

May 7, 1940.

K. W. WILCKENS

2,200,109

CURRENT LIMITER

Filed May 23, 1934

2 Sheets-Sheet 1

Fig. 1.

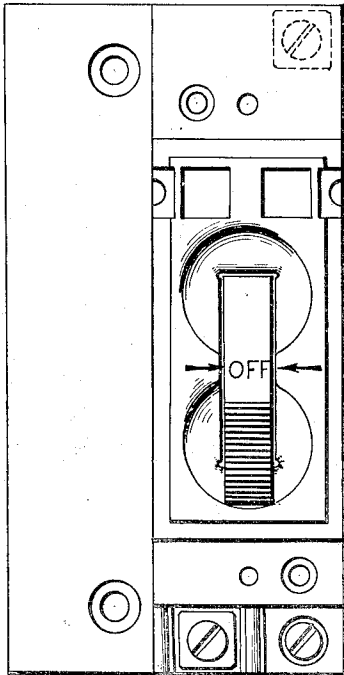


Fig. 2.

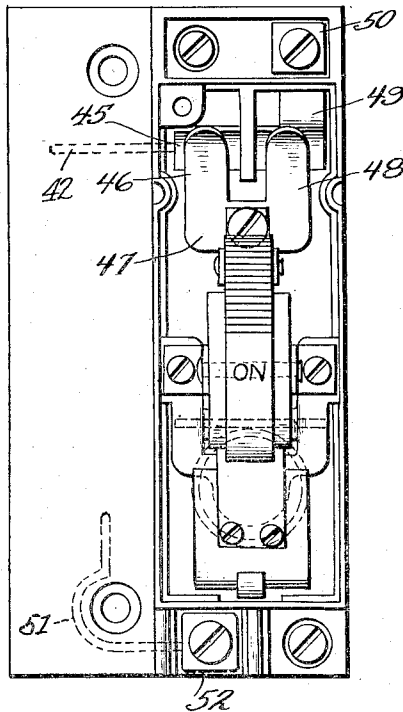
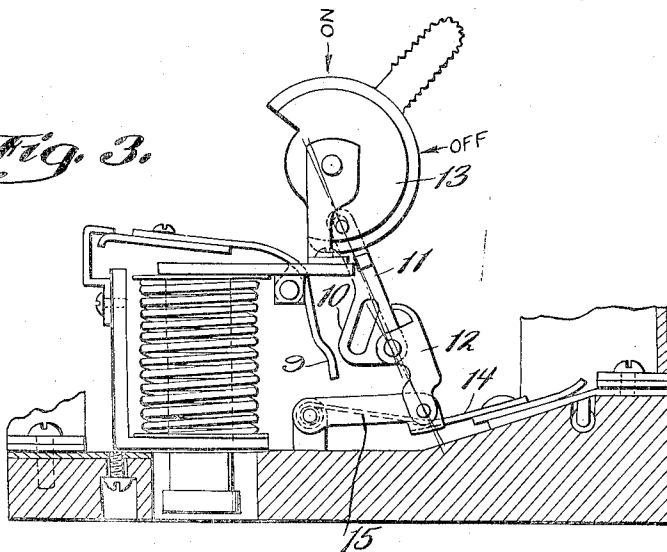


Fig. 3.



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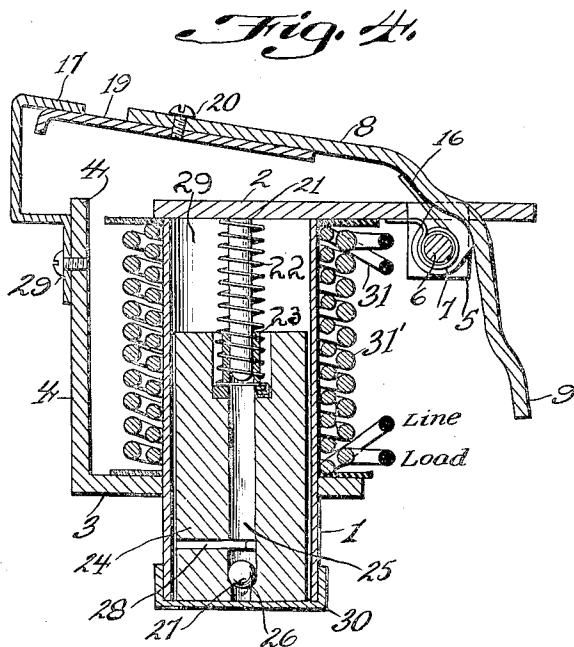
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2 Sheets-Sheet 2



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CURRENT LIMITER

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by mesne assignments, to Heinemann Circuit
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4 Claims. (Cl. 200—109)

My invention is a circuit breaking device which will be equally effective in a number of different positions regardless of the weight of the movable members.

5 My invention further provides a circuit breaker which is simple in construction and certain and accurate in operation, and affords positive protection in the event of short circuits.

10 In the preferred embodiment of my invention a circuit controlling switch is actuated by current as the result of the flow of current through an electromagnet comprising a plurality of turns of conductor.

15 The intensity of the magnetic flux and its attraction for the armature is regulated by the movement in the magnetic field of a bridge member or magnetically permeable core which varies the reluctance of the magnetic circuit of the electromagnet and varies the width of an air gap or gaps in such magnetic circuit. Such 20 bridge member is moved relatively to the magnetic field, by the magnetic attraction thereof, under control of retarding mechanism which preferably consists of a fluid tight fluid container 25 in which the core is housed and is movable axially against the retarding action of fluid which slowly seeps from one portion to another portion of the fluid container upon the movement of the core.

30 The electromagnet utilized in the preferred embodiment of my invention consists of a hollow tube containing a magnetically permeable core movable axially within the tube and normally spring-biased away from the magnetic field and toward one end of the tube. The tube 35 contains a liquid or gas which seeps slowly between the periphery of the core and the inner wall of the tube on movement of the core longitudinally within the tube against the action of the biasing spring. Or the liquid or gas may pass 40 quickly from one end of the tube to the other end thereof through a bore or passage through the core, such passage or bore being controlled by a non-return valve. Consequently, the core is movable quickly in the direction toward which 45 it is biased by the spring and is movable slowly in the opposite direction.

The tube has wound on the periphery thereof, along a portion of its length, a number of turns of electrically conducting wire connected with 50 terminals or electrodes.

It is important that the armature be attracted on the occurrence of an overload, in excess of the rated capacity for which the device is set, only in the event such overload is so excessive or so 55 long continued as to cause damage. If, in in-

stance, the overload is but momentary, it may be harmless if it does not exceed say ten times the rated capacity for which the device is set, but harmful if such an overload is long continued. If the overload exceeds say ten times 5 the rated capacity for which the device is set, it may be harmful no matter how brief its duration.

The core member is normally so positioned in the tube as to leave an air gap in the magnetic 10 circuit within the coil between poles of the electromagnet. The reluctance of the magnetic circuit is so increased by the gap that a momentary flow of current through the electromagnetic coil in excess of the rated capacity for which 15 the device is set, but less than say ten times such rated capacity, creates insufficient magnetic flux to operate the switch-controlling armature until the core is moved into the magnetic circuit so as to bridge or decrease the air gap and decrease 20 the reluctance of the circuit. When the core is so positioned that it decreases or closes the air gap in the magnetic circuit within the coil between the pole pieces of the electromagnet, the magnetic flux or number of lines of magnetic force resulting from the flow of a given current 25 through the electromagnet windings is so increased that the switch operating armature may be actuated upon the flow of current slightly in excess (say, 125%) of the rated capacity for 30 which the device is set.

The windings of the electromagnet are so designed that, with the maximum reluctance of its magnetic circuit, there will be sufficient magnetic flux to attract the armature and operate 35 the switch when the current is so much in excess of the rated capacity for which the device is set as to be dangerous to apparatus in the circuit, say in excess of ten times the rated capacity for which the device is set. 40

Should the intended maximum rate of current consumption be exceeded for any substantial time, even to the extent of only 125%, the circuit is automatically broken. If the intended 45 rate of consumption is exceeded only momentarily, as for instance during the time required for heating lamp filaments or starting a motor, the circuit is not interrupted. If there is an accidental or intentional slight overload of undue duration, the magnetic flux will be increased by 50 the closing of the air gap in the magnetic circuit, the armature will thereupon be attracted and the switch will be operated to open the circuit. If there is a heavy overload, the armature will be immediately attracted and the switch 55

operated to open the circuit regardless of the setting of the device.

The characteristic features and improvements of my invention will further appear from the following description and the accompanying drawings of an illustrative embodiment of my improvements.

In the drawings, Fig. 1 is a front elevation of a current limiter embodying my improvements; Fig. 2 is a front elevation of the same device with the cover removed from the operating parts and the connections of the line and load terminals indicated in dotted lines; Fig. 3 is a fragmentary transverse sectional view taken longitudinally of Fig. 2 and Fig. 4 is an enlarged transverse sectional view through the electromagnet and its armature.

In the embodiment of my invention illustrated in the drawings, a cylindrical brass tube 1 is brazed or soldered to a magnetically permeable metal sheet 2 forming a pole piece. A magnetically permeable metal sheet 3 is secured on the tube 1 between its ends and has a flange 4 extending normally thereto in the direction of the axis of the tube so as to form a pole piece complementary to and in the plane of the pole piece 2.

The pole piece 2 has the ears 5 bent therefrom or secured thereto and providing bearings for a shaft 6 on which is journaled the bearings 7 of a non-magnetic lever 8. The lever 8 is so bent as to form a bell crank having an arm 9 adjacent to the projecting boss 10 of a link 11 which forms with the link 12 a toggle through which the handle 13 operates and positions the switch arm 14 normally biased to open position by a spring 15.

The lever 8 has an armature 19 fixed thereto by a screw 20, the armature being movable toward and from the end of the tube 1. The lever and armature are normally biased away from the pole pieces 2 and 4 by the spring 16 wound on the shaft 6, such movement being limited by the stop 17 fixed to the pole piece 4 and preferably of non-magnetic material.

The pole piece 2 has fixed thereto the non-magnetic guide pin 21 which fits loosely within a hub 23 of the magnetically permeable core 24 and has coiled thereon an expansion spring 22 by which the core is biased away from the pole piece 2.

The core 24 contains an axial bore or passage 25 having in the one end thereof a hemispherical valve seat 26 with which coacts the ball valve 27 whose movement away from its seat is limited by the pin 28. The pin 28 limits the movement of the valve 27 without materially impeding the flow of fluid through the bore when the valve is unseated from the valve seat 26. The core 24 makes a slip fit with the tube, such fit being sufficiently loose to permit the slow seepage of oil or other fluid from one end to the other end of the chamber 29 within the tube when the core 24 is moved axially in the tube. The outer end of the tube is sealed by a cap 30, and the chamber 29 formed by the tube 1, the pole piece 2, and the cap 30 is preferably liquid tight so that the device may be mounted in any desired position when liquid is used as the retarding medium.

The tube 1 has wound thereon a number of turns of insulated wire forming a coil 31, 31'.

A conductor 42 has its end connected with the switch terminal 45 adapted to be contacted by one leg 46, of a bifurcated switch blade 47 fixed to the switch member 14. The other leg 48 of the switch blade is adapted to contact with a ter-

minial 49 connected with the line terminal 50. A conductor 51 is connected with the load terminal 52.

As the current flow increases, the magnetic flux created by the electromagnet causes the core 24 to move toward the pole 2, thereby decreasing the reluctance of the magnetic circuit. The rate of movement of the core 24 may be regulated by the viscosity of the fluid in the chamber 29. When a rapid movement of the core proportionately to the magnetic flux is desired, the fluid in the chamber 29 may be air, a gas or a light liquid. When a slower movement of the core 24 is desired, a more viscous liquid, such as an oil, may be used in the chamber 29. If the potential of the current passing through the winding should be greatly increased, as by a short circuit, the magnetic flux would be sufficiently great to attract the armature 19 and thereby cause the arm 9 to break the toggle and permit the opening of the switch 47. If the overload is insufficient to immediately attract the armature 19, such overload will cause the core 24 to move gradually toward the pole 2 and shorten the air gap in the magnetic circuit, with a resulting increase in the magnetic flux. When the reluctance of the magnetic circuit has been so decreased that the magnetic flux attracts the armature 19, the arm 9 will break the toggle and permit the operation of the switch.

It will, of course, be understood that the core 24 is moved by the spring 22 away from the pole piece 2 as soon as the circuit through the electromagnet is broken by the opening of the switch. The movement of the core 24 by the spring 22 unseats the ball 27 from its seat and permits the substantially unimpeded flow of the retarding fluid in the tube 1 through the passage 25.

In each setting of the device, the magnetic flux created by a heavy overload will be sufficient to attract the armature 19 irrespective of the position of the core 24. As the core 24 moves horizontally in the tube 1 in any of the usual positions of the current limiter, its action is unaffected by the force of gravity.

By my improvements there is provided a switch-controlling mechanism comprising a conducting coil adapted to create a magnetic flux upon the passage of current therethrough. A path for such magnetic flux is provided by a magnetically permeable member extending from one end of the coil externally thereof to a point adjacent to the other end of the coil and adjacent to a plate of magnetic material extending transversely to the axis of the coil so as to form a short air gap across which pass lines of force generated by current flowing through the coil. A pivotally mounted magnetically permeable armature swings toward and from such plate and member and bridges the air gap when it contacts with the plate and member, and the movement of such armature operates a switch-controlling device.

Having described my invention, I claim:

1. In a circuit breaker of the tripping toggle type, an electro-magnetic trip mechanism comprising a tube having an end closure of magnetizable material forming a pole piece, a magnetizable member between the ends of said tube and forming a second pole piece, an electro-magnetic coil wound on said tube between said magnetizable member and said end closure, a magnetizable core magnetically movable into engagement with said end closure and extending therefrom to said magnetizable member, and an armature magneti-

cally movable into magnetically bridging contact with the said pole pieces to operate the tripping toggle.

2. In a circuit breaker of the tripping toggle 5 type, an electro-magnetic trip mechanism comprising a tube having an end closure of magnetizable material forming a pole piece, a magnetizable member between the ends of said tube and forming a second pole piece, an electro-magnetic 10 coil wound on said tube between said magnetizable member and said end closure, a magnetizable core magnetically movable into engagement with said end closure and extending therefrom to said magnetizable member, a spring movable 15 telescopically to said core and biasing said core away from said end closure, and an armature magnetically movable into magnetically bridging contact with said pole pieces.

3. In a circuit breaker of the tripping toggle 20 type, an electro-magnetic trip mechanism comprising a substantially L-shaped magnetizable bracket, a tube supported by one arm of said

bracket and extending along the other arm of said bracket, an electro-magnetic coil wound on said tube, a magnetizable bracket fixed to the free end of said tube, and a substantially L-shaped 5 lever fulcrumed on said second bracket and including a magnetically operable member magnetically bridging the space between said first named bracket and second named bracket to operate said toggle.

4. In a circuit breaker of the tripping toggle 10 type, an electro-magnetic tripping mechanism comprising a substantially L-shaped magnetizable bracket, a tube fixed to one arm and extending along the other arm of said bracket, a substantially L-shaped bracket fixed to the free 15 end of said tube, a toggle-operating handle fulcrumed on one arm of said second bracket and a magnetically operable toggle actuating lever fulcrumed on the other arm of said second bracket. 20

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