Dec. 14, 1937. R. N. ROWE 2,102,545

ELECTRIC SWITCH

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Fig. 1.

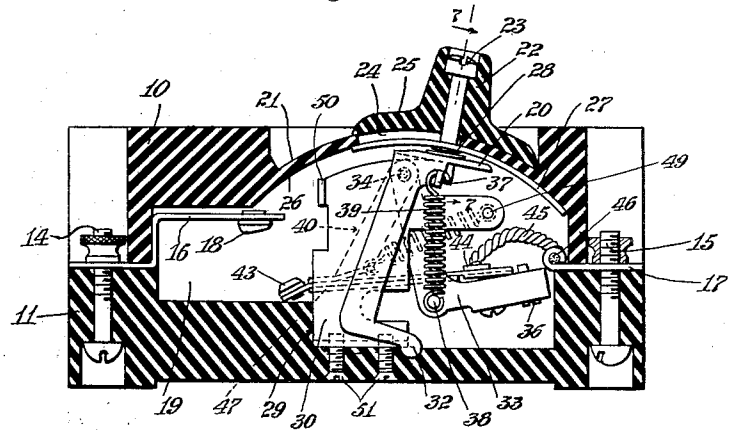


Fig. 2.

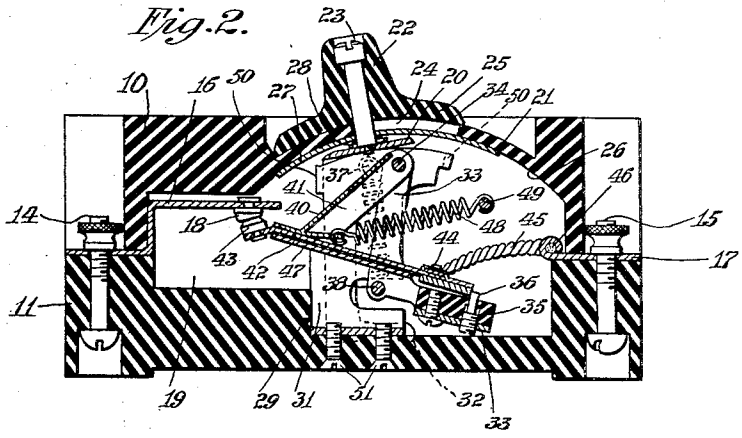
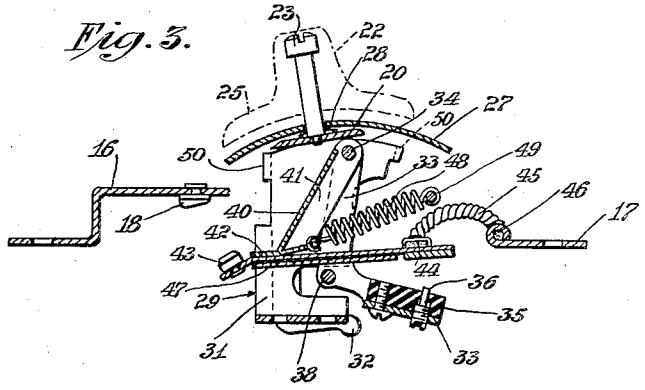


Fig. 3.



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Fig.4.

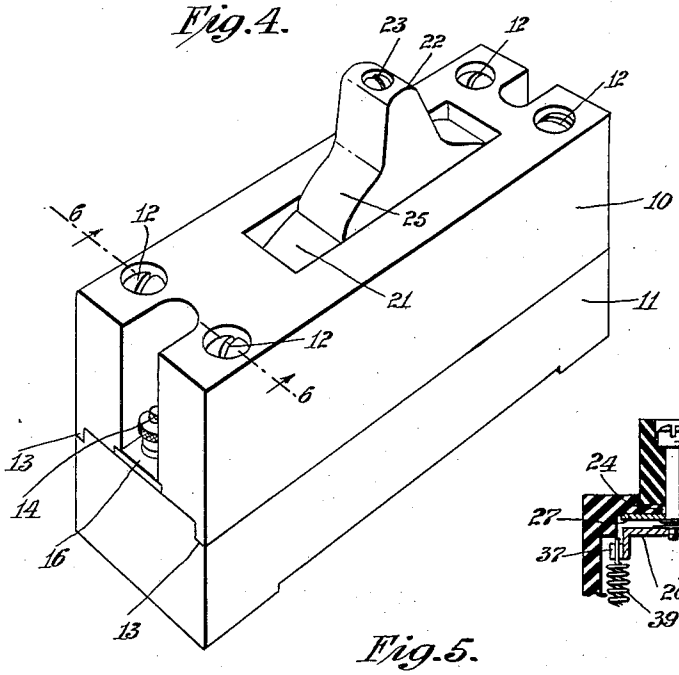


Fig.7.

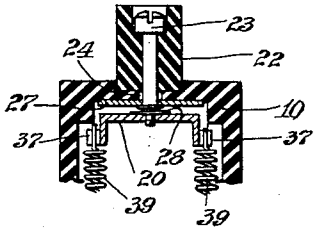


Fig.5.

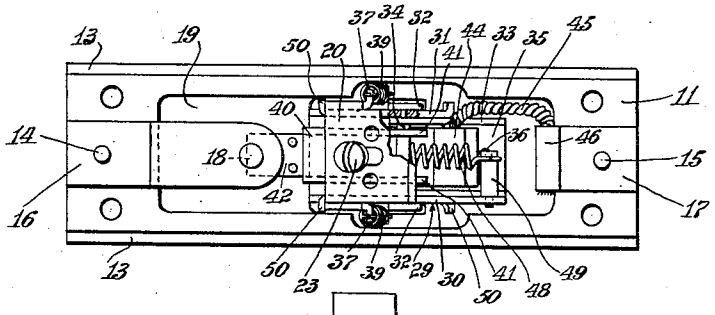
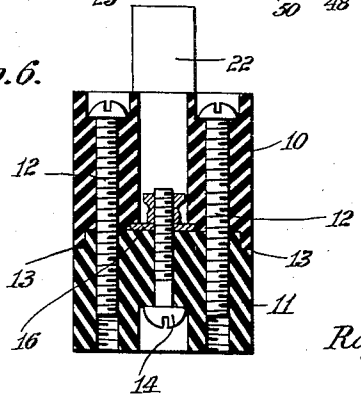


Fig.6.



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Fig.8.

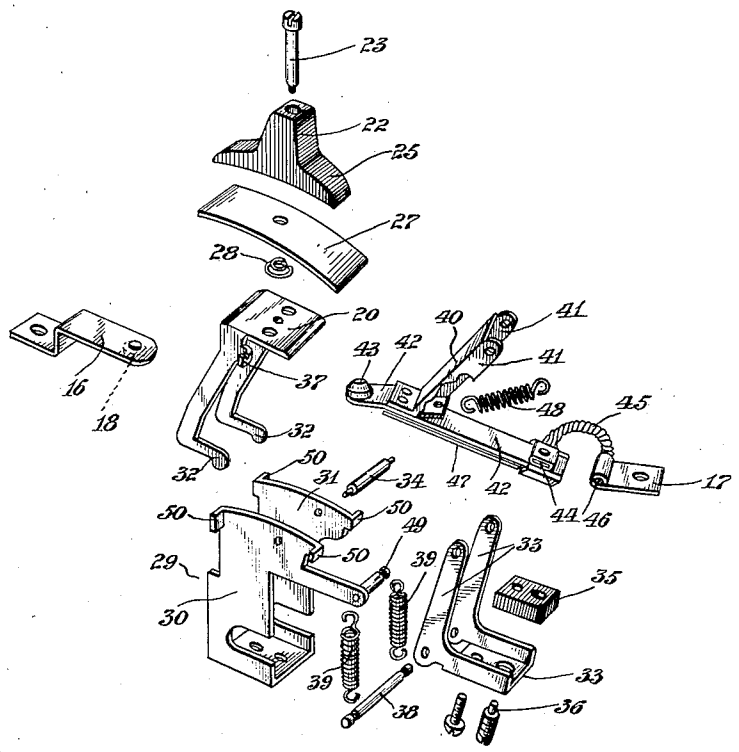
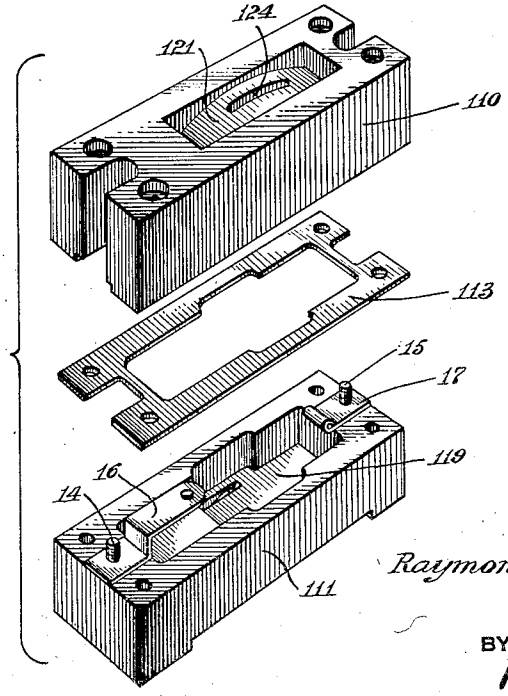


Fig.9.



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2,102,545

UNITED STATES PATENT OFFICE

2,102,545

ELECTRIC SWITCH

Raymond N. Rowe, Plainville, Conn., assignor to The Trumbull Electric Manufacturing Company, Plainville, Conn., a corporation of Connecticut

Application May 9, 1936, Serial No. 78,818

11 Claims. (Cl. 200—116)

My invention relates to circuit breakers and more particularly to an improved circuit breaker of the type utilizing the principle of self compression arc interruption. In circuit breakers utilizing this principle, advantage is taken of two factors, namely, (1) that when contacts are separated under load or short-circuit an arc is drawn in an atmosphere composed of air, metal vapors and some gas from insulation surfaces, and (2) that the heat from the arc raises these gases to a high temperature. It is a known practice to seal the contacts in a relatively small chamber so that the expanding heated gases will create a high pressure in the area of the arc. This pressure increase offers an impediment to the flow of current through the arc area and the arc will thus be quenched or interrupted.

The primary object of the present invention is to produce an efficient and effective circuit breaker of the compression arc interruption type.

The use of this principle of arc interruption is comparatively easy of accomplishment when the moving contacts have a straight plunger motion or are carried by a rotatable shaft. In these cases the entrance of the moving contact into the compression chamber is sealed by suitable packing around the reciprocating or rotating part. However, if the moving contact has an arcuate motion or has a movement in two dimensions relative to the plane of the stationary contact, as is often the case in some designs of switches equipped with circuit breakers, it is not possible to make an effective seal of the moving contact within the compression chamber.

A special object of my invention is to make a compression arc interrupter adapted for use with any of the above described movements of contacts.

A still further object is to increase the safety factor in circuit breakers for electrical systems.

Another object is to reduce fire hazard in the use of circuit breakers.

Another object is to produce a novel and effective seal between the contact parts and the switch operating handle in switches and circuit breakers.

Another object is to decrease the physical dimensions of circuit breakers, thus facilitating their use instead of the present fuses in systems already installed.

The accomplishment of these and other objects is brought about by enclosing not only the contacts but also the entire switch and circuit breaker tripping mechanisms within a sealed casing. Thus the casing for the parts acts as a compression chamber.

In order to accomplish the desired result it is necessary both to seal the casing and to make the sealed chamber sufficiently small so that the expanding gases will build up an effective arc interrupting pressure. This is necessary because high temperature gas is not ordinarily considered a good medium to stop an arc.

The compression chamber must be small enough so that, with a given spacing of arcing contacts, sufficient pressure will be built up by the expanding contained gases to quench rapidly any arc which is formed by the extra potential in the breaker. The necessary size of the compression chamber, for any given distance of contact separation and any given impressed voltage, may be determined experimentally. When this desired restriction of volume has been ascertained for meeting a certain set of requirements, then the switch and circuit breaker mechanisms must be built in such a manner as to come well within the volume required. Of course, the switch parts themselves will diminish the volume of the gases in the chamber when the parts are in place.

Because the switch handle must, in most intances, extend outside of the casing, special provision is made for sealing the handle. This seal is made both internally and externally of the casing, thus providing a stronger as well as a more efficient structure.

Finally, the casing must be made strong enough to withstand the pressures built up by the arc. This is done by making heavy walls, preferably of rag bakelite, and securing the parts of the casing together at a number of balanced spaced points. The handle seal is provided with an internal plate of metal to insure further strength at this portion of the compression chamber.

A more detailed description of one form of my invention is given below, and should be read in connection with the accompanying drawings in which:

Fig. 1 is a longitudinal partial sectional view of one form of my invention, the compression chamber being shown in section and a combined switch and circuit breaker in elevation. The parts are in "off" position.

Fig. 2 is a view similar to Fig. 1, showing the switch and circuit breaker parts in section, the parts being in "on" position.

Fig. 3 is a sectional view of the switch and circuit breaker parts in "tripped" position.

Fig. 4 is an external perspective view of a complete device according to my invention.

Fig. 5 is a plan view of the device as shown in Fig. 2, with the top part of the compression chamber and the switch handle members removed.

Fig. 6 is a vertical section substantially on the plane of line 6—6 of Fig. 4.

Fig. 7 is a vertical section substantially on the line 7—7 of Fig. 1.

Fig. 8 is an exploded perspective view of the internal switch and circuit breaker parts with the handle.

Fig. 9 is an exploded perspective view of a slightly modified form of casing and seal.

In these drawings, the compression chamber and casing is formed of a top piece 10 and a base 11, both of proper weight and strength to withstand safely the pressures involved. I prefer to mould these parts of rag bakelite, a phenolic condensation product which is reinforced with rag scraps.

The two parts of the casing are firmly held together by any suitable means, such as the four screws 12, which pass through bores in the top piece and threadedly engage the base. These screws are located at evenly spaced points, such as the corner portions of the case, so that all sides are held under pressure. If desired, a further sealing of the parts may be obtained through the use of interfitting shoulder or step portions 13. Cement, shellac, or other adhesive may be used if desired, to insure a good seal between the casing parts.

Located outside of the casing wall is a line terminal binding screw 14 and a load terminal binding screw 15, shown as threadedly engaging a line terminal contact plate 16 and a load terminal connection plate 17 respectively. These plates are snugly and securely surrounded by the casing where they pass into the compression chamber. A stationary contact piece 18 is secured to the inner end of plate 16.

At 19 is indicated the interior compression chamber which also contains the switch and circuit breaker parts. A switch yoke piece 20 is pivoted within the chamber 19.

On the outside of the casing at 21 is a convex surface with a radius of curvature centered at the pivot point of switch yoke 20. A switch handle 22, preferably of insulating material, closely fits and rides on the convex surface 21.

A screw 23 passes through the handle and threadedly engages an aperture in the top of yoke piece 20 to hold the handle close against the convex surface. This screw passes through a slot 24 in the casing wall, the slot being long enough to permit movement of the handle to "on" and "off" positions, but being only slightly wider than the diameter of the screw 23. Arcuate flanges 25 on the handle close the slot 24 at all times, the handle and flanges being wide enough to extend well beyond all edges of the slot.

At 26 is a concave wall in the chamber 19, with a radius of curvature centered on the pivot point of the yoke 20. A sealing and reinforcing plate 27, preferably of metal or other strong material, closely fits and rides in this concavity, the screw 23 freely passing through this plate although closely surrounded thereby. A spring 28, between the plate 27 and yoke 20, presses the plate into engagement with the wall 26 to seal the slot 24 at all times.

Within the chamber is mounted an appropriate switch and circuit breaker mechanism. Although, for purposes of showing a completely operative device, I have shown one form of switch, it is obvious that others might be used. While I have illustrated a thermostatically operated circuit breaker trip, any other form of electro-responsive trip device, such as a magnetic trip, might be substituted. The prime desideratum is to make these parts small enough so that the compression chamber is of a size to function properly.

The novel compact structure illustrated includes a switch frame 29 which has vertical side portions 30 and 31. The yoke 20, mentioned above, straddles these frame sides and is provided with rounded ends 32 which bear in suitable depressions in the bottom of the chamber to pivot the yoke.

A switch throw piece 33 is pivotally connected to the switch frame sides by a pivot pin 34. At the free end of the piece 33 is suitably mounted an insulation block 35, carrying the pin catch 36. This pin may be screw threaded for adjusting or calibrating the trip action of the mechanism.

Ears 37 on yoke 20 and a pin 38 through throw piece 33 are connected by means of springs 39.

On the same pivot 34 as the switch throw piece is mounted the trip piece 40, having side arms 41 which support a flexible, resilient, current carrying bar 42. This bar has a contact 43 which is adapted to engage stationary contact 18 when the switch is "on." The free end of bar 42 is normally in the path of arcuate movement of catch pin 36. This end of the bar is also connected at 44 to a flexible lead 45 which in turn is connected as at 46 to the inner end of the load terminal plate 17.

On the bar 42 is a bimetallic member 47 which flexes upwardly when overheated, to lift the free end of the bar 42 out of the path of movement of pin catch 36.

A spring 48 is connected between the trip piece 40 and a projecting arm 49 on the switch frame to urge this trip piece toward circuit breaking position.

Stops in the form of lugs 50 on the frame 29 limit the extent of movement of yoke piece 20. At 51 are illustrated screws for holding the switch frame in place within the chamber.

Assuming the switch and breaker parts to be in the position of Fig. 1, in order to close the switch the handle 22 is moved to the left. The yoke 20 is also moved to the left and the springs 39, when past the center point, pull the throw piece 33 over. Pin catch 36 engages the free end of bar 42 and pushes trip piece 40 (against the action of spring 48) so that contact 43 engages stationary contact 18. The parts are then in the position of Fig. 2.

The switch is thrown off by a reverse movement of the handle whereby the yoke, springs 39, and throw piece 33 move back and trip piece 40 is pushed back by engagement with the insulating block 35. The spring 48 aids in this return movement of the trip piece 40.

When the switch is "on", current goes through terminal 16, contacts 18 and 43, bar 42 (with its bimetallic piece 47), connection 44, cable 45, connection 46, and load terminal 17. On an overload or short circuit the bimetallic element 47 becomes heated and flexes upwardly, lifting the free end of bar 42 clear of the end of catch pin 36.

Spring 48 then pulls the trip piece 40 to disengage contact 43 from contact 18. The other parts of the device remain in substantially the

same position. See Fig. 3. As long as the bimetallic bar is flexed, the switch is trip free, that is, the circuit cannot be switched or held "on" until the electro-responsive means returns to normal.

To reset the device, after the bimetallic element has been allowed to cool, it is merely necessary to throw the handle to "off" position, when the yoke will move springs **39** to pull the throw piece **33** back. The end of pin **36** will slide under and slightly flex the end of bar **42** until the pin passes behind the end of the bar to the position shown in Fig. 1. The switch may then be thrown "on" as before.

When the switch is in either the "off" or "tripped" position the walls of chamber **19** act as stops for the contact end of element **40** and the catch end of element **33**.

By the above described structure I have provided an extremely efficient, simple, and compact circuit breaker. The small size of the chamber permits the use of the compression arc interruption principle and does away with expensive auxiliary arc quenching mechanisms. The switch casing and arc quenching medium are one and the same. No matter what form of movement the contact may make in breaking the circuit, the only seal necessary around a moving part is the simple one at the handle.

The close fit of the casing parts with one another and with the terminal pieces means not only a good seal for compression arc interruption but also entirely eliminates any flash from the arc outside of the casing. The handle structure is also incidentally effective as a fire hazard destroyer. There are absolutely no vents in the casing.

Besides strengthening one wall of the chamber and making a seal at that wall, the switch handle reinforcing plate inside of the chamber automatically increases its sealing effect when pressure is built up in the chamber. Internal pressure tends to make this plate adhere even more closely than usual to the inside wall. In spite of this, no added strain is thereby put on either the switch handle or internal mechanism.

Another result of this structure is to materially reduce the size of circuit breakers, making them more easily adaptable in places where fuses were formerly used.

In Fig. 9 I have shown a slightly modified form of compression chamber casing in which **110** is the top piece; **111**, the base; and **113**, a gasket of rubber or other suitable material. This casing has the interior chamber **119**, the convex outer surface **121**, the handle slot **124**, and other parts similar to the form previously described. The casing parts, and the gasket, form a tight seal with each other and around the terminal members **16** and **17** as in the first form.

I claim:

1. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts on heavy overload, will expand and create pressure sufficient to extinguish the arc rapidly without the assistance of any escaping gas, that improvement which includes a switch mechanism for moving said contacts into and out of engagement with each other mounted entirely within said compression chamber, electro-responsive means for opening said switch mechanism upon overload also mounted entirely within said chamber, and means for actuating said switch mechanism, said actuating means being manipulative from outside of said chamber, and means preventing the escape of gas under pressure from said casing at the location of said actuating means.

2. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume and strength of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts on substantially short circuit conditions, will expand and create pressure sufficient to extinguish said arc rapidly without the assistance of any escaping gas, that improvement which includes a means for moving said contacts into and out of engagement with each other mounted entirely within said compression chamber, electro-responsive means also mounted entirely within said chamber for opening said switch mechanism by relatively moving said contacts out of engagement with each other, and means for resetting said electro-responsive means, said resetting means being manipulative from outside of said chamber, and means preventing the escape of gas under pressure from said casing at the location of said resetting means.

3. In a circuit breaker of the type having a sealed compression chamber of molded electric insulating material and contacts movable relative to one another located within said chamber, the volume and strength of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts on heavy overload, will expand and create pressure alone sufficient to extinguish said arc rapidly, that improvement which includes a switch mechanism for moving said contacts into and out of contact with each other mounted entirely within said compression chamber, electro-responsive means also mounted entirely within said chamber for opening said switch mechanism by relatively moving said contacts out of engagement with each other, and a handle for actuating said switch mechanism, said handle extending outside of said chamber, and sealing means preventing the escape of gas under pressure from said casing at the location of said handle.

4. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts, will expand and create pressure sufficient to extinguish said arc rapidly, the improvement which includes a switch mechanism for moving the contacts into and out of engagement with each other and mounted substantially entirely within the compression chamber, electro-responsive means also mounted substantially entirely within said chamber for separating said contacts, a handle slidable along a longitudinal slot in said chamber for actuating said switch mechanism, a sealing plate separately and yieldably mounted with respect to said handle held against the inside of said chamber and extending across said slot when the handle is in position with the contacts closed, said sealing plate being pressed against the inside of the chamber around said slot to close the slot on the generation of pressure within the chamber, said handle extending through the sealing plate.

5. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts, will expand and create pressure sufficient to extinguish said arc rapidly, the improvement which includes a switch mechanism for moving the contacts into and out of engagement with each other and mounted substantially entirely within the compression chamber, electro-responsive means also mounted substantially entirely within said chamber for separating said contacts, a handle slidable along a longitudinal slot in said chamber for actuating said switch mechanism, a sealing plate held against the inside of said chamber and extending across said slot when the handle is in position with the contacts closed, said sealing plate being pressed against the inside of the chamber around said slot to close the slot on the generation of pressure within the chamber, said handle extending through the sealing plate, and flanges on said handle closing said slot on the outside of the chamber.

6. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts, will expand and create pressure sufficient to extinguish said arc rapidly, the improvement which includes a switch mechanism for moving the contacts into and out of engagement with each other and mounted substantially entirely within the compression chamber, electro-responsive means also mounted substantially entirely within said chamber for separating said contacts, a handle slidable along a longitudinal slot in said chamber for actuating said switch mechanism, a sealing plate held against the inside of said chamber and extending across said slot when the handle is in position with the contacts closed, said sealing plate being pressed against the inside of the chamber around said slot to close the slot on the generation of pressure within the chamber, said handle extending through the sealing plate, said sealing plate being of metal resiliently held against the inside of the chamber and movable with the handle.

7. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts, will expand and create pressure sufficient to extinguish said arc rapidly, the improvement which includes a switch mechanism for moving the contacts into and out of engagement with each other and mounted substantially entirely within the compression chamber, electro-responsive means also mounted substantially entirely within said chamber for separating said contacts, a handle slidable along a longitudinal slot in said chamber for actuating said switch mechanism, a sealing plate held against the inside of said chamber and extending across said slot when the handle is in position with the contacts closed, said sealing plate being pressed against the inside of the chamber around said slot to close the slot on the generation of pressure within the chamber, said handle extending through the sealing plate, said sealing plate being of metal resiliently held against the inside of the chamber and movable with the handle, and non-metallic flanges on the handle closing said slot outside of the chamber.

8. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts, will expand and create pressure sufficient to extinguish said arc rapidly, the improvement which includes a switch mechanism for moving the contacts into and out of engagement with each other and mounted substantially entirely within the compression chamber, electro-responsive means also mounted substantially entirely within said chamber for separating said contacts, a handle for actuating said switch mechanism and extending out of the chamber, sealing means around said handle where it passes out of the chamber to check the escape of gas from the chamber, a spring cooperating with said handle and sealing means for pressing said sealing means against the inside of said chamber, said switch mechanism being of the type in which said contacts are moved in and out of engagement by at least one of the contacts having an arcuate motion.

9. In a circuit breaker of the type having a sealed compression chamber and contacts movable relative to one another located within said chamber, the volume of said chamber being such that the entrapped gases, when heated by the arc drawn between said contacts, will expand and create pressure sufficient to extinguish rapidly said arc, that improvement which includes a switch mechanism for moving said contacts into and out of contact with each other mounted entirely within said compression chamber, electro-responsive means also mounted entirely within said chamber for separating said contacts, a handle extending through and movable along an elongated slot in said chamber, a sealing plate yieldably mounted on said handle and closing said slot on the inside of the chamber, a portion of the chamber wall transversely on each side of the slot being thin and countersunk, said sealing plate being substantially wider than said thin portion of the chamber wall whereby the pressure applied to said sealing plate on the inside of the casing is transmitted to portions of the chamber walls which are thicker than said thin portion, said handle extending through and being movable with said sealing plate.

10. A circuit breaker having walls of electrically insulating material forming a gas-tight compression chamber, a stationary and a movable contact in said chamber, snap action operating means for said movable contact mounted in said chamber, an elongated opening in one wall of said chamber, a handle for said operating means extending through said opening, a pivoted support for said handle in said chamber, a sealing plate carried by said handle cooperating with an inner surface of said wall adjacent said opening so as to seal said chamber gas-tightly when said handle is in a position to move said movable contact into engagement with said stationary contact, said walls defining a chamber having a relatively small volume such that the air entrapped at about atmospheric pressure in said chamber is heated by the arc formed upon separation of said contacts in opening a circuit to thereby generate gas pressures sufficient to extinguish the arc rapidly.

11. A circuit breaker having a gas-tight chamber, stationary and movable contacts within said

chamber, snap action means for automatically operating said movable contact to open the circuit on overload, a handle pivoted in said chamber for operating said movable contact and extending out of the chamber through a slot, a sealing plate carried by the handle and cooperating with an inner surface of said chamber along said slot to seal the chamber against escape of gas, said chamber being narrow and small enough to allow and strong enough to withstand gas pressure generated by an arc under heavy overload or substantially short circuit to quench the arc substantially solely by said gas pressure.

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