

April 30, 1963

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3,088,009

LOAD FALL-OFF CIRCUIT BREAKER

Filed March 10, 1961

3 Sheets-Sheet 1

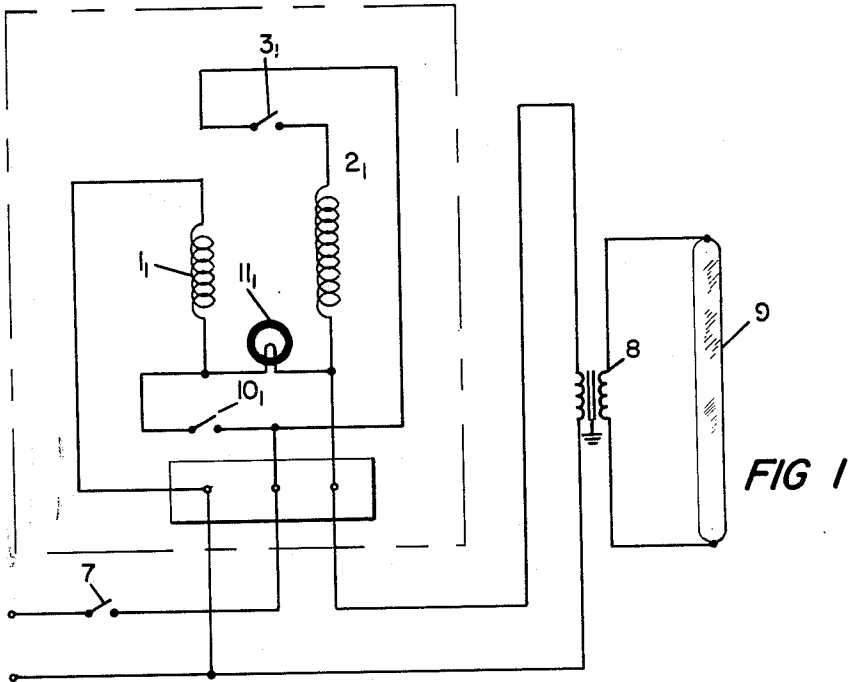


FIG 1

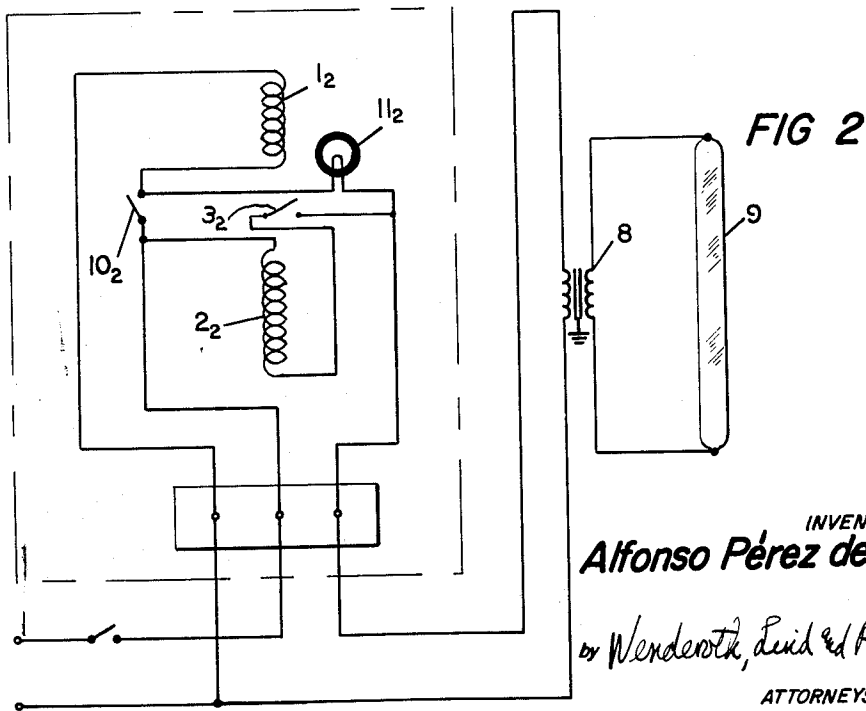


FIG 2

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3 Sheets-Sheet 2

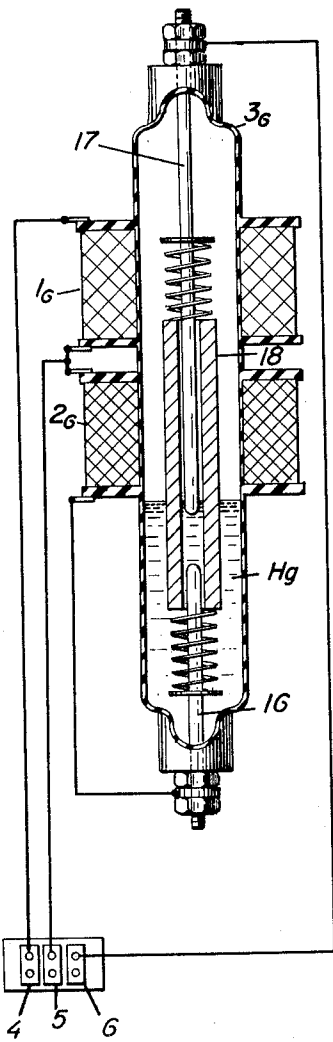
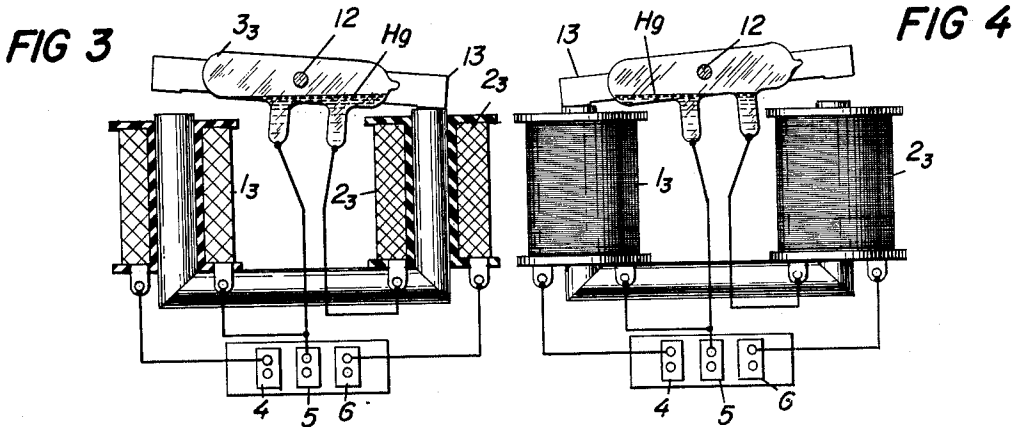
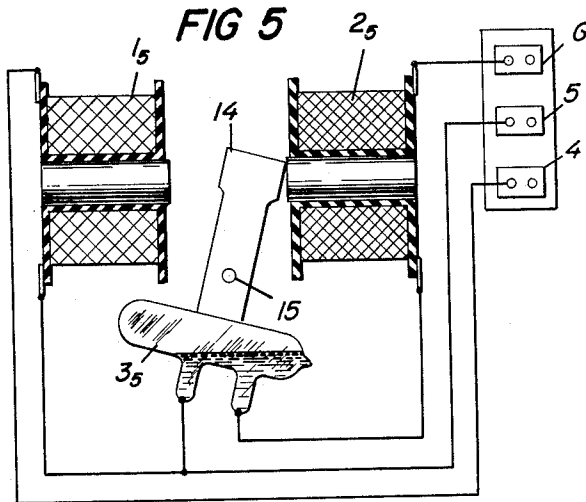


FIG 6



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3 Sheets-Sheet 3

FIG 8

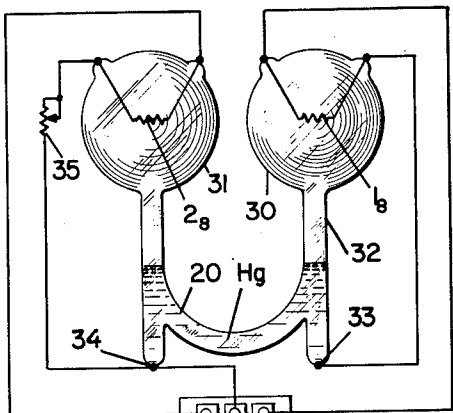


FIG 9

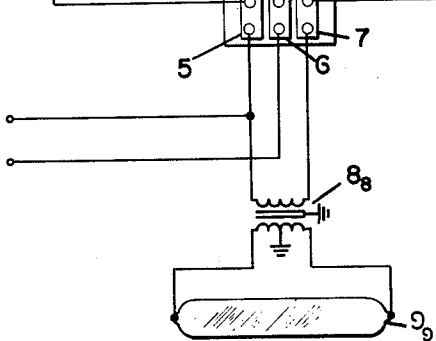
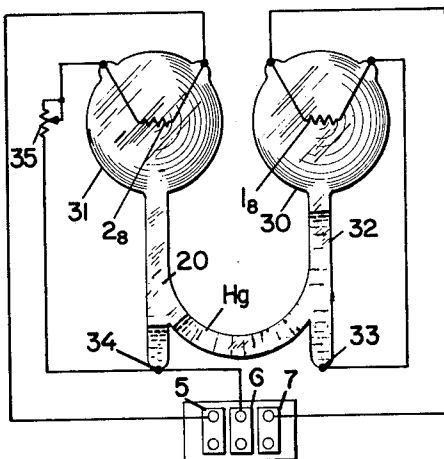
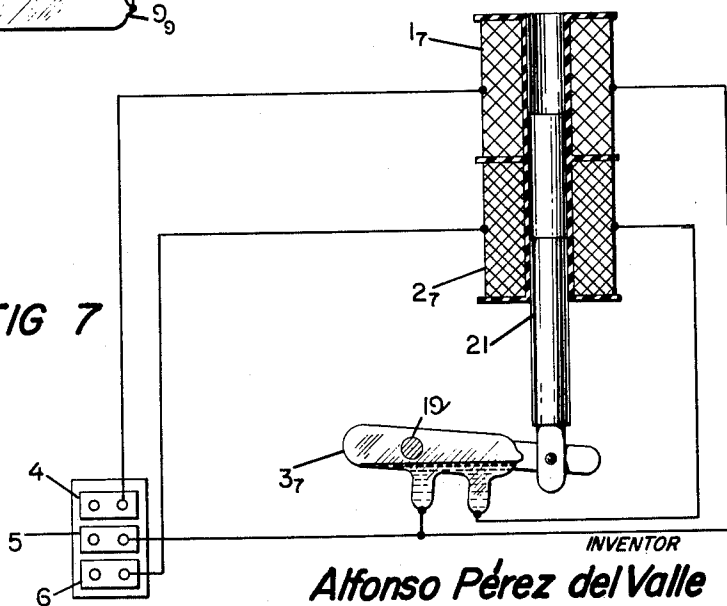


FIG 7



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2

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LOAD FALL-OFF CIRCUIT BREAKER
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1 Claim. (Cl. 200-102)

This invention relates to a circuit breaker which automatically breaks a current supply circuit when the load imposed on the circuit by an apparatus which receives electrical energy by induction, such as a transformer or an electric motor fails accidentally.

Heretofore, in order to prevent the consequences of abnormal current flow, such as in short circuits and surges, electrical installations have used fuses and other overload devices.

The object of the present invention is to provide an automatic circuit breaking device which prevents such things as contact damage, fire caused by sparks, burning of combustible devices, or the danger to unskilled operators in attempting to break the circuit at the precise moment when the load is interrupted or suddenly reduced.

The new device is characterized by an electrical circuit wherein a switch, for instance a mercury switch having a magnetic core, or a metal switch of the usual relay type, or the like, is held in a first position in which it closes the circuit by the action of a first electromagnet which is connected in series with the apparatus being supplied with current, while another electromagnet opposed to said first electromagnet is provided which has a constant attractive force which is sufficiently great to shift the switch and disconnect the supply of current whenever there is a drop in the force exerted by the first electromagnet due to an accidental decrease in the load.

For a better understanding of the invention reference will now be made to the attached drawings in which:

FIG. 1 is a diagram of the electrical circuit of the invention showing the device connected to an electrical apparatus such as a transformer for an illuminated sign, in which the control coils of the circuit breaker are mounted in the vertical position and parallel to each other;

FIG. 2 is a diagram of an embodiment similar to that of FIG. 1 with the control coils for the electromagnets mounted in a vertical position one above the other;

FIGS. 3 and 4 are part diagrammatic and part sectional elevation views of a further embodiment in the positions of making and breaking the circuit, respectively, which embodiment employs a mercury switch provided with the corresponding end armatures and tilting about a pivot point;

FIG. 5 is a part diagrammatic and part sectional view of another embodiment of the device according to the invention with the coils in a horizontal position and employing a mercury switch having an armature between the cores of the coils and mounted for oscillation about a pivot;

FIG. 6 is a part diagrammatic and part sectional view of another embodiment in which the operating coils are combined with a switch having a magnetic core;

FIG. 7 is a part diagrammatic and part sectional view of an embodiment in which the tilting switch is controlled by coils mounted in a vertical position one above the other and having a single common movable core; and

FIGS. 8 and 9 are part diagrammatic and part sectional views of a further embodiment, respectively showing the electrical circuit to the load.

In each of the embodiments of FIGS. 1-7 there are provided two control electromagnets, 1 and 2, control magnet 2 being connected in series with the load pro-

ducing apparatus, the magnitude of the magnetic force exerted thereby being function of the load, while the other electromagnet 1 is opposed to electromagnet 2 and energized independently of the load from a source of current, usually the same source as is used to supply the load. The coils of electromagnet 1 are such that the magnetic force exerted thereby has a value lower than that of electromagnet 2 when the load is normal. A magnetically actuated switch means 3 is provided which is ordinarily held in the closed-circuit position by electromagnet 2, when the load is at least normal, but is shifted by the constant force exerted by coil 1 when the magnetic force exerted by electromagnet 2 decreases due to a reduction in the load imposed on the circuit by the said receiving apparatus. The shift disconnects the current supply to the load consuming apparatus. Terminals 4 and 5 are for the power input, and terminal 6 is the output terminal to the load consuming apparatus. A switch 7 controls the power supply. A grounded core transformer 8 couples the load consuming apparatus to the power supply, the load here being represented by a luminous tube 9.

Turning now to the specific embodiments, the embodiments shown in FIGS. 1 and 2 have as the switch means 3 a magnetically actuated single pole switch 3₁, or 3₂, which is normally held closed by the control electromagnet 2₁ or 2₂ and is opened by the constant force electromagnet 1₁, or 1₂. The circuit also incorporates an emergency switch 10, or 10₂ and a neon pilot-lamp 11 or 11₂. The said emergency switch is connected in series with the constant force electromagnet 1, which opens switch 3 of the device when the magnetic force exerted by control electromagnet 2 is reduced. The purpose of the emergency switch 10 is to permit deenergization of the said constant force electromagnet 1. The pivoting part of switch 3 is mounted for movement in a vertical plane so that when no magnetic force is exerted on it, it falls due to gravity and closes the circuit to the power consuming apparatus. The location of the fault that caused the automatic apparatus to break the current supply to the load consuming apparatus can thus be determined, and the emergency switch then opened, whereupon control electromagnet 2 will be energized to hold the switch 3 closed and the emergency switch 10 can again be closed. On the other hand the pilot lamp 11 is connected in the circuit of the new device in such a way that it lights up when the device automatically breaks the circuit and also when the emergency switch 10 is opened to cut the constant force electromagnet 1 off from the power supply, and remains lit until the said emergency switch 10 closes and reestablishes the normal working position of the device.

In the embodiment of FIGS. 3 and 4 there is provided a switch means in the form of a mercury switch 3₃ which is pivotally mounted for rotation around a horizontal axis 12. The mercury Hg in the switch completes the circuit to the load consuming apparatus when the switch is tilted to the position shown in FIG. 4 breaks the circuit. The mercury switch has a bar 13 of magnetic material, the ends of which are immediately above the solenoids 1₃ and 2₃. The solenoid 1₃ is connected to the source of current and exerts a constant force on the bar 13, while the solenoid 2₃ is in the circuit with the load consuming apparatus, and attracts the end of the bar 13 with a force proportional to the load.

When the load falls off or ceases, the force exerted by the solenoid 2₃, will be exceeded by the force exerted by the solenoid 1₃ and the mercury switch 3₃ will be tilted to the position shown in FIG. 4 to break the circuit.

In the embodiment shown in FIG. 5 a mercury switch

3

3₅, which is the same type as that shown in FIGS. 3 and 4, has a transversely extending arm 14 thereon, which arm is of magnetic material, and the arm 14, and consequently the switch 3₅, is pivoted about a horizontal pivot 15. Solenoids 1₅ and 2₅ are horizontally positioned on opposite sides of the arm 14, so that when the load falls off, the force exerted by the solenoid 1₅ on the arm 14 will exceed the force exerted by the solenoid 2₅, and the switch will be pivoted to break the circuit.

In the embodiment shown in FIG. 6, a mercury switch 3₆ is provided which is vertically positioned and has a pool of mercury Hg in the bottom thereof into which projects one contact 16. The other contact 17 projects downwardly to the upper surface of the mercury Hg. A moveable element 18 is positioned in the switch for vertical movement into and out of the pool of mercury Hg. The size of the element 18 is such that when it is in the position shown the level of mercury Hg is raised to reach the contact 17, while when the element 18 is moved upwardly out of the mercury, the level falls below the lower end of contact 17. Solenoids 1₆ and 2₆ surround the switch 3₆, and when the current flow through solenoid 2₆ falls or ceases, the force exerted by solenoid 1₆ will lift the element 18, thus breaking the circuit.

The embodiment of FIG. 7 has a mercury switch 3₇ pivoted about a horizontal pivot 19, and a magnetic member 21 is articulated to the switch 3₇ so that movement of the magnetic member oscillates the switch 3₇ to make and break the circuit through the switch. With the solenoid 2₇ connected in the load carrying circuit, and the solenoid 1₇ connected to the source of current, when the load falls off or ceases, the force exerted by the solenoid 1₇ will exceed that exerted by solenoid 2₇, thus raising the magnetic member 21 and tilting the switch 3₇ to break the circuit.

In the embodiment of FIGS. 8 and 9, Hg in a mercury type switch is held in the position closing the circuit, or shifted from such a position, respectively by a pressure balance or unbalance due to the thermal expansion of a gas. As shown in the figures, control resistance 1 is connected in series with the load consuming apparatus 8₈, and 9₈ and its thermal value varies as a function of the intensity of the current consumed by the said apparatus. This resistance is positioned in a bulb on one end of mercury switch 20. In a bulb 31 on the opposite end of switch 20 is a constant value resistance 28 which is connected directly to the source of current and has a constant thermal value with respect to the load consumed by the apparatus. Mercury Hg is provided in a tube 32 extending between end bulbs 30 and 31. Contacts 33 and 34 extend into the tube 32, and with the mercury in the normal position as seen in FIG. 8, the contacts are connected by the mercury. In the bulbs 20 and 31 is a gas which holds the mercury

4

Hg in the balanced position for closing the circuit when the load is normal, or shifts it to the disconnected position as shown in FIG. 9 when the balance is disturbed because of the expansion of the gas in the bulb 31 is greater than that in bulb 30 because the thermal value of resistance 1 decreases due to an accidental drop or cessation of the load. An adjustable resistance 35 is connected in series with constant value resistance 2₈ for the purpose of adjusting the heating of the gas in bulb 31. This permits balancing of the mercury for different loads and consequent different heating effects of resistance 1₈ in bulb 30.

It should be noted that since electrical resistances 1₈ and 2₈ are the sources of heat which expand the gas operating the switch, they may be placed either inside the end bulbs of the switch proper, as already described, or may surround it externally.

I claim:

A circuit breaker for breaking a current supply to a load consuming apparatus when the load falls suddenly, consisting essentially of a vertically extending solenoid actuated switch having a magnetically actuated vertically movable member therein the movement of which into and out of the mercury causes the opening and closing of the switch, said switch being connected between a source of current and the load consuming apparatus, a first switch actuating solenoid around the lower end of said switch and connected in series with said switch between said source of current and said load consuming apparatus and actuating said movable switch member in the downward and closing direction, and a second switch actuating solenoid around the upper end of said switch and connected only to said source of current and actuating said movable switch member in the upward and switch opening direction, said switch actuating solenoids having a number of turns such that said first switch actuating solenoid moves said movable switch member downwardly against the action of said second switch actuating solenoid when the current drawn by said load consuming apparatus is normal, and said second switch actuating solenoid actuating moves said movable switch member upwardly to the open position when the force exerted by said first switch actuating solenoid falls off when the load falls.

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