Nov. 22, 1949 J. A. FAVRE 2,489,085

TRIP FREE ELECTRIC CIRCUIT BREAKER

Filed March 10, 1945

Fig. 1.

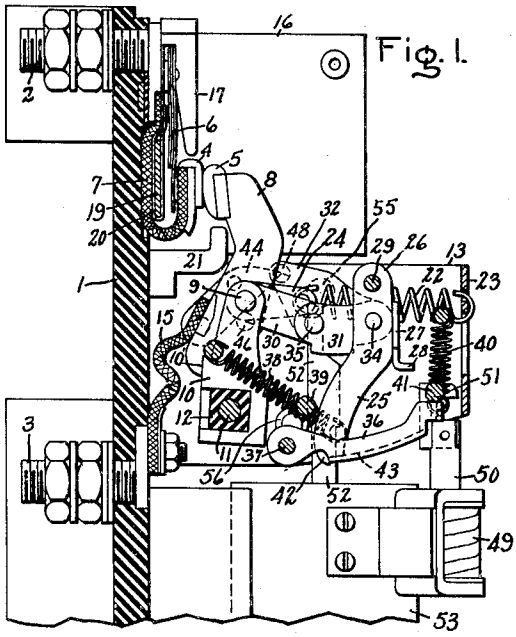


Fig. 2.

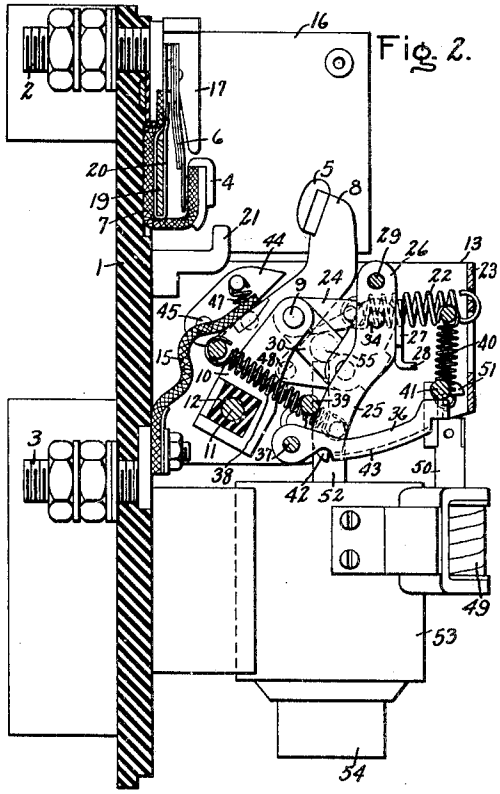


Fig. 3.

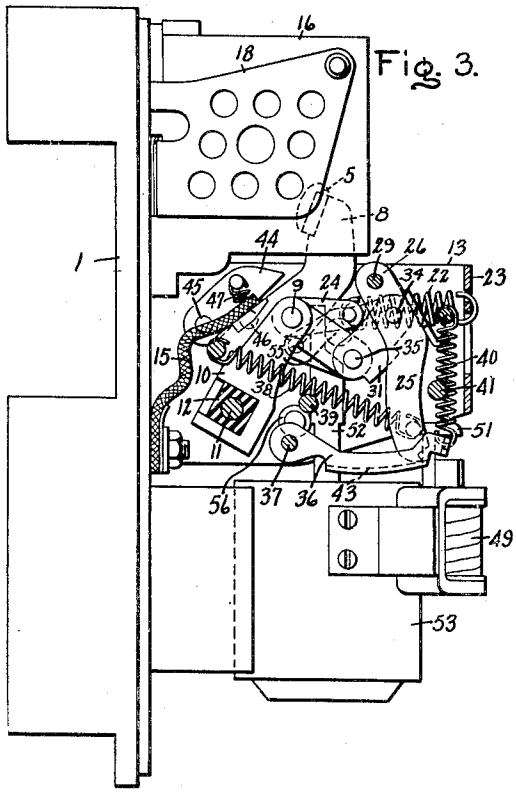
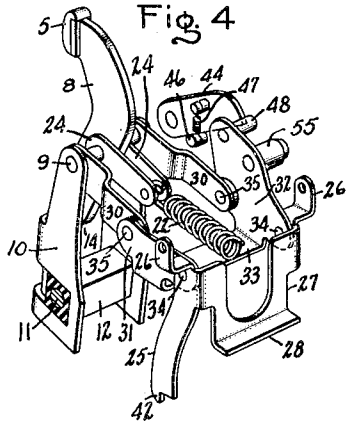


Fig. 4



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# UNITED STATES PATENT OFFICE

2,489,085

## TRIP-FREE ELECTRIC CIRCUIT BREAKER

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Application March 10, 1945, Serial No. 582,053

8 Claims. (Cl. 200—89)

1

My invention relates to improvements in electric switches and more particularly to improvements in trip-free circuit breakers and especially trip-free circuit breakers for controlling relatively high frequency alternating current systems on aircraft.

An object of my invention is to provide a lightweight and compact circuit breaker which is suitable for controlling relatively high frequency alternating current systems. Another object of my invention is to provide a circuit breaker operating mechanism which requires relatively few and simple operating parts and yet can be automatically tripped and subsequently reset during the circuit opening operation of the circuit breaker and reclosed by a solenoid under remote control. Still another object of my invention is to provide a sensitive trip-free circuit breaker operating mechanism embodying a toggle which is underset whether the circuit breaker is open or closed. A further object of my invention is to provide for a circuit breaker a trip-free closing mechanism which does not interfere with the automatic resetting feature when the circuit breaker is closed on a faulty circuit. These and other objects of my invention will appear in more detail hereinafter.

My invention will be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a side elevation, partly in section, of an embodiment of my invention in a trip-free circuit breaker shown in the closed circuit position; Fig. 2 is a view similar to Fig. 1 showing the circuit breaker in the open circuit position with the trip latch reset; Fig. 3 is a view similar to Figs. 1 and 2 showing the circuit breaker tripped immediately after closing on a faulty circuit; and Fig. 4 is a perspective view of the operating mechanism of the circuit breaker shown in Figs. 1, 2 and 3.

In the accompanying drawing, I have illustrated an embodiment of my invention in a single-pole, trip-free air circuit breaker which, as shown, is mounted on a base 1 of suitable insulating material through which project upper and lower studs 2 and 3 for the necessary main circuit connections. The circuit breaker comprises two cooperating contacts 4 and 5. The contact 4 is a relatively stationary contact which, as shown, is suspended by a leaf spring mounting 6 and is connected to the stud 2 by a flexible lead 7. The contact 5 is a movable contact which,

2

as shown, is rigidly mounted on a rigid current conducting arm 8. This arm is supported on a pin 9 mounted in a channel shaped carrier 10 which is mounted on a shaft 11. This mounting comprises an insulating member 12 so shaped as to prevent turning of the carrier relatively to the shaft. The shaft 11 is rotatably positioned in the sides of a U-shaped frame member 13 which supports the circuit breaker operating mechanism. Relative movement of the arm 8 and the carrier 10 is prevented by providing the lower end of the arm with a notch 10' into which the web 14 of the carrier snugly fits. The conducting arm 8 is connected to the lower stud 3 by a flexible lead 15. It will be apparent to those skilled in the art that for a multi-pole breaker the shaft 11 may be extended to receive the number of carriers necessary to make up the desired number of poles.

In order to insure satisfactory arc interruption, especially at high altitudes, I provide an arc extinguishing chute that is more fully described and claimed in the application filed by Robert M. Bennett July 21, 1945, Serial Number 606,374, now Patent Number 2,460,118, January 25, 1949, and assigned to the present assignee. As shown, this comprises side walls 16 which may be of suitable inorganic insulating material, such as disclosed, for example, in United States Letters Patent 2,270,723, issued January 20, 1942. The arc chute also includes an end shield 17 of suitable insulating material for protecting the leaf spring mounting 6. For better blowout effect, I also provide an outer magnetic member having two side walls 18 and a cross connecting web 19 around which the flexible lead 7 extends to provide the desired magnetic action. The web 19 is insulated from the lead 7 by a layer 20 of suitable insulating material. To prevent any possibility of the arc striking back toward the mechanism, the arc chute includes the barrier portion 21 just below the contacts 4 and 5. In order to save weight, the sides of the magnetic member 18 are perforated, as shown.

For controlling the movement of the contact 5, I provide an operating mechanism which includes means for biasing the contact 5 to the open circuit position. As shown, this means comprises a spring 22 which is connected between the end wall 23 of the frame 13 and two links 24 mounted on the pivot 9 on opposite sides of the arm 8, as shown more clearly in Fig. 4. For holding the arm 8 in the closed circuit position, I provide a lever 25 which is pivotally supported in the sides of the frame 13. As shown more

clearly in Fig. 4, the upper end of the lever 25 comprises two spaced parallel ears 26 which are interconnected by a web 27 provided with a stiffening flange 28. The ears 26 are pivoted to the sides of the frame 13 at 29. For operating and holding purposes, I provide a toggle interconnecting the arm 8 and the lever 25. This toggle comprises a first link which, as shown, actually consists of two substantially parallel spaced links 30 which are connected to the arm 8 on opposite sides thereof by the pin 9. The second link of the toggle is pivotally connected to the lever 25 at an intermediate point 34 thereof. Thus, as shown, this second link comprises two parallel arms 31 and 32 extending from a transverse web 33 and pivotally connected at 34 to the parallel portions of the lever 25. The link elements 30 of the first link are pivotally joined at 35 to the two parallel arms 31 and 32 of the second link to form the toggle joint. As shown in Fig. 1, the toggle formed by the links 30 and 31 interconnects the intermediate point 9 of the pivoted switch arm 8 with the intermediate point 34 of the oppositely spaced pivoted latching lever 25. Thus the toggle can swing laterally as a unit in the circuit opening direction since in accordance with the present invention the intermediate point 34 of the pivoted latching lever 25 is movable in a limited arc extending in spaced-apart substantial alignment with the initial part of the arc of movement of the intermediate point 9 of the pivoted switch arm 8 that is predominately biased in the circuit opening direction by spring 22.

For holding the lever 25 against movement in the direction of the biased arcuate movement of the switch arm 8, counterclockwise as viewed in Figs. 1 and 2, I provide suitable means such as a trip latch 36 which is pivoted at 37 in one side of the frame 13. For moving the lever 25 and the trip latch 36 into holding engagement, I provide suitable biasing means such as a spring 38 which tends to turn the lever 25 clockwise against a stop 39 and a spring 40 which tends to turn the trip latch 36 counterclockwise against a stop 41. The lever 25 has a notched tail portion 42, which in the latched position shown in Figs. 1 and 2 drops back of a flange or arcuate shelf 43 on the trip latch 36.

For holding the toggle in condition for sensitive release, I provide means for retaining the arm 8 in the closed circuit position while the trip latch 36 is in the holding position. As shown, this means comprises a prop 44 which is engageable with one of the toggle links near the end of the circuit closing movement of the arm 8 to hold the toggle in an underset position. As shown, the prop 44 is pivoted inside of the frame 13 at 45 and is biased to the holding position against a stop 46 by suitable means such as a spring 47. For holding the toggle in the underset position, the arm 32 of the second toggle link is provided with an intermediate projecting portion or pin 48 which is so shaped that during clockwise rotation of the arm 32 it engages the point of the prop 44 and turns the prop counterclockwise slightly against the bias of the spring 47 until the point of the prop falls under the flattened lower side of the pin 48 whereby to prevent counterclockwise rotation of the second link as long as the trip latch 36 is in latching engagement with the lever 25. In the actual closing operation of the circuit breaker, the pin 48 overtravels slightly and does not engage the prop 44 until sufficient contact pressure has been developed and the closing force removed.

For effecting the release of the trip latch 36 so as to cause the opening of the circuit breaker, I provide suitable electro-magnetic means such as a trip coil 49 which is arranged, when energized sufficiently to attract its armature 50, to turn the trip latch 36 clockwise into the releasing position against the bias of the spring 40. For this purpose, a transverse arm on the trip latch 36 is arranged to be engaged by suitable means such as a hook-shaped member 51 attached to the armature 50. As will be apparent to those skilled in the art, the trip coil 49 may be energized in response to the operation of a relay which functions in dependence on some abnormal condition of the circuit controlled by the circuit breaker or the trip coil may be directly energized by the circuit current, for example, or the trip coil may be of the so-called shunt trip type for remote control.

For effecting the circuit closing operation of the circuit breaker while the trip latch 36 is in the holding position, I provide suitable means which is shown as comprising a reciprocable member 52 mounted for movement in one direction, upwardly as viewed in Figs. 1 and 2, to effect the engagement of the pin 48 on the toggle link arm 32 with the prop 44. For effecting this upward or closing movement of the member 52, I provide, as shown, suitable electromagnetic means comprising a solenoid 53 whose armature 54 is suitably connected to the member 52 to effect the upward movement thereof when the solenoid 53 is sufficiently energized. For actuating the toggle during this upward movement of the member 52, the toggle link arm 32 is provided with a projection shown in the form of a roller 55 positioned in the path of movement of the upper end of the member 52. In order to prevent the reciprocable member 52 from maintaining the circuit breaker in the circuit closed position in the event that it is closed, for example, on a faulty circuit and energization of the closing solenoid 53 is maintained, the width and shape of the upper end of the member 52 are such that the roller 55 cannot be maintained in the holding position by the member 52 if the latch 36 is actuated to the tripping position. In other words, the roller 55 is free to roll off the top surface and down the front edge of the upper end of the reciprocable member 52 so that the parts assume the position shown in Fig. 3 if the trip latch 36 is released while the solenoid 53 is energized when the circuit breaker is in the closed position. In order to take care of lateral thrust on the member 52, I provide suitable means such as a guide roller 56.

Assuming the circuit breaker closed, that is, with the parts positioned as shown in Fig. 1, and that the trip coil 49 is sufficiently energized to attract its armature 50, then the trip latch 36 will be rotated clockwise sufficiently to disengage or release the tail 42 of the lever 25 thereby effecting counterclockwise rotation of the intermediate point 9 of the switch arm 8 about the pivot point 11 so as to swing the toggle laterally and thereby move the intermediate point 34 in a limited arc extending in spaced-apart substantial alignment with the initial part of the arc of movement of the intermediate point 9 of the biased switch arm 8. Inasmuch as the toggle comprising the links 30, 31 and the respectively parallel links 30, 32 is underset, the spring 22 which biases the arm 8 to the circuit open position will effect a quick opening of the circuit breaker, since the lever 25 is rotated counterclockwise thereby carrying pin 34 to the right so

that the toggle links are free to move laterally to the right thus permitting the pin 48 to ride off the prop 44. Near the end of the opening movement of the arm 8 the trip coil 49 is deenergized either by the opening of the circuit at the contacts 4, 5 in the case of a series trip coil or by suitable auxiliary switching means in the case of a shunt trip coil as is well known to the art. Consequently the plunger 50 is free to drop out and lever 25 and the trip latch 36 will then reset by reason of the respective biases from the springs 38 and 40 associated with these members. Thus, at the end of the circuit opening movement, the parts are positioned as shown in Fig. 2.

When it is desired to close the circuit breaker, the closing solenoid 53 is energized and the reciprocable member 52 rises into engagement with the roller 55 to turn the toggle arm 32 clockwise thereby setting the point of the prop 44 under the projection 46 on the arm 32. The prop then maintains the toggle in the underset position shown in Fig. 1 with the parts positioned as shown in this figure until such time as the trip latch 36 is again released. If, during the closing movement, the trip latch is released by energization of the trip coil 49 while the reciprocable member 52 is in the upper position for closing the breaker, the toggle will collapse due to the lateral movement to the right of the pin 34 from the underset position shown in Fig. 1 to the position shown in Fig. 3 with the roller 55 moving to the right and down the front edge of the reciprocable member 52 so that the circuit breaker is not prevented from opening freely. When the circuit breaker opens in this manner, the latching mechanism cannot be set until the narrow upper end of the reciprocable member 52 moves down away from the roller 55. Consequently the lever 25 is maintained in the forward position shown in Fig. 3. In order to assure that the lever 25 and the trip latch 36 will reset when the reciprocable member 52 drops, the trip latch shelf 43 is continued through the arc of the trip latch so that, as soon as the reciprocable member 52 drops, the biasing springs 38 and 40 will immediately return the lever 25 and the trip latch 36 to the latched position shown in Fig. 2.

While I have shown and described my invention in considerable detail, I do not desire to be limited to the exact arrangement shown, but seek to cover in the appended claims all those modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is,

1. A circuit breaker having in combination two cooperating contacts, a pivoted arm supporting one of said contacts for arcuate movement into and out of engagement with the other of said contacts, resilient biasing said arm for arcuate movement in the circuit opening direction, a pivoted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with the initial part of the arc of movement of an intermediate point of said biased arm, a trip latch biased to engage the free end of said lever to prevent arcuate movement thereof in the direction of the biased movement of said arm, means normally biasing said lever for opposite arcuate movement into holding engagement with said latch, means including a toggle having a first link pivotally connected to said intermediate point of said arm and a second link pivotally connected to said intermediate point of said lever for moving said arm to the closed circuit position and stressing said resilient biasing means to predominately oppose the normal bias of said lever when said toggle is in an underset position, and a movable prop biased to a position for holding the knee of the toggle in said underset position to retain said arm in the closed circuit position, and means for moving said trip latch against its bias to release said lever for joint arcuate movement in the direction of the biased movement of said arm sufficiently to release the knee of said toggle from said prop and thereby collapse said toggle to complete the biased arcuate movement of said arm and permit said lever to reengage said latch in accordance with its normal bias.

2. A circuit breaker having in combination two cooperating contacts, a pivoted arm supporting one of said contacts for arcuate movement into and out of engagement with the other of said contacts, resilient means biasing said arm for arcuate movement in the circuit opening direction, a pivoted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with the initial part of the arc of movement of an intermediate point of said biased arm, a trip latch biased to engage the free end of said lever to prevent arcuate movement thereof in the direction of the biased movement of said arm, means normally biasing said lever for opposite arcuate movement into holding engagement with said latch, a toggle having a first link pivotally connected to said intermediate point of said arm and a second link pivotally connected to said intermediate point of said lever, a toggle operating device having a member reciprocable in one direction for engaging the knee of the toggle to extend the toggle to an underset position and thereby move said arm to the closed circuit position and stress said resilient biasing means to predominately oppose the normal bias of said lever, a movable prop biased to a position for independently holding the knee of the toggle in said underset position to retain said arm in the closed circuit position, and abnormal current responsive means for moving said trip latch against its bias to release said lever for joint arcuate movement in the direction of the biased movement of said arm sufficiently to release said toggle from said prop and said member and thereby collapse said toggle to complete the biased arcuate movement of said arm and permit said lever to reengage said latch in accordance with its normal bias after reciprocation of said member in the opposite direction.

3. A trip-free circuit breaker having in combination two cooperating contacts, a pivotally mounted arm supporting one of said contacts for limited arcuate movement into and out of engagement with the other of said contacts, means predominately biasing said arm for arcuate movement in the circuit opening direction, a pivotally mounted lever having an intermediate point adjacent the pivot axis thereof movable in a limited arc extending in substantial alignment with the initial part of the arc of movement of an intermediate point of said biased arm, a trip latch biased to engage the free end of said lever to prevent arcuate movement thereof in the direction of the biased movement of said arm, means normally biasing said lever into holding engagement with said latch, a toggle comprising a first link pivotally connected to said intermediate point of said arm and a second link pivotally connected to said inter-

mediate point of said lever, a catch and a roller carried by one of said links, a movable prop biased to engage with said catch for holding said toggle in an underset position, means for moving said toggle to said underset position to engage said contacts including a reciprocating member engageable with said roller, and abnormal current responsive means for moving said trip latch against its bias to release said lever for joint arcuate movement in the direction of the predominating biased movement of said arm sufficiently to release the catch from the prop and the roller from the member and thereby collapse said toggle to complete the biased arcuate movement of said arm.

4. A trip-free circuit breaker having in combination two cooperating contacts, a pivoted arm supporting one of said contacts for arcuate movement into and out of engagement with the other of said contacts, resilient means biasing said arm for arcuate movement in the circuit opening direction, a pivoted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with a part of the arc of movement of an intermediate point of said biased arm, a trip latch biased to engage the free end of said lever to prevent arcuate movement thereof in the direction of the biased movement of said arm, means normally biasing said lever for opposite arcuate movement into holding engagement with said latch, a toggle having a first link pivotally connected to said intermediate point of said arm and a second link pivotally connected to said intermediate point of said lever, an operating device having a reciprocating member engaging the knee of the toggle to extend the toggle to an underset position and thereby move said arm to the closed circuit position and stress said resilient biasing means to predominately oppose the normal bias of said lever, and automatic means for moving said trip latch against its bias to release said lever for joint arcuate movement in the direction of the biased movement of said arm sufficiently to release the knee of said toggle from said reciprocating member and thereby collapse said toggle to complete the biased arcuate movement of said arm and permit said lever to reengage said latch in accordance with its normal bias.

5. A circuit breaker having in combination two cooperating contacts, a pivoted arm supporting one of said contacts for arcuate movement into and out of engagement with the other of said contacts, resilient means biasing said arm for arcuate movement in the circuit opening direction, a pivoted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with a part of the arc of movement of an intermediate point of said biased arm, a trip latch biased to engage the free end of said lever to prevent arcuate movement thereof in the direction of the biased movement of said arm, means normally biasing said lever for opposite arcuate movement into holding engagement with said latch, a toggle having a first link pivotally connected to said intermediate point of said arm and a second link pivotally connected to said intermediate point of said lever, and a toggle operating device having a member reciprocable in one direction for engaging the knee of the toggle to extend the toggle and thereby move said arm to engage said contacts and stress said resilient biasing means to predominately oppose the normal bias of said lever, and abnormal current responsive means for moving said trip latch against its bias to release said lever for joint arcuate movement in the direction of the biased movement of said arm sufficiently to release the knee of said toggle from said reciprocating member and thereby collapse said toggle to disengage said contacts and permit said lever to reengage said latch in accordance with its normal bias after reciprocation of said member in the opposite direction.



6. A circuit breaker having in combination two cooperating contacts, a pivoted arm supporting one of said contacts for arcuate movement into and out of engagement with the other of said contacts, resilient means biasing said arm for arcuate movement in the circuit opening direction, a pivoted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with a part of the arc of movement of an intermediate point of said biased arm, a trip latch biased to engage the free end of said lever to prevent arcuate movement thereof in the direction of the biased movement of said arm, means normally biasing said lever for opposite arcuate movement into holding engagement with said latch, a toggle having a first link pivotally connected to said intermediate point of said arm and a second link pivotally connected to said intermediate point of said lever, a solenoid having a reciprocating plunger operated member for moving said arm to engage said contacts and stressing said resilient biasing means to predominately oppose the normal bias of said lever, and abnormal current responsive means for moving said trip latch against its bias to release said lever for joint arcuate movement in the direction of the biased movement of said arm sufficiently to release the knee of said toggle from said reciprocating member and thereby collapse said toggle to disengage said contacts while said solenoid is energized and permit said lever to reengage said latch in accordance with its normal bias upon deenergization of said solenoid.

7. A trip-free circuit breaker comprising two cooperating contacts, a pivotally mounted arm supporting one of said contacts for reverse arcuate movement into and out of engagement with the other of said contacts, means predominately biasing said arm for arcuate movement in the circuit opening direction, a pivotally mounted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with the initial part of the arc of movement of an intermediate point of said arm in the circuit opening direction, a toggle interconnecting said arm and said lever comprising a first link pivoted on said arm at said intermediate point thereof and a second link pivoted on said lever at said intermediate point thereof, a trip latch engageable with said lever for holding the lever against movement in the direction of the biased movement of said arm, auxiliary biasing means for biasing said lever for movement into holding engagement with said latch when the toggle is collapsed, a projection on said second link at an intermediate point thereof, an auxiliary latch engageable with said projection near the end of the circuit closing movement of said arm for holding said toggle in an underset position whereby to retain the arm in the closed circuit position while said trip latch is in holding engagement with said lever, and means including a reciprocating member for en-

gaging the knee of the toggle to move the toggle to said underset position.

8. A trip-free circuit breaker comprising two cooperating contacts, a pivotally mounted arm for supporting one of said contacts for reverse arcuate movement into and out of engagement with the other of said contacts, means predominately biasing said arm for arcuate movement in the circuit opening direction, a pivotally mounted lever having an intermediate point movable in a limited arc extending in spaced-apart substantial alignment with the initial part of the arc of movement of an intermediate point of said arm in the circuit opening direction, a toggle interconnecting said arm and lever comprising a first link pivoted on said arm at said intermediate point thereof and a second link pivoted on said lever at said intermediate point thereof, a trip latch engageable with said lever for holding the lever against movement in the direction of biased movement of said arm, auxiliary biasing means for biasing said lever for movement into holding engagement with said trip latch when the toggle is collapsed, a prop engageable with said second link at an intermediate point thereof near the end of the circuit closing movement of said arm for holding said toggle in an underset position whereby to retain said arm in the closed circuit position while said trip latch is in the holding position, a roller mounted on said second link at an intermediate point thereof, and means for extending said toggle to said underset position to actuate said arm to the closed circuit position while said trip latch is in the holding position comprising a solenoid having a member operable upon energization of the solenoid to engage said roller whereby to effect the engagement of said one of said links with said prop in said underset position.

JOHN A. FAVRE.

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## Certificate of Correction

Patent No. 2,489,085 November 22, 1949

JOHN A. FAVRE

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 5, line 61, after the word "resilient" insert *means*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
*Assistant Commissioner of Patents.*

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