. A plunger **4** is slidably arranged within the cylinder **3** with an oil filled therein. A plunger head **5** made of magnetic material is provided at the head portion of the cylinder **3**. A compression spring **6** is arranged so as to engage between the plunger head **5** and a projection extending from the front face of the plunger **4**. The bobbin **2** is fixed to an L-shaped yoke **7** provided with an upper flange **9** and side flanges **8**, through the latter of which the cylinder **3** penetrates. **10** is a pair of upstanding bent portions of the yoke **7**, with the electromagnet devide is secured to an insulative housing. **11** and **11'** are leakage magnetic paths arranged in the vicinity to the plunger head **5** and at opposite sides with respect to the cylinder **3** as inserted in a flange of the bobbin **2**. The upper ends of the leakage magnetic paths **11** and **11'** are connected to the yoke **7**. An armature **12** is located in front of the plunger head **5** and is pivoted to the insulation housing **14** (See FIG. 2) at the upper portion thereof by means of a shaft **15**. Another compression spring **13** is disposed between the armature **12** and the bobbin flange **8** at the armature side.

FIG. 2 illustrates an example of the circuit protector embodying the electromagnet device as shown in FIGS. 1A and 1B. The armature **12** is rotatably secured through the shaft **15** to the housing **14** made of insulating material. A hook **16** is rotatably coupled to the armature **12** at the shaft **15** and the right end of a seesaw type turning plate **17** is engageably provided above the hook **16**. The left end of the turning plate **17** is kept in contact with a sliding member **18** which slides up and down. Slidably secured to a downward leg **19** of the sliding member **18** is a movable contactor **20**. **21** is a fixed contactor secured to the insulation housing **14** below the movable contactor **20**. **22** indicates a spring engaged between the movable contactor **20** and the fixed contactor **21**. **23** is a push button. **24** is a link, the upper end of which is rotatably secured to the push button **23** through a pin **27** and the lower end of which is also rotatably secured to the turning plate **17** through a pin **26**. **25** indicates a testing rod. With the structure as above mentioned, upon depression of the push button **23**, resulting force is transmitted to the turning plate **17** through the link **24**, thereby the pin **26** pivoting the plate **17** is descended along a slot **26'** provided on the insulation housing **14**. The right end of the turning plate **17** comes into contact with the top portion of the hook **16** and the left end depresses the sliding member **18** downward and, therefore, the movable contactor **20** comes into contact with the fixed contactor **21**. In this case, the pin **27** engaged to the lower portion of the push button **23** is likewise descended along an L-shaped slot **27'** in the housing **14** and locked in its sideward bottom port and, thus, the contacts are maintained in their "ON" state. When the lower part of the armature **12** is attracted toward the plunger head **5** in the direction of an arrow as shown by a steady state overcurrent flowing through the coil **1**, the top portion of the armature **12** rotates clockwise and in turn the top portion of the hook **16** also rotates clockwise and is released from engagement with the right end of the turning plate **17**. As a result, the movable contactor **20** is urged upward by the force of the spring **22** and thus the contacts reach "OFF" state. Depression of the testing rod **25** rotates the top portion of the armature **12** clockwise and the contacts are opened in the similar manner to the foregoing.

Next, the operation of the device according to the present invention will be described in detail.

When the plunger **4** is positioned away from the plunger head **5**, the lowering of magnetomotive force between the plunger **4** and the plunger head **5** will become large due to a large leakage magnetic flux caused by the leakage circuits **11** and **11'** and, therefore, effective magnetomotive force for the armature **12** through the distance of the attraction gap g is small. For this reason, the armature does not actuate with the temporary overcurrent.

When the steady state overcurrent flows through the coil 1 and the plunger 4 moves inside the cylinder 3 to contact with the plunger head 5, the magnetomotive force with the attraction gap g to the armature 12 does not greatly differ from the magnetomotive force afforded to the coil 1, if the leakage at the part of the plunger 4 and the yoke 7 and the saturation of the iron core are made as small as possible, even when leakage magnetic flux of the leakage circuits 11 and 11' is large in a certain extent. When the overcurrent flows through the coil 1 in this steady state, the armature 12 is attracted by attractive force produced by this overcurrent, thereby the contacts are opened.

FIG. 3 shows an electric equivalent circuit in which the following references are used:

F: Magnetomotive force applied to the coil.

Rp: Magnetic reluctance of the plunger and the plunger head.

Re: Magnetic reluctance of the leakage circuit.

Ra: Magnetic reluctance of the attraction gap of the armature.

r: Magnetic reluctance of the yoke, plunger and their connecting portion.

In FIG. 3, if Rp becomes zero, $fa = F - r(\phi a + \phi e)$. With R$e$ provided, fa is reduced only by the item $r \cdot \phi e$ and, if r is reduced, fa does not differ from the case where Re is not provided, as far as Rp is small. Namely, in the steady state where the plunger is close to the plunger head, fa is determined independently of Re and the armature normally operates with the overcurrent, thereby the contacts are opened.

When Rp is great, $\phi e \cdot$Rp will be large and fa becomes considerably smaller as compared with the case where Re is not provided. That is, in this case, fa is small due to Re and the armature does not actuate with the overcurrent, so that the contacts remain in closed condition.

FIG. 4 is a characteristic diagram showing the variation of the armature magnetic flux ϕa with respect to the change in plunger position, i.e., in the distance between the plunger and the plunger head, wherein curve A represents the case having no leakage circuit and curve B represents the case having the leakage circuit.

FIG. 5 is a characteristic diagram showing the variation in the attractive force to which the armature is subjected with magnetomotive force fa, with respect to the armature gap, i.e., the change in distance between the armature and the plunger head, in which curves C and D represent the variations when plunger stroke from the head is zero in the cases without and with the leakage circuit, and curves E and F represent the variations when the stroke is 10mm. in the cases without and with the leakage circuit.

FIG. 6 is a characteristic diagram, in which the abscissa indicates the variation of distance between the plunger and the head and the ordinate indicates magnification of current value at which the circuit protector operates with respect to the value of rating current, in which curve G represents the case without the leakage circuit and curve H represents the case with the leakage circuit.

As will be seen from these characteristic curves, it is possible to obtain a protector having an electromagnetic tripping mechanism of a large instantaneous opearation value, when the magnetic leakage circuit is provided in the electromanget device, according to the present invention.

According to the present invention, as detailed in the foregoing, the contacts do not open at the starting current which is temporary overcurrent not enough to move the plunger 4, while the contacts close with the overcurrent occurring at the steady state lasting for a predetermined time period.

What is claimed is:

1. An electromagnetic circuit protector comprising the combination of an armature mounted for pivotal movement between first and second positions for opening a pair of electrical contacts to protect an electrical circuit, a magnetizable pole member located at said second position, a magnetizable plunger mounted for reciprocating movement in a non-magnetizable cylinder leading to said pole member, biasing means urging said plunger away from said pole member, a magnetizable yoke having one end located closely adjacent said plunger and a second end extending toward said armature and said pole member, a coil disposed around said cylinder for advancing said plunger toward said pole member against the urging of said biasing means when the coil is energized for a predetermined time interval, thereby attracting said armature to said pole member due to a first magnetic circuit formed by said yoke, plunger, pole member and armature, and magnetizable short circuiting means contacting said yoke and extending to a position proximate to said pole member and lying in substantially the same plane as said pole member in the direction transverse to the direction of movement of said plunger so that the short circuiting means is substantially as far from said plunger as said pole member, said short circuiting means cooperating with said pole member, yoke and plunger to form a second magnetic circuit for short circuiting a part of the magnetic flux from said first magnetic circuit when said plunger is not engaging said pole member and thereby preventing attraction of said armature to said pole member when said coil is energized for only a short time interval less than said predetermined time interval.

2. The circuit protector according to claim 1 wherein said coil is wound on a flanged bobbin and said short circuiting means is disposed at both sides of the pole member in a flange of the coil bobbin.

3. The circuit protector according to claim 1 wherein said pole member is positioned between the armature and the short circuiting means.

4. The circuit protector according to claim 1 wherein said yoke and armature are formed in an integral body member.

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