

The pressure in the contact zone, notably in the arc extinguishing chamber, is a direct function of the power of the arc, and it can quickly reach high values, for example from 3 to 10 bars. This overpressure acts on a simple membrane or movable piston device which actuates the circuit breaker tripping mechanism. The pressure increase and transmission of this pressure to the detector take place all the more quickly the higher the currents are. The device is however not sensitive to weak currents, and spurious tripping on a simple overload can easily be avoided by providing a return spring of the piston, or of the measuring membrane.

The actuator is a leaktight or almost leaktight assembly constituted by the cylinder with the piston or membrane and the connecting duct between the cylinder and the extinguishing chamber. This duct of small cross-section can be relatively long and is easily housed in the case. The movement of the piston only requires a very small gas flow in the duct and almost all of this flow takes place before pollution of the gases due to the action of the arc. The actuator is thus protected from these polluted gases.

High-speed opening of a limiting circuit breaker is not easily compatible with selectivity of tripping which requires opening of the circuit breaker directly upstream from the fault, whereas the other downstream circuit breakers remain closed to ensure continuity of power supply to the sound part of the mains system. It has been attempted to achieve selectivity conditions between two circuit breakers arranged serially, by coordinating their tripping curve, but these conditions are difficult to achieve for the times involved are extremely short. Saturation phenomena often mask measurement of the differences of the currents to be broken, and selectivity is not always achieved.

The present invention is based on the observation that a break

in a limiting circuit breaker always generates a high arc voltage, and thereby a notable arc energy resulting in a pressure increase in the breaking zone. This pressure increase is ultra high-speed, and selectivity can be achieved by using a return spring weighted in such a way as to trip at a preset pressure. Indeed, when two circuit breakers of different ratings have the same short-circuit current flowing through them, the pressure in the upstream circuit breaker is much lower than if it had broken on its own and selectivity is automatically achieved in a particularly simple manner, for only the circuit breaker having the lower rating trips. This selectivity is absolutely independent from the overload and/or short-circuit fault detector, whose design can be adapted to its role of operating on small currents. The action of the fault detector can be slightly delayed in order to avoid any interference with the overpressure actuator, which provides instantaneous protection as soon as it is required.

According to a development of the invention, each pole of a multipole circuit breaker comprises an overpressure actuator, so as to operate as soon as an overpressure occurs in any one of the poles, and to perform tripping as quickly as possible. The piston of the overpressure actuator can be common to the different poles, the latter being connected to the piston by ducts equipped with an anti-return device. The different arc extinguishing chambers are preferably connected to a common manifold with a check valve interposed, this manifold itself being connected by a duct to the piston or membrane of the overpressure actuator, which acts on the circuit breaker trip bar. Tripping on a fault can be obtained by a standard thermal or electromagnetic trip device, or by a solid-state trip device with polarized relay. All these trip devices and actuators act on the same trip bar which releases the circuit breaker opening mechanism, in a manner well-known to those specialized in the art.

The overpressures are high, and the overpressure actuator can

therefore comprise a piston of small surface, about one square centimetre, and this small size makes it easy to house in a moulded case, possibly of an existing device.

Other advantages and features will become more clearly apparent from the following description of an illustrative embodiment of the invention, given as an example only and represented in the accompanying drawings in which :

Figure 1 is a schematic axial section view of a pole of a circuit breaker equipped with an overpressure actuator according to the invention;

Figure 2 is an enlarged scale view of the overpressure actuator according to figure 1;

Figure 3 is a schematic view of the overpressure actuator associated with a three-pole circuit breaker;

Figure 4 is a schematic sectional view of an overpressure actuator associated with a polarized relay of a solid-state trip device;

Figure 5 represents the variation curves of the tripping characteristics.

In figure 1, a pole of a moulded case circuit breaker 10 comprises a pair of contacts 11, 12 located in an arc extinguishing chamber 13 equipped with deionization plates 14. The arc extinguishing chamber 13 is bounded by partitions 15 one of which has passing through it a support arm 16 of the movable contact 12. The arc extinguishing chamber 13 is almost leaktight and communicates by a channel 17 of small cross-section with the outside of the moulded case 10. The movable contact arm 16 is pivotally mounted on a bar 18 belonging to an operating mechanism 19, having a manual opening and closing handle 20 of the contacts 11, 12 and a latch 21 controlling

tripping of the mechanism 19. The movable contact 12 is biased by a spring 22 to the closed position, and is capable of pivoting counterclockwise due to the electrodynamic repulsion force generated by the current flowing in the contact arm 16 and contacts 11, 12. The latch 21 is controlled by a trip bar 23 common to the different poles of the circuit breaker. The circuit breaker comprises a standard trip device with a bimetal strip 24, and electromagnetic coil 25, both acting on the trip bar 23. A circuit breaker of this kind is well-known to those specialized in the art and does not need to be described in greater detail. It is sufficient to recall that when a short-circuit occurs, repulsion of the contacts 11, 12 brings about high-speed opening of these contacts, against the force of the spring 22, this high-speed opening causing limitation of the short-circuit current. Opening of the contacts 11, 12 is confirmed by the operation of the electromagnetic trip device 25 acting via the trip bar 23 on the latch 21, which opens the circuit breaker mechanism 19.

According to an embodiment of the present invention, the circuit breaker comprises an overpressure actuator comprising a piston 26 and cylinder 27 assembly cooperating with the trip bar 23. Referring more particularly to figure 2, it can be seen that the piston 26 slidably mounted in the cylinder 27 bears a rod 28 capable of striking the trip bar 23. A return spring 29 keeps the piston 26 in the retracted position, represented in figure 2. The face opposite the rod 28 of the piston 26 is subjected to the pressure in the chamber 30 which communicates via a duct 31 with the arc extinguishing chamber 13. In the example represented in figure 1, the duct 31 opens onto the chamber 13 in the vicinity of the deionization plates 14, but pressurization can be performed at any point of the chamber 13, uniformization of the pressure inside this chamber being almost instantaneous.

Operation of the circuit breaker according to the invention is derived from the above description. When the contacts 11, 12

open on a short-circuit, the arc drawn between these contacts produces heating of the gas contained in the arc extinguishing chamber 13 and consequently a pressure increase, as a direct function of the energy of the arc. This pressure increase is transmitted by the duct 31 to the chamber 30, and as soon as this overpressure overrides the force of the return spring 29, causes the piston 26 to slide to the left and actuation of the trip bar 23 causing the mechanism 19 to open, confirming the separation of the contacts. Detection of a strong current arc is extremely fast, whereas the overpressure actuator 26, 27 hardly operates for a normal break or a weak current, the overpressure generated in the arc extinguishing chamber 13 being insufficient to overcome the force of the return spring 29. This same spring 29 enables selectivity to be achieved between two circuit breakers of different ratings having the same short-circuit current flowing through them as the pressure developed will be less great than if it had broken on its own.

The circuit breaker can be multipole and in this case each pole can be equipped with its own overpressure actuator 26, 27 acting on the trip bar 23. When a short-circuit occurs, the most loaded pole causes tripping by the pressure increase in its arc extinguishing chamber 13, this trip causing all the poles of the circuit breaker to open.

According to a preferred embodiment, illustrated by figure 3, three poles P1, P2, P3 of a three-pole circuit breaker communicate via ducts 31 with a manifold 32, itself connected to the chamber 30 of the overpressure actuator 26, 27. The orifice via which the ducts 31 enter the manifold 32 is capable of being blocked off by a check valve 33, preventing the gases from flowing from one pole to the other. In the example represented in figure 3, the pressure increase in the arc extinguishing chamber of the first pole P1 is the quickest, and this pressure is transmitted via the duct 31 and manifold 32 to the overpressure actuator 26, 27, the valve 33

being open. The other two poles P2, P3 are isolated from the manifold 32 by closing of their corresponding valve 33, and the actuating device remains almost leaktight.

The invention is applicable to circuit breakers with solid-state trip devices using current transformers to detect an overload or short-circuit. These current transformers supply a signal to an electronic processing device which delivers a tripping order to a polarized relay 34 when preset thresholds are exceeded. Referring to figure 4, it can be seen that the polarized relay 34 comprises a plunger core 35 held in the retracted position by a permanent magnet 36, and biased to the operating position of the trip bar 23, by means of a push-rod 38, by a spring 37. The tripping order is transmitted to a coil 39 which releases the core 35. The overpressure actuator 26, 27 is adjacent to the polarized relay 34 and the rod 28 is located facing the trip bar 23 to actuate the latter when an overpressure occurs. The trip bar 23 bears a lug 40, capable of cooperating with the rear face of the head of the push-rod 38, leaving a clearance "j", sufficient for movement of the trip bar 23 due to the action of the overpressure actuator 26, 27, without the core 35 of the relay 34 moving. This lug 40 causes discharging of the polarized relay 34 after the mechanism 19 has tripped.

Operation of the circuit breaker with solid-state trip device is naturally identical to that described above with a standard trip device. In both cases, the high-speed operation of the overpressure actuator allows a small time delay of the trip device on a fault, this time delay being able to be obtained by a simple clearance between the electromagnetic trip device and the trip bar, or between the polarized relay 34 and this trip bar 23. Any other delay means, for example of the runner type can be used.

The curves in figure 5 show the mode of action of the trip device according to the invention. Curve "a" shows the

separation distance of the contacts 11, 12, on opening on a short-circuit by electrodynamic repulsion of the movable contact 12. Curve "b" shows the variation of the arc voltage corresponding to opening of the contacts 11, 12. Curve "c" illustrates the increase of the prospective short-circuit current, whereas curve "d" corresponds to the current limited by the electrodynamic repulsion of the contacts 11, 12. Curve "e" shows the pressure variation in the arc extinguishing chamber 13. Separation of the contacts 11, 12 takes place at a time "t1" and the overpressure actuator causes opening of the mechanism 19, and thereby that of the three poles of the circuit breaker at a time "t2" confirming opening of the contacts by electrodynamic repulsion. A piston 26, with a diameter of 10mm, has enabled amply sufficient forces to be obtained to actuate the trip bar 23. A piston of this size can easily be housed in the moulded case 10, and the duct 31 of small cross-section enables the pressure to be picked up at any point of the arc extinguishing chamber 13. The usual leaktightness of the arc extinguishing chambers 13 is amply sufficient to obtain the necessary overpressures, and it is not necessary to provide additional leaktightness means of these chambers. The assembly is particularly simple and selectivity is obtained by using return springs 29 of suitable size.

CLAIMS

1. A trip device of an electrical circuit breaker with moulded case (10) having per pole a pair of contacts (11, 12) elastically urged into contact in the closed position of the circuit breaker and capable of separating due to the action of electrodynamic repulsion forces when the current flowing through the contacts (11, 12) exceeds a preset threshold to bring about limiting of said current, said trip device comprising an overload (24) and/or short-circuit (25) fault detector which actuates an automatic opening operating mechanism (19) of the circuit breaker on a fault, and an actuating device (26, 27) reacting to an overpressure generated in the zone of said contacts (11, 12) by an arc drawn when electrodynamic repulsion of the contacts (11, 12) takes place to actuate the circuit breaker opening mechanism (19), characterized in that said actuating device (26, 27) constitutes a leaktight assembly only in communication with the zone of the contacts (11, 12), and comprises a movable part such as a piston (26) or membrane which presents a limited actuation travel, which is subjected on the one hand to said pressure and on the other hand to a weighted return device (29), and whose movement causes tripping of said circuit breaker opening mechanism (19), said weighted return device (29) being arranged to avoid spurious actuation on a simple overload or when operation of a load-side limiting circuit breaker occurs.

2. The trip device according to claim 1, characterized in that said contacts (11, 12) are arranged in an almost leaktight arc extinguishing chamber (13), and that said actuating device (26, 27) comprises a duct (31) emerging into the arc extinguishing chamber (13) to transmit to the actuating device (26, 27) an overpressure prevailing in said chamber (13).

3. The trip device of a multipole circuit breaker according to claim 1 or 2, characterized in that each pole (P1, P2, P3)



cooperates with an actuating device (26, 27) to bring about opening of the multipole circuit breaker when an overpressure is generated in any one of said poles (P1, P2, P3).

4. The trip device according to claim 1 or 2, characterized in that the movable part (26) of the actuating device (26, 27) subjected to the overpressure is common to all the poles and is linked to each of the poles (P1, P2, P3) by a duct (31, 32) equipped with an anti-return device (33).

5. The trip device according to claim 4, characterized in that said movable part (26) communicates with a manifold (32) common to all the poles (P1, P2, P3) and communicating with the contact zone (11, 12) of each of the poles (P1, P2, P3) via a duct (31) equipped with a check valve (33).

6. The trip device according to any one of the above claims, characterized in that said fault detector comprises a thermal element (24) and/or electromagnetic element (25) through which the current flows and acting on a trip bar (23) and that said actuating device (26, 27) acts on the same trip bar (23), the action of the fault detector being time delayed with respect to that of the actuating device so as to provide selectivity of tripping.

7. The trip device according to any one of the claims 1 to 5, characterized in that the fault detector comprises a current sensor which transmits fault signals to a solid-state processing unit, said unit sending a circuit breaker tripping order to a polarized relay (34) when preset thresholds are exceeded, and that the action of the polarized relay (34) is time delayed with respect to that of the actuating device (26, 27).

