May 15, 1928. C. AALBORG 1,669,546

CIRCUIT INTERRUPTER

Filed Feb. 12, 1925 2 Sheets-Sheet 1

Fig. 1.

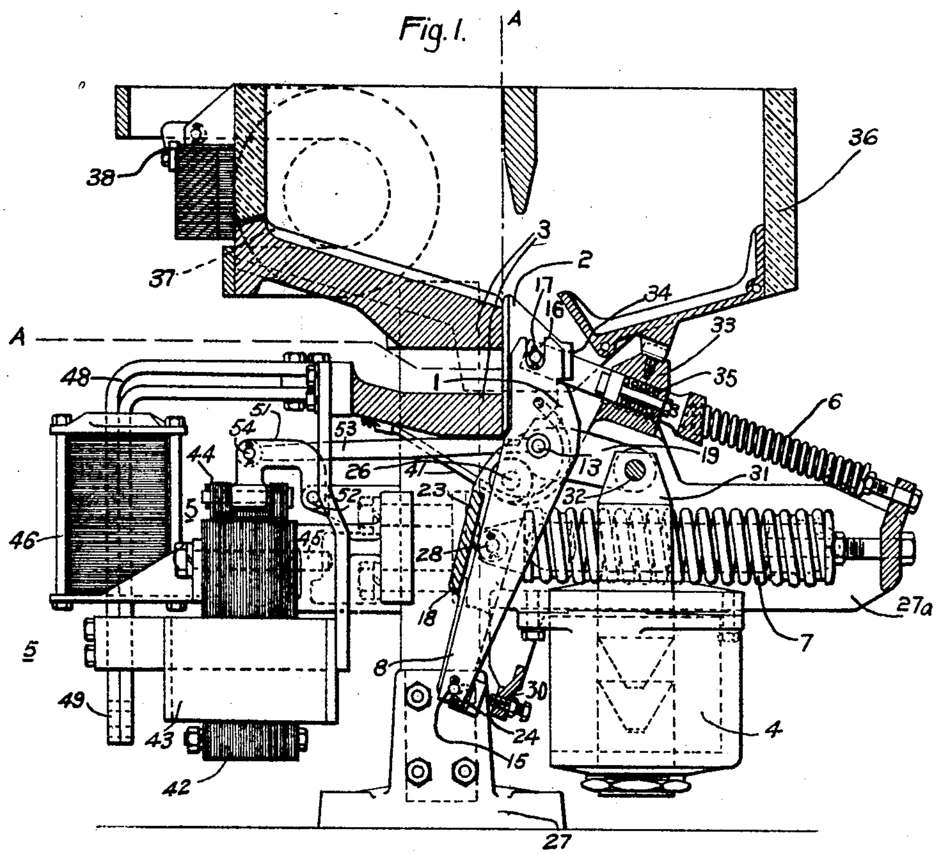

Fig. 2.

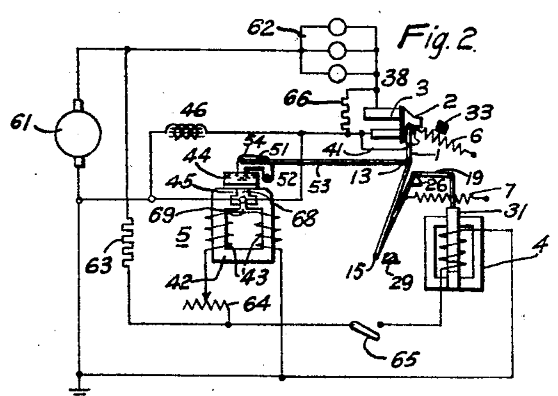

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Fig. 3.

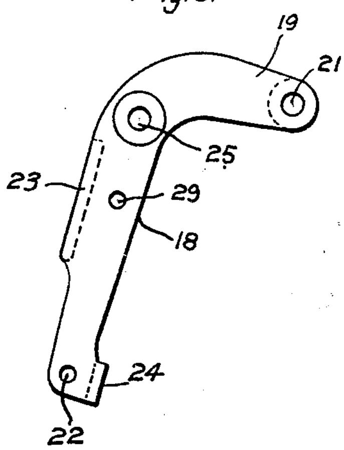


Fig. 4.

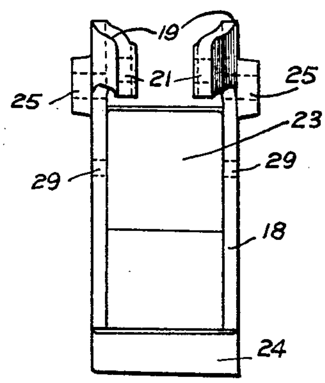


Fig. 5.

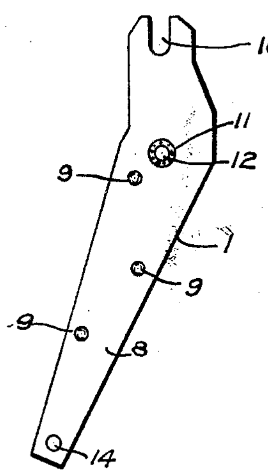
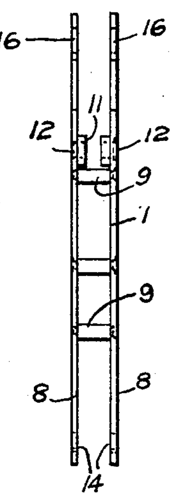


Fig. 6.



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UNITED STATES PATENT OFFICE.

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CIRCUIT INTERRUPTER.

Application filed February 12, 1925. Serial No. 8,739.

My invention relates to circuit interrupters and particularly to high-speed circuit interrupters.

One object of my invention is to provide a circuit interrupter that shall operate in response to the inital surge of excessive current fluctuations.

Another object of my invention is to provide a circuit interrupter that shall operate in an interval of time approximating a magnitude of .020 of a second, or less.

It is a further object of my invention to so design the mechanical and electrical elements of my circuit interrupter as to reduce the inertia of the several moving elements to a minimum consistent with the rigidity required for sustaining the mechanical forces impressed upon them.

In the operation of direct-current electrical circuits, particularly such as are employed for railway work, it is important that such circuits shall be interrupted in advance of the crest of the current surges, such as are set up by short-circuit conditions. By reason of the fact that direct-current arcs do not pass through periods of zero potential and current as do alternating-current arcs, it is very important to interrupt direct current circuits before the surge has caused the current across the open circuit interrupter to reach maximum value in order that the arc may not persist and destroy the contact members of the circuit interrupter. Accordingly, I have designed a circuit interrupter that is capable of interrupting a direct current of several thousand amperes in .020 of a second or less. This exceedingly quick operation insures that the circuit is opened before the current reaches maximum value in case of short-circuit or similar conditions.

In the accompanying drawings,

Figure 1 is a view, partially in elevation and partially in section, of a circuit interrupter embodying my invention.

Fig. 2 is a diagrammatic view of circuits and apparatus embodying my invention.

Figs. 3 and 4 are side and face views, respectively, of a supporting member constituting a detail of my invention, and

Figs. 5 and 6 are side and face views, respectively, of a member constituting a detail of my invention.

In the several figures of the drawings, similar reference numerals indicate corresponding parts.

My invention comprises, in general, a floating contact lever 1 that carries a bridging contact member 2 for co-operation with a pair of stationary contact members 3, together with a closing electromagnet 4, a holding electro-magnet 5, and springs 6 and 7 for co-operating with the electromagnets 4 and 5.

Referring to Figs. 1, 5 and 6, the contact lever 1 comprises a pair of spaced metal strips 8 that are secured to each other by rivets 9. The strips 8 are provided with bosses 11 and openings 12 that together constitute a seat for a shaft 13, while the lower ends of the strips 8 are provided with openings 14 for the reception of a pin 15. The upper ends of the strips 8 are provided with notches 16 that constitute a seat for a supporting shaft 17 of the bridging contact 2.

Referring to Figs. 1, 3 and 4, the contact lever 1 is inserted in a supporting or carrying member 18 that entirely surrounds the lower portion thereof. The upper end of the member 18 is constituted by bifurcated curved ends 19 that extend at substantially right angles to the main body portion thereof and are provided with openings 21 near the extremities thereof. The lower end of the member 18 is provided with alined openings 22 for the reception of the pin 15 that also projects through the openings 14 in the contact lever 1, whereby the pin 15 constitutes the sole fixed connection between the contact lever 1 and the supporting member 18.

The front enclosing wall 23 of the member 18 and the back enclosing wall 24 do not engage the contact lever 1 under any circumstances. The member 18 is provided with alined openings 25 at its elbow to receive pins 26 which serve to pivotally support it in the frame 27.

The spring 6 is operatively connected between the frame 27 and the shaft 17 resting in notches 16 in the contact lever 1, while the spring 7 is connected between the frame 27 and a pin 28 that is inserted in openings 29 in member 18, whereby the spring 7 acts directly upon the carrying member 18 and the spring 6 acts directly upon the contact lever 1. An adjustable stop member 30 is mounted on the frame 27 for engagement with the back wall 24 of the member 18, whereby the degree of rearward movement of the latter may be regulated.

The closing electromagnet 4 comprises an armature member 31 that is secured to the arm 19 of the member 18, by a pin 32, seated in the openings 21, whereby the vertical movement of the armature 31 is translated into a turning movement of the member 18. The frame 27 is provided with an enlarged portion 33 that constitutes a stop for the rear face 34 of the bridging contact member 2. A shock-absorbing spring and plunger 35 may be inserted in the stop member 33, if desired.

An arc chute 36 is secured to the frame 27 above the bridging contact member 2 and the stationary contact members 3. The arc chute 36 is provided with any conventional form of blowout coil 37 that is connected to a line terminal 38. A jumper 41 is attached to the lower stationary contact member 3 and the bridging contact member 2 for a purpose to be hereinafter described.

The holding electromagnet 5 comprises a core member 42 that is energized by coils 43 and an armature member 44 that normally bridges an air gap in the core member 42. A straight conductor 45, that is in parallel circuit with, but whose flux opposes that of, the coils 43 passes through the air gap of the core member 42 at substantially right angles to the plane of the core member 42 and in close proximity to the armature member 44. Under normal operating conditions, the magnetic field induced by the current traversing the conductor 45 is not sufficient to prevent the flux induced by the coils 43 from holding the armature 44 in place.

A reactor 46 is connected in parallel circuit with the coils 43 and the conductor 45 externally of the holding electromagnet 5. The reactor 46 comprises a plurality of laminations of magnetizable metal that surround a conductor 48, the end 49 of which constitutes the second line terminal. The armature member 44 is supported by a rectangular lever 51 that is pivotally mounted at 52. A lever 53, which is pivotally connected at 54 to the lever 51, connects the latter to the shaft 13 on the armature member 1.

Referring to Fig. 1, a dash line A—A is shown that passes between the stationary contact members 3 and the bridging contact member 2 when the latter is in its open position. All the apparatus below and to the right of this line is of one polarity while all the apparatus above and to the left of the line is of opposite polarity, whereby the need for extensive insulation between electrical parts is done away with.

By reason of the jumper 41, the bridging member 2 is maintained at the same polarity and voltage as the lower stationary contact member 3, whereby danger of arc ignition between the upper and lower stationary contact members 3, or between the lower stationary contact member 3 and the bridging contact member 2, is eliminated, thereby insuring that all arcs that may be formed shall be between the upper stationary contact member 3 and the bridging contact member 2.

Referring to Fig. 2, the circuit interrupter is shown connected between a generator 61 and a load 62. The holding coil 5 is connected across the terminals of the generator 61 through a fixed resistor 63 and a variable resistor 64. The parallel-connected straight conductor 45 and the reactor 46 are connected in series with the contact members 2 and 3 and the load 62.

The closing coil 4 is connected in parallel circuit with the holding coil 5 and in series connection with a manually-operated switch 65 for initiating the closing operation of the circuit interrupter. If desired, a current-limiting resistor 66 may be connected in shunt circuit to the contact members 2 and 3, in which case, the circuit interrupter operates merely to interrupt that portion of the current traversing the generator 61 that is in excess of the current for which the resistor 66 is designed.

It will be noted that the ends of the core member 42 are recessed to provide space for the conductor 45 between two parallel air gaps 68 and 69. The air gap 68 is bridged by the armature member 44. The air gap 69 is relatively short and, accordingly, there is a comparatively small change in the total flux traversing the core member 42 by reason of changes in the value of the current traversing the conductor 45.

The advantage of the foregoing construction is that, when the magnetic field of the conductor 45 is relatively strong to oppose the magnetic field of the core member 42, which holds the armature member 44 in position, the magnetic circuit through the air gap 69 is of relatively low reluctance and the change in total flux in the core member 42 is so small that there is no resulting "inductive kick" of such magnitude as to hold the armature 44 in closed position.

The parts shown diagrammatically in Fig. 2 have been much simplified to aid in describing the operation of the circuit interrupter, although their reference numerals correspond to the working parts shown in Fig. 1.

With the circuit interrupter in the closed position shown in Figs. 1 and 2, the armature 44 opposes the contractile force of the spring 6, and the bridging member 2 is held in contact with the stationary contact members 3. Upon the occurrence of an excessive current surge in the working circuit, the reactor 46 causes an increased portion of the current to traverse the straight conductor 45, with the result that the strength of its magnetic field increases correspondingly to oppose that of the core member 42 upon the armature member 44. The armature 44 is thereupon released to permit the lever 51 to turn about its pivot point 52 under the force exerted by the spring 6 and, at the same time, the bridging contact member 2 is drawn away from the stationary contact members 3. During this movement, the contact lever 1 turns in a clockwise direction about the pin 15 until the rear face 34 engages the plunger 35.

When the circuit interrupter is in its open position, and it is desired to close it, the operator closes the switch 65 to energize the closing electromagnet 4 and thereby cause it to draw its armature member 31 downwardly, with the result that the supporting member 18 is turned in a clockwise direction, carrying the lower end of the contact lever 1 with it. During the latter movement, the rear face 34 of the contact member 2 engages the stop member 33 and the contact lever 1 fulcrums about the latter, by reason of the bias of the spring 6. During this movement, the lever 53 is moved to the left of (the drawing), thereby causing the lever 51 to turn in a counter-clockwise direction, and to move the armature 44 into engagement with the core member 42, where it is held. Simultaneously, the spring 7 is extended and placed under considerable tension.

The operator then opens the switch 65 to de-energize the closing electromagnet 4. The spring 7 then contracts to cause the supporting member 18 and the contact lever 1 to be turned in a counter-clockwise direction about the shaft 13 until the back wall 24 of the supporting member 18 nearly engages the stop member 29. During this movement, the relative vertical positions of the pin 15 and shaft 13 change, with the result that the armature member 1 is turned until the bridging contact member 2 engages the stationary contact members 3. During the latter movement, the spring 6 is again placed under tension. The foregoing cycle of operations may be repeated whenever circuit conditions so require.

I have devised a circuit interrupter that is especially adapted for interrupting circuits at relatively high speeds and in which the mass of material in the moving elements has been materially reduced, thereby eliminating the time lag heretofore necessary in imparting a high velocity to the moving contact members, etc. I have also materially simplified the construction of such circuit interrupters by eliminating the insulating material between the several operating elements thereof and operating the circuit interrupter with such elements all of the same potential, whereby the only insulation that is necessary is the dielectric medium between the stationary and the movable contact members when the circuit interrupter is in open position and the insulation between the current carrying parts and the frame.

Various modifications and changes may be made without departing from the spirit and scope of the invention, as defined in the accompanying claims.

I claim as my invention:

1. In a switch structure, a floating member, a contact member controlled by said floating member, a holding electromagnet, a closing electromagnet, and a resilient member for actuating said floating member to move the contact member into closed position biasing a second resilient member at the same time, both resilient members acting together to actuate the floating member and contact member into open position.

2. In a switch structure, a floating member, a contact member controlled by said floating member, a holding electromagnet, a closing electromagnet for imparting a turning movement to said floating member whereby the holding electromagnet becomes effective, a member stressed during the first turning movement for imparting a second turning movement to said member for moving the contact member into circuit-closing position, and a second member stressed during the last turning movement for effecting a circuit-interrupting movement of the first-mentioned member when the force of the holding electromagnet reaches a predetermined minimum.

3. In a switch structure, a floating contact lever, a contact member carried thereby adjacent to one end thereof, a holding electromagnet, a closing electromagnet for imparting a turning movement to the contact lever whereby the holding electromagnet becomes effective, the rear face of the contact member serving as a fulcrum during the turning movement, a member stressed during the first turning movement for imparting a second turning movement to the contact lever for moving the contact member into its circuit-closing position, and a member stressed during the last turning movement for effecting a circuit-interrupting movement of the contact lever when the force of the holding electromagnet is below a predetermined value.

4. In a switch structure, a frame, a supporting member pivotally mounted thereon, a resilient member connecting the frame and supporting member, a contact member pivotally mounted on the supporting member, and a second resilient member connecting the frame and contact member.

5. In a switch structure, a frame, a supporting member pivotally mounted thereon, a resilient member connecting the frame

and supporting member, means for actuating the supporting member against the force of the resilient member, a contact member pivotally mounted on the supporting member, holding means therefor and a second resilient member operatively connecting the frame and the contact member, whereby, upon the actuating means becoming ineffective, the first resilient member turns the supporting member and contact member against the force of the second resilient member.

6. In a switch structure, a frame, a stationary contact member, a supporting member pivotally mounted thereon, a resilient member connecting the frame and supporting member, means for actuating the supporting member against the force of the resilient member, a contact lever pivotally mounted on the supporting member, a contact member carried thereby, holding means for the contact lever, and a second resilient member connecting the frame and the contact lever, whereby, upon the actuating means becoming ineffective, the first resilient member turns the supporting member and contact lever against the force of the second resilient member to cause the engagement of the contact members.

7. In a switch structure, a frame, a stationary contact member, a supporting member pivotally mounted thereon, a resilient member connecting the frame and supporting member, means for actuating the supporting member against the force of the resilient member, a contact lever pivotally mounted on the supporting member, a contact member carried thereby, holding means for the contact lever, and a second resilient member connecting the frame and the contact lever whereby, upon the actuating means becoming ineffective, the first resilient member turns the supporting member and contact lever against the force of the second resilient member to cause the engagement of the contact members, the second resilient member returning the contact lever to its initial position upon the holding means becoming ineffective.

8. In a switch structure, a frame, a supporting member pivotally mounted thereon, a resilient member connecting the frame and supporting member, means for actuating the supporting member against the force of the resilient member, a contact lever pivotally mounted on the supporting member, holding means therefor, and a second resilient member connecting the frame and the contact lever, whereby, upon the actuating means becoming ineffective, the first resilient member turns the supporting member and contact lever about the holding means against the force of the second resilient member.

9. In a switch structure, a frame, a supporting member pivotally mounted thereon, a resilient member connecting the frame and supporting member, means for actuating the supporting member against the force of the resilient member, a contact lever pivotally mounted on the supporting member, holding means therefor, and a second resilient member connecting the frame and the contact lever, whereby, upon the actuating means becoming ineffective, the first resilient member turns the supporting member and contact lever about the holding means against the force of the second resilient member, the second resilient member returning the contact lever to its initial position upon the holding means becoming ineffective.

10. In a circuit interrupter, an electromagnet having a pair of air gaps in parallel relation, an energizing coil therefor, and a straight conductor extending adjacent to one of the air gaps whereby, under predetermined conditions the reluctance of that air gap is changed without altering the reluctance of the other air gap.

11. In a circuit interrupter, an electromagnet having a pair of air gaps in parallel relation, an energizing coil therefor, and a straight conductor in circuit with the energizing coil extending adjacent to one of the air gaps, whereby under predetermined conditions the reluctance of that air gap is changed without altering the reluctance of the other air gaps.

12. In a circuit interrupter, a frame, a stationary contact member, a movable contact member and means for actuating the movable contact member comprising a resilient member for imparting the final closing movement to the movable contact member and for biasing it into firm engagement with the stationary contact member after closure and a second resilient member for biasing the movable contact member into open position.

13. In a circuit interrupter, a frame, a stationary contact member, a movable contact member and means for actuating the movable contact member comprising a resilient member for imparting the final closing movement to the movable contact member and for biasing it into firm engagement with the stationary contact member after closure and a second resilient member for biasing the movable contact member into open position and means for separately adjusting the resilient members.

14. In a switch structure a pair of separable contacts, one of said contacts being mounted upon a floating member having two cooperating biasing members, a holding magnet having an armature hingedly supported by the floating member between the biasing members, the relative positions of said biasing members being such that one biasing member operates the floating mem-

ber against the biasing action of the other biasing member to close said contacts and that both biasing members unite their action to operate the floating member to open the said contacts upon the release of the holding magnet.

15. In a switch structure, a floating member, a contact member controlled by said floating member, a holding electro-magnet controlling a hinge which supports the floating member, and a pair of co-directional biasing members for the floating member, one above and one below said hinge.

16. The combination with a floating member in a circuit interrupter, of a pair of biasing members having a differential action about a fulcrum to bias the floating member in one angular direction, when said fulcrum is held unmovable, and means to release said fulcrum, said biasing members being so positioned that they cooperate to move the floating member in another angular direction when the fulcrum is released.

In testimony whereof, I have hereunto subscribed my name this 9th day of February 1925.

CHRISTIAN AALBORG.