A no-fuse circuit breaker having a releasable contact mechanism and a trip mechanism therefor, wherein the trip mechanism comprises main and auxiliary magnetic circuits having main and auxiliary pole portions spaced apart in parallel relation and defining corresponding air gap portions, an armature member movably disposed between the main and auxiliary poles for movement in a direction perpendicular to the pole portions and being arranged to be adjustable in distance from at least one of the pole portions upon being rotated, and means for resiliently supporting the armature member such that when a predetermined overload current flows, the armature moves toward the main pole portion to reduce the main air gap, whereby a trip may be released by engagement therewith of a member connected to the armature.

8 Claims, 8 Drawing Figures
NO-FUSE CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to a no-fuse circuit breaker of the type having an electromagnetic trip arrangement and more particularly to an improvement in the electromagnetic tripping arrangement of such a circuit breaker.

2. Brief Description of the Prior Art

In conventional no-fuse circuit breakers of relatively large current rating, the trip unit usually has two functions, namely of actuating the breaker to open at a rated over-load current after a time delay and of instant actuation upon detecting the presence of an excessive overload current. The former function is usually performed by a bi-metallic metal strip heated by the heat generated by the current, and the latter function is usually performed by use of an electromagnetic force of magnetic flux generated by the current.

Adjustment of the current value at which the trip in the rated overload current occurs can easily be made by adjusting, with a screw or the like, the distance between a free end of the bi-metallic metal strip and the trip lever of the breaker. Adjustment of the current value at which the excessive overload trip occurs, however, is rather difficult.

SUMMARY OF THE INVENTION

Accordingly, a primary object of the present invention is to provide a no-fuse circuit breaker having an improved and simple trip arrangement which permits easy adjustment of the current value at which the excessive overload trip occurs.

The foregoing and other objects are attained according to one aspect of the present invention through the provision of a trip arrangement having main and auxiliary magnetic circuits including main and auxiliary pole portions defining corresponding air gap portions, an armature member movably disposed therebetween in a direction perpendicular to the pole portions and being arranged to be adjustable in distance from at least one of the pole portions being rotated, and means for resiliently supporting the armature member such that when a predetermined overload current flows, the armature moves toward the main pole portion to reduce the main air gap, whereby a trip may be released by engagement therewith of a member connected to the armature.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, wherein like reference numerals designate like or corresponding parts throughout the several views, and in which:

FIG. 1 shows a side elevation view, partly in cross-section, of a no-fuse circuit breaker incorporating the present invention, parts not necessary for an understanding of this invention being omitted, and the mechanism being shown in a closed-circuit position;

FIG. 2 shows a front view of the fault trip arrangement shown in FIG. 1, as taken along the line 2—2;

FIG. 3 shows a cross-sectional view taken along the line 3—3 in FIG. 2;

FIG. 4 shows a perspective view of the magnetic circuits of an electromagnetic trip arrangement in the embodiment shown in FIG. 1;

FIGS. 5 and 6 show perspective views of different embodiments of an armature member shown in FIG. 1;

FIG. 7 shows a perspective view of a further different embodiment of an armature member; and

FIG. 8 shows a perspective view of another embodiment of the magnetic circuit.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring now to the drawings, and more particularly to FIG. 1, the invention is shown as being incorporated in an electric circuit breaker including a casing 11 formed of an insulative material, being shown in dot-and-dash line, which comprises a base and a cover. The circuit breaker comprises a "three-pole" circuit breaker having three side-by-side load terminals 12 at one end thereof and three side-by-side line terminals, not shown, being electrically connected to three side-by-side conductor strips 13 at the other-end thereof. The construction of the circuit breaker at each of the "poles" is substantially identical, and therefore the current path between the load and line terminals, as well as the trip arrangement, will be described in detail in connection with only one such pole, that is, the center pole.

The conductor strip 13 from the line terminal carries a pair of side-by-side main contacts 14, only one of which is shown, and an arcing contact 15. A pair of cooperating movable main contacts 16a and 16b, the contact 16a being partly broken away for illustration purposes, and a movable arcing contact 17 are provided on a movable contact arm 18 of substantially U-shaped cross-section in its body portion, which is pivotally mounted by a pin 19 on a mechanism frame, not shown. For easy understanding, the pins mounted on the mechanism frame are indicated with hatching. The movable main contacts 16a and 16b are guided by the pin 19 and a pin 20, which is mounted on the movable contact arm 18, and are provided with compression springs 21 and 22. The movable arcing contact 17 is fixedly mounted by the pin 20 and a screw 23 on the movable contact arm 18 near the free end portion thereof being disposed between the movable main contacts 16a and 16b. The movable main and arcing contacts 16a, 16b and 17 are electrically connected through flexible conductors 24 and 25 to a conductor strip 26 which in turn is electrically connected through a heat generating conductor strip 27 to the load terminal 12. The center movable contact arm 18 carries a contact cross-arm 28 to which the two outside movable contact arms are also rigidly connected by suitable means, not shown. A suitable arc extinguishing structure is also provided as indicated at 29.

In order to actuate the movable contact arm 18, there are pivoted toggle links 30 and 31. The link 30 extends downwards between the main movable contacts 16a and 16b and is pivotally mounted on the movable contact arm 18 by a pin 32 supported thereon by a pair of L-shaped members. The link 31 comprises two flat parts disposed in parallel relation with a clearance therebetween, in which the link 30 and a releasable support or a "cradle" 33, to be described, are interposed. The link 31 is rotatably supported on the link 30 and the cradle 33 at its lower and upper end portion.
by pins 34 and 35, respectively. The cradle 33 is pivot-
ally supported in the mechanism frame by a pivot pin
36 and has a releasable latched extension 37 at one end
which is releasably held by a holding member 38. The
toggle link 31 is provided with a stop pin 31a for re-
stricting the mutual movement between the link 31 and
the cradle 33. An operating handle 39 of insulating ma-
terial is mounted on a handle support 40 having a pair of
legs 41a and 41b extending downwardly on both sides
of the link 31 and the cradle 33 and being pivot-
ally supported at their lower ends in the mechanism
frame by a pivot pin 42. On both outer sides of the link
31 and the cradle 33 between the pair of legs 41a and
41b, a pair of tension type springs 43, only one being
shown, are connected between the handle support 40
and the knee pin 34 of the toggle links 30 and 31.

The holding member 38 has a cam surface 44 and is
rotatably supported by a pivot pin 45 on the mecha-
nism frame. Holding member 38 is urged by a spring,
not shown, to rotate in the clockwise direction as
viewed in FIG. 1, but rotation of the member 38 is lim-
ited by a suitable stop, not shown, so as to prevent rota-
tion over the position shown in the drawing. A latch
member 46 for supporting the holding member 38 is
pivotally mounted as a part of the mechanism frame.
The latch member 46 has a roller 48 which abuts up-
wardly on the cam surface 44 of the holding member 38 when
the members 46 and 38 are relatively positioned as shown
in FIG. 1. The latch member 46 is also urged by a suit-
able spring, not shown, to rotate in the clockwise direc-
tion and is also prevented from rotating past the posi-
tion shown in the drawing. Anti-clockwise rotation of
the latch 46 is restrained by a catch member 49 rotat-
bly supported by a pin 50 on the mechanism frame.
The catch member 49 has a projection 51 engageable
with the latch member 46, an upward extension 52 and
a double-headed arm portion 53, better seen in FIG. 2.
An adjustable member, such as a screw 54, is provided
on the upward extension 52 of the catch 49. Provided
on the heat generating conductor strip 27 is a bi-
metallic metal strip 55.

The manual operation of the circuit breaker will now
be explained. In the state shown in the drawing, the
 cradle 33 is restricted by the holding member 38 so
that the pin 35 is considered to be stationary with respect
to the mechanism frame. In this condition, the tension
springs 43 maintain the toggle knee in a position so
that the toggle links 30 and 31 are held in a straightened
condition, thereby holding the contacts in a circuit
closed position. When the handle 39 is moved counter-
clockwise from the "on position," shown in FIG. 1,
toward an "off position," the spring 43 is moved sub-
stantially across the pivot pin 35, whereby the toggle is
collapsed to move the contact arms and to open the cir-
cuit, and vice versa.

Next, the normal overload tripping operation will be
explained. An overload current flowing through the
conductor strip 27 generates enough heat to move the
free end of the bi-metallic strip 55 leftward to engage
the adjustable member 54 and thereby cause the catch
member 49 to rotate in the counterclockwise direction,
whereby the projection 51 disengages from the latch
member 46 to release the same for rotation freely in the
counter-clockwise direction. Thus the holding member
38 is also released to be free to rotate in the counter-
clockwise direction, and in turn, the cradle 33 is re-
leased to rotate in the clockwise direction. When this
occurs, the force of the tension springs 43 act on the
cradle 33 through the toggle link 31 to rotate the cradle
in the clockwise direction. The contact arm 18 thereby
rotates in the counter-clockwise direction about the pin
19 whereby the circuit is opened. The handle 39 is also
moved to the "trip position," as shown.

In order to reclose the circuit breaker, the handle 39
must be first moved to the "off" or "reset position" to
cause the latched extension 37 of the cradle 33 to again
engage the holding member 38.

Referring now to FIGS. 2, 3 and 4, as well as FIG. 1,
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an improved electromagnetic trip arrangement accord-
ing to the present invention will be explained.

There are provided a main and an auxiliary magnetic
circuit 60 and 61, respectively, of magnetic material
through which magnetic flux generated by the conduc-
tor strip 27 flows, each having an air gap portion ar-
 ranged in series therein, and pole portions near the air
gaps of the respective circuits are disposed in parallel
relation to each other. In detail of this embodiment,
these magnetic circuits are made of a flat plate of soft
ferro-magnetic material, such as soft iron, folded to
form a C-shaped configuration through which a leg of
the conductor strip 27 passes, as shown in FIG. 4.

In the main magnetic circuit 60, a pair of poles 62
and 63 forming the air gap thereof are arranged in a
substantially common horizontal plane but in staggered
relation along a horizontal line relative to each other.
A pair of poles 64 and 65 of the auxiliary circuit 61
are also arranged in a similar manner, but they are stag-
gered oppositely so that the flux paths in the air gaps
defined by each of the circuits 60 and 61 are in crossed
relationship. In this embodiment, the main and auxi-
liary circuits are integrally formed, but they also may be
formed in two or more parts, if desired.

As shown in FIGS. 1, 2 and 3, provided between the
main and auxiliary circuits 60 and 61 is a disc-shaped
armature member 66, also formed of soft ferro-
magnetic material, which is fixedly mounted on a rod
member 67 which, in turn, is movably supported by a
support member 68 of non-magnetic material. The sup-
port 68 comprises a pair of laterally extending arms to
slidably and rotatably support the rod 67 and a pair of
vertically extending supporting legs. An insulating
washer 69 of polyester film is provided to prevent the
armature 66 from making direct contact with the auxi-
lary poles 64 and 65, since such direct contact of the
poles 64 and 65 and the armature member 66 is liable
to cause a phonic noise. The non-metallic insulating
washer 69, however, eliminates this drawback. A
spacer 70 is also provided.

The armature 66 is spring biased upwardly by a com-
pression spring 71 mounted between the upper lateral
arm of the support 68 and an abutment 72 secured to
the rod 67. The rod 67 has a large diameter portion 73
positioned above the abutment 72 which, when the ar-
mature 66 moves downwardly, engages with and
pushes down the arm portion 53 of the catch 49 to
thereby rotate the catch 49 in the counter-clockwise
direction, as seen in FIG. 1, to trip the circuit.

Flow between the main poles 62 and 63 and between
the auxiliary poles 64 and 65 of the magnetic fluxes oc-
curs due to the current flowing through the conductor
strip 27. The fluxes between the auxiliary poles 64 and
65 and between the main poles 62 and 63, respectively
give upward and downward forces, or restricting and
operating forces, to the armature 66. In this connec-
tion, the main and auxiliary magnetic circuits are so arranged that the flux between the main poles 62 and 63 is larger than that between the auxiliary poles 64 and 65. When an excessive overload current flows in the conductor strip 27, the armature 66 is pulled downward by the operating force against the upward force of the spring 71 and the flux between the auxiliary poles 64 and 65, and the circuit is tripped. In order to adjust the current value at which the excessive overload trip occurs, the armature 66 has a particular shape, such as shown in FIGS. 5 and 6. In FIG. 5, the disc-like shaped armature 66 is partially cut away in its upper region, and FIG. 6, the armature member 66 of FIG. 5 is further diametrically slotted. Thus, an adjustment in the rotational position or angular orientation of the armature 66 with respect to the poles causes a change in the clearance between the armature 66 and the auxiliary poles 64 and 65, whereby the restricting force against the trip operation can be adjusted.

In order to adjust the rotational position of the armature 66, adjusting members 74 and 75 of insulating material are slidably and rotatably mounted on a support member 76. The member 74 has a recess shaped for receiving the top portion of the rod 67 and to be coupled thereto such that rotation thereof is transmitted to the rod but that axial movement relative to each other is allowed. The member 74 also has a plurality of radial slots 77 formed in the upper surface portion thereof which are engageable with a projection 78 provided on the support 76, as shown in FIG. 3. A spring washer and a normal washer 79 and 80, respectively, are provided between a lower surface portion of the member 74 and an upper surface portion of a leg of support 76 to give an upward biasing force to the member 74. Accordingly, the armature 66 does not rotate in the state shown in the drawings because the projection 78 is engaged with a slot 77. But when the member 74 is pushed downwardly by pressing on the member 75, the projection 78 becomes disengaged from the slot 77, whereby the armature 66 then can be rotated, as desired. Thus, the current value at which the excessive overload trip occurs can be adjusted by the manual external operation of pushing down and rotating of the members 75 and 74.

As another embodiment of the armature member 66, a bar-shaped magnetic material, as shown in FIG. 7, also may be used. In this case, the distance between the armature 66 and the main poles 62 and 63 is also changed as in the previous case, that is, the operational force generated therewith is also changed as the armature 66 rotates. Although the construction of the armature is more simplified than that shown in FIGS. 5 and 6, there is some disadvantage in that the armature 66 receives a relatively large rotational force.

In the embodiments described hereinbefore, the basic adjustment can be performed by adjusting the thickness of the spacer 70 and the insulating washer 69. If it is necessary to do this with more ease, screws may be provided on the auxiliary poles 64 and 65, as shown in FIG. 8, and the insulating washer 69 may even be omitted.

According to this invention, a no-fuse circuit breaker of simple construction is provided in which the current value at which the excessive overload trip occurs can be easily adjusted. This invention is effective in a circuit breaker having an overload rating current of about 200-1500 amperes and an excessive overload rating current of about 3-15 times the rated overload current.

Obviously, many modifications and variations of the present invention are possible in light of these teachings. It is to be understood therefore that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A no-fuse electric circuit breaker having a releasable contact mechanism and a trip mechanism therefor including an electromagnetic trip arrangement which comprises:

a main and an auxiliary magnetic circuit of magnetic material in which a magnetic flux being caused by a current flowing through a circuit to be protected flows, each having main and auxiliary pole portions disposed in parallel relation and defining main and auxiliary air gaps, respectively;

an armature member of magnetic material disposed between said main and auxiliary pole portions and movable in a direction substantially perpendicular thereto so as to be subjected to operating and restricting forces and being adjustable in distance from at least one of said pole portions through rotation in a plane substantially parallel to said pole portions, said operating and restricting forces being magnetic forces caused by magnetic fluxes flowing in said main and auxiliary magnetic circuits, respectively; and

means for resiliently supporting said armature member adjacent said auxiliary pole portions to reduce magnetically said auxiliary air gap portion, whereby when a predetermined current flows through said circuit, said armature member is drawn toward said main pole portion to reduce said main air gap portion so that said contact mechanism is released.

2. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 1, wherein:

said main magnetic circuit comprises a substantially C-shaped flat plate in which the open ends thereof form the main poles, and said main poles lie in a common plane but in non-aligned relation;

said auxiliary magnetic circuit comprises a substantially C-shaped flat plate in which the open ends thereof form the auxiliary poles, and said auxiliary poles lie in a common plane but in non-aligned relation; and

said main poles and said auxiliary poles lie in substantially parallel spaced-apart planes.

3. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 2, wherein:

said main and said auxiliary magnetic circuits are integrally formed.

4. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 2, wherein said armature member is a substantially disc-shaped member having one surface partially cut-away to provide an uneven thickness.

5. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 4, wherein said cut-away surface of said armature member is provided with at least one slot.

6. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 5, wherein said re-
silent supporting means for said armature member comprises:
an elongated rod secured at one end to one surface of said armature member;
means supporting the other end of said rod; and
biasing means urging said rod to move in a direction away from said main poles.
7. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 6, further comprising:

means engageable with said slot in said armature member for rotating said rod about its axis.
8. An electromagnetic trip arrangement for a no-fuse circuit breaker as set forth in claim 7, further comprising:
means on said rod for engaging a trip for said releasable contact mechanism when said rod is moved in a direction toward said main poles against the force of said biasing means.

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