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W. HÖPP

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CIRCUIT BREAKER

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Fig. 1.

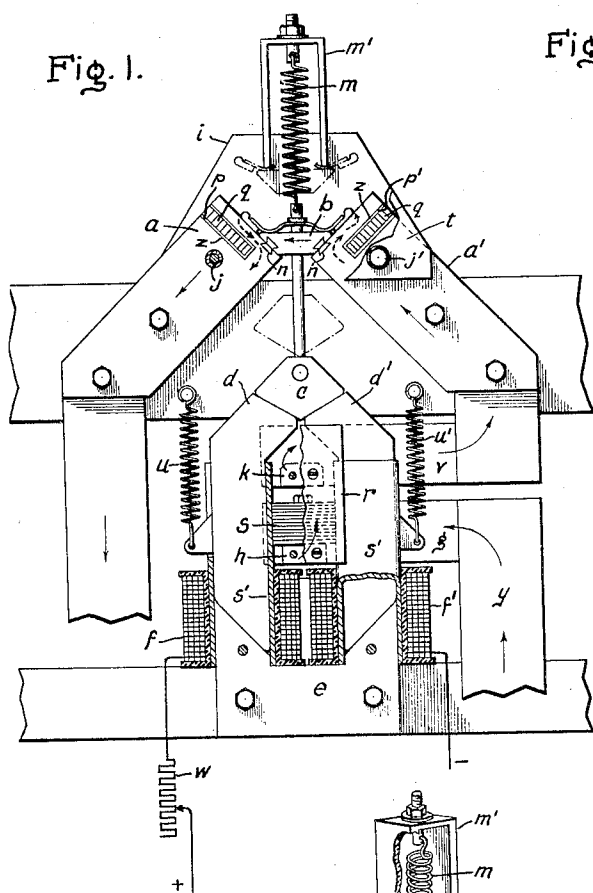


Fig. 2.

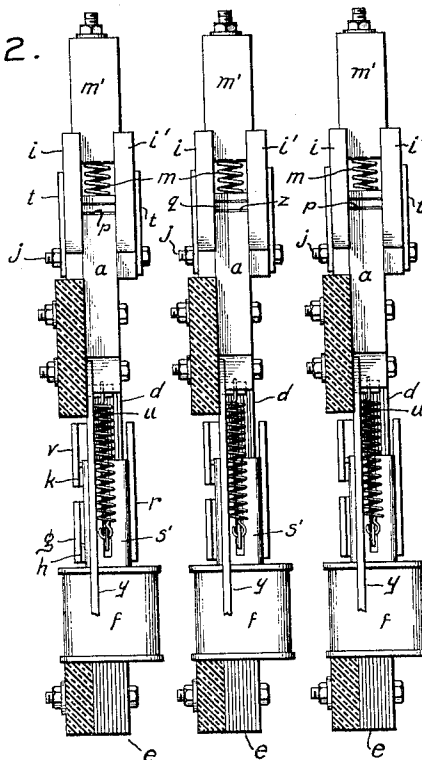
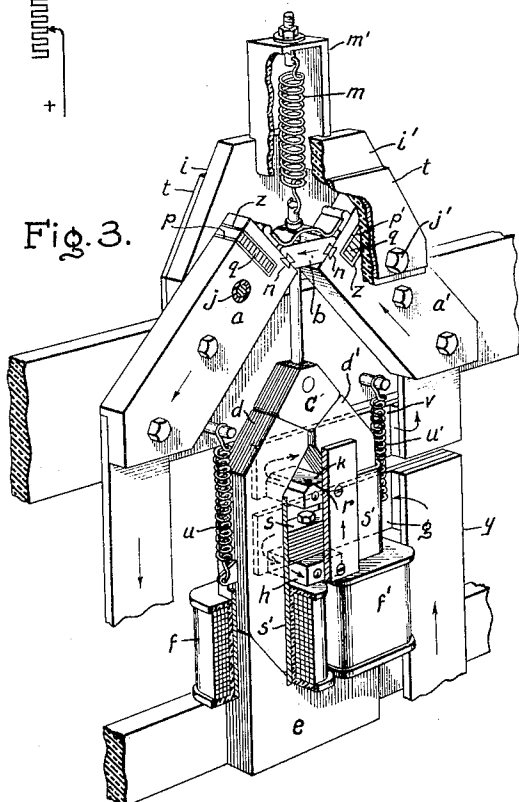


Fig. 3.



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UNITED STATES PATENT OFFICE

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CIRCUIT BREAKER

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13 Claims. (Cl. 200—94)

The invention relates to circuit breakers and more particularly automatic quick acting circuit breakers.

The principal objects are to increase the operating speed as well as the interrupting capacity of the circuit breaker.

Increased difficulties are met in connection with switches for current of high intensity, and more particularly as regards high speed circuit breaker operation. For example, the cross section of the conductors leading to the switch contacts must be increased in accordance with the magnitude of the current to be carried. As a result the weight of the moving switch elements has heretofore been correspondingly increased to prevent undue heating, with the result that the accelerating force necessary for a quick break is unduly great. It is, therefore, desirable that high speed circuit breakers for high intensity current should be designed so that the movable parts may be as small as possible.

Furthermore, difficulties are encountered in providing a magnetic arc blowout for dispersing the arc with a speed commensurate with that obtained in the operation of the moving switch element without involving complicated and expensive arc blowout magnets.

The present invention provides a particularly suitable and simple solution of these problems. In accordance with the invention in one form thereof a movable contact bridge is disposed between two stationary contacts, the said bridge forming a very short conductor of small cross section in the path of the current. Thus the weight of material shifted when the bridge is moved to the circuit interrupting position is reduced to a minimum by dimensioning the contact bridge in this manner. The rapidity of the switch action is thereby greatly increased. The contacts do not become detrimentally heated notwithstanding the reduced cross section of the bridge since it has been found that by constructing the bridge of small cross section and of short length only a very small rise in temperature occurs.

In accordance with the invention, the magnetic arc blowout is obtained in a simple manner. The main stationary contacts of the circuit breaker are formed as flat bars inclined at an angle to each other. The outer end of each bar is slotted so as to restrict the current flow in the portion of the bars near the bridge. In this way owing to the high intensity of the current a fairly strong magnetic field is set up adjacent the movable contact bridge where the circuit rupturing arcs are produced. In addition to the magnetic field produced by the current flow additional magnetic energy is made available by inserting cores of magnetic material in the notches. A member of magnetic material on each side of the

bars extends from the ends of the cores across the switch contacts. A strong magnetic field is thereby produced directly adjacent the movable bridging contact. The flat bars are much wider than the bridging contact and serve the additional function of conducting heat away from the bridge.

For a more complete understanding of the invention, reference should now be had to the drawing in which Fig. 1 is a front elevation, partly in section, of a circuit breaker embodying the invention; Fig. 2 is a side elevation, partly in section, of several high speed circuit breakers of the type shown in Fig. 1, while Fig. 3 is a perspective view, partly in section, of the circuit breaker shown in Fig. 1.

Referring now to the drawing, it will be observed that a very short contact bridge *b* of very small cross section is disposed between two oppositely inclined main contacts *a* and *a'*. The contact bridge *b* is supported for movement to and from the circuit closing position by means of a movable magnetic member or armature *c*. A holding electromagnet *e* with holding coils *f*, *f'* and oppositely inclined movable pole pieces *d*, *d'* is nested within the space between the main contacts *a*, *a'*. The contact bridge *b* is biased for rapid movement away from the contacts *a*, *a'* by a tension spring *m*. The spring *m* is supported by a bracket *m'* which bracket is mounted on two insulating plates *i* and *i'* secured to the main contacts *a* and *a'* as by bolts *j* and *j'*. The holding force of the magnet *e* is arranged to be sufficiently weakened by a releasing winding to permit the opening of the contacts by the spring *m*. The releasing winding is formed by conductors *g*, *h*, *r*, *k* and *v*, which conductors form a part of the load circuit which is controlled by the switch. These conductors form a single-turn, stationary releasing winding encircling a stationary leakage yoke *s* of magnetic material, which yoke extends between the movable pole pieces *d* and *d'* of the magnet *e*. With this arrangement the main current passing through the releasing winding serves to shift the flux of the magnet *e* from the armature *c* through the stationary leakage yoke *s*, thereby releasing the armature for operation in accordance with its bias. The manner in which the releasing winding functions is fully described and broadly claimed in Tritle Reissue Patent No. 15,441 assigned to the same assignee as the present invention. The main current flow, as indicated by the full-line arrows, is by way of conductor *y*, the releasing winding formed by the conductors *g*, *h*, *r*, *k*, and *v*, and through the non-oxidizing main contact pieces *n*.

By providing deep notches *p* and *p'* adjacent the outer ends of each of the main contacts *a* and *a'*, the current flow when the switch is in its open position is limited to a substantial degree to the

narrow portion of the main contacts between the slot and the bridge *b*. In this manner the magnetic field incident to the current flow is concentrated along the outer portion of the main contacts *a* and *a'* or the arcing horns along which the arc is formed. The strength of the magnetic field produced by the current flow is preferably increased by providing cores *q* of magnetic material disposed in the notches or slots formed in the main contacts *a* and *a'*. The magnetic material is insulated from the contacts *a* and *a'* by electrical insulating material 2. The magnetic field is further increased somewhat by magnetic plates *t* (Fig. 2) laterally disposed in spaced relation with respect to the main contacts *a* and *a'*. The plates *t* cooperate with the magnetic material in the slots *p* to surround the arcing horns with magnetic material except at the contact surfaces thereof.

The total amount of magnetic energy available at the main contacts, due to the electromagnetic field and to the properties of the magnetic material, is sufficient to blow out the arc without the necessity of blowout coils with stamped-out turns, etc.

By arranging the stationary contact bars *a* and *a'* in substantially the same plane and by dimensioning the contact bridge so that it is of the same thickness as the main contacts results in a switch of extremely narrow construction. Consequently it is possible to assemble a number of circuit breakers in juxtaposition to each other in a minimum amount of space. This renders possible the connection of a number of circuit breakers in parallel with the circuit without lowering the rapidity of the switch action or without excessive waste of space. Such an assembly of circuit breakers is shown in Fig. 2.

Continuing with the description, the magnet *e* is provided with movable poles *d* and *d'*. The coils *f* and *f'* are mounted on the stationary poles of the electromagnet. A stationary guide *s'* serves to support the poles *d* and *d'* during their vertical movement. The leakage yoke *s* rigidly secured to the conductor *h* is also fixedly mounted. The springs *u* and *u'* serve to balance the weight of the movable pole pieces *d* and *d'* so that these poles under the influence of the springs follow the armature *c* of the magnet to the circuit interrupting position when the coils *f* and *f'* are de-energized.

In the operation of my invention it will be assumed that the switch is in the circuit closing position shown in the drawing. As soon as the current increases to a predetermined magnitude the releasing winding formed by the conductors *g*, *h*, *r*, *k* and *v* shifts the flux from the armature *c* of the magnet so that the spring *m* quickly operates the contact bridge to the circuit interrupting position. The resultant arc forms between the outer ends of the main contacts *a* and *a'* to the corresponding sides of the contact bridge *b*. The main contacts or contact bars *a* and *a'*, therefore, form arcing horns for the circuit breaker. It will be seen that the current as indicated by the broken-line arrows flows along the outer ends of the main contacts of the arcing horns. Consequently this restricted path for the current concentrates the magnetic field produced by the current along the surfaces of the main contacts at which surfaces the arcs occur. The effect on the magnetic inserts *q* of the magnetic field encircling the arcing horns is to cause the inserts *q* to add additional magnetic flux so that the magnetic energy available is increased. The members *t* of magnetic material forming side

plates for the arcing horns also assist in increasing the intensity of the magnetic field. The arc is thereby effectively extinguished without the use of blowout coils.

In order to operate the electromagnet to its circuit closing position the energization of the coils *f* and *f'* is reduced by increasing the resistance of the variable resistance *w* connected in series with these coils. The magnetic poles *b* and *b'* are thereupon raised by the springs *u* and *u'* into engagement with the armature *c*. The resistor *w* is then operated to increase the current flowing through the coils *f* and *f'* until the coils develop sufficient attractive effort to return the poles *d* and *d'*, the armature *c* and the contact bridge *b* to their original circuit closing positions.

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

1. In a circuit breaker, stationary conductors arranged in oppositely inclined spaced relation to form stationary switch contacts, each of said contacts having slots to form a restricted current path adjacent the ends of said contacts, a movable bridging contact movable upwardly from a circuit closing position between said contacts and below said slots to a circuit interrupting position, and means for moving said bridging contact.

2. A circuit breaker comprising stationary conductors in oppositely inclined spaced relation, the adjacent ends of said conductors forming arcing horns, a bridging member, means for moving said member into and out of engagement with said conductors, and means restricting the current flow along said adjacent ends of said conductors for producing a magnetic field along each of said arcing horns.

3. In a circuit breaker, conductors having contact surfaces in oppositely inclined spaced relation, a bridging member movable into and out of engagement with said surfaces, each of said conductors being provided with a slot extending substantially parallel with its contacting surface and adjacent thereto so as to form an arcing horn in which the current is confined when said bridging member is moved to an open circuit position so as to thereby produce magnetic fields for extinguishing the arcs between said bridging member and said surfaces, and a plurality of members made of magnetic material in said slots for increasing said magnetic fields.

4. An automatic quick acting circuit breaker comprising a pair of stationary flat contact bars disposed in oppositely inclined spaced relation with the adjacent ends of the bars to form contact surfaces disposed at a substantial angle to each other, a bridging contact of smaller cross section than said stationary contact bars cooperating with less than the total contact surfaces thereof, means for biasing said bridging contact out of engagement with said contact surfaces of said stationary contact bars, a magnetic member connected to said bridging contact and operable in the space below the ends of said oppositely inclined stationary contact bars, an electromagnet having oppositely inclined movable poles nested within the space between the oppositely inclined stationary contact bars in attractive relation with said magnetic member for holding the bridging contact in engagement with said stationary contact bars, and a releasing winding connected in series with said bars for releasing said bridging contact, and means fixedly supporting said releasing winding with respect to said movable poles.

5. In an automatic quick acting circuit breaker, 130

a movable contact member, means for operating said movable contact to one position, an electro-magnet for holding said movable contact in another position and having a releasing winding for releasing said movable contact for operation to said one position, said electromagnet having magnetic pole pieces relatively movable with respect to said releasing winding and said electromagnet for operating said movable contact from said one position to said other position.

6. In an automatic quick acting circuit breaker, a movable contact biased to one position, a magnetic member connected therewith, an electromagnet having a stationary frame and pole pieces mounted for movement into engagement with said magnetic member for operating the movable contact from said one position to another position and holding same in said other position, and a fixedly mounted releasing winding associated with said electromagnet for controlling the holding flux thereof to release said magnetic member.

7. In a circuit breaker, stationary conductors arranged in oppositely inclined spaced relation to form stationary switch contacts, each of said contacts having a slot to form a restricted current path adjacent its end for producing an arc extinguishing magnetic field, a movable bridging contact therefor biased out of engagement with said stationary contacts, and means for releasing said bridging contact for operation from a circuit closing position between said contacts and below said slots to a circuit interrupting position.

8. A high speed circuit breaker comprising a pair of stationary contact bars disposed in oppositely inclined spaced relation, a movable contact for bridging the lower portion of said contact bars, biasing means for biasing said movable member out of engagement with said bars, an electromagnet having a frame provided with oppositely inclined pole pieces disposed below and in nesting relation with said bars, a movable magnetic member connected with said movable contact, and intermediate pole pieces extending between said magnetic member and said frame for controlling the movement of said magnetic member and said movable contact.

9. An automatic high speed circuit breaker comprising stationary contact bars of relatively greater width than the thickness thereof, means supporting said bars in oppositely inclined spaced relation, the adjacent ends of said bars forming contact surfaces at a substantial angle to each other, a bridging contact movable between said adjacent ends to engage less than the entire contact surfaces, said bars having slots adjacent said contact surfaces and extending more than half the width of said bars to form a restricted current path adjacent the ends of said bars, means for biasing said bridging contact out of engagement with said contact surfaces, a magnetic member secured to said bridging contact and movable in the space below said bars, an electromagnet having a frame forming oppositely inclined pole pieces, movable pole pieces having oppositely inclined ends for engaging said frame and said magnetic member, biasing means for biasing said movable pole pieces against said movable member, said electromagnet and said movable pole pieces normally being arranged to hold said bridging contact in engagement with said contact surfaces, and a fixedly mounted releasing winding associated with said movable pole pieces for controlling the holding flux thereof to release said magnetic member.

10. In a circuit breaker, conductors having

contact surfaces in oppositely inclined spaced relation, a bridging member movable into and out of engagement with said surfaces, each of said conductors being provided with a slot extending substantially parallel with its contacting surface and adjacent thereto so as to form an arcing horn in which the current is confined when said bridging member is moved to an open circuit position to produce magnetic fields for extinguishing arcs between said bridging member and said surfaces, and means for strengthening said magnetic field comprising a plurality of members of magnetic material in each of said slots, and a member of magnetic material on each side of said arcing horns.

11. In a circuit breaker, conductors having contact surfaces in spaced relation with each other, conducting means for establishing an electrical circuit from one of said surfaces to the other, each of said conductors being provided with a slot extending substantially parallel with its contacting surface and adjacent thereto so as to form an arcing horn in which the current is confined when said conducting means interrupts said circuit, said current producing a magnetic field encircling said arcing horn, and a plurality of members of magnetic material arranged in said slots so as to increase the intensity of said magnetic field.

12. A circuit breaker comprising upwardly extending stationary conductors in oppositely inclined spaced relation, a bridging member movable from a closed circuit position in engagement with the lower portions only of said conductors upwardly between said conductors to an open circuit position, the upper portions of said conductors constituting arcing horns around which a magnetic field is produced by the current flowing therein when the bridging member is moved to its open circuit position, and a member of magnetic material associated with said arcing horns so as to increase the magnetic field around said horns.

13. An automatic high speed circuit breaker comprising stationary contact bars of relatively greater width than the thickness thereof, means supporting said bars in oppositely inclined spaced relation, the adjacent ends of said bars forming contact surfaces at a substantial angle to each other, a bridging contact movable between said adjacent ends to engage less than the entire contact surfaces, said bars having slots adjacent said contact surfaces and extending more than half the width of said bars to restrict the current flow along said adjacent ends of said bars so as to produce a magnetic field along each of said contact surfaces, magnetizable members in said slots for increasing the intensity of said magnetic fields, means for biasing said bridging contact out of engagement with said contact surfaces, a magnetic member secured to said bridging contact and movable in the space below said bars, an electromagnet having a frame forming oppositely inclined pole pieces, movable pole pieces having oppositely inclined ends for engaging said frame and said magnetic member, biasing means for biasing said movable pole pieces against said movable member, said electromagnet and said movable pole pieces normally being arranged to hold said bridging contact in engagement with said contact surfaces, and a fixedly mounted releasing winding associated with said movable pole pieces for controlling the holding flux thereof to release said magnetic member.

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