July 3, 1951 J. R. McFARLIN 2,559,024

ELECTRICAL DISCONNECTOR

Filed July 19, 1944

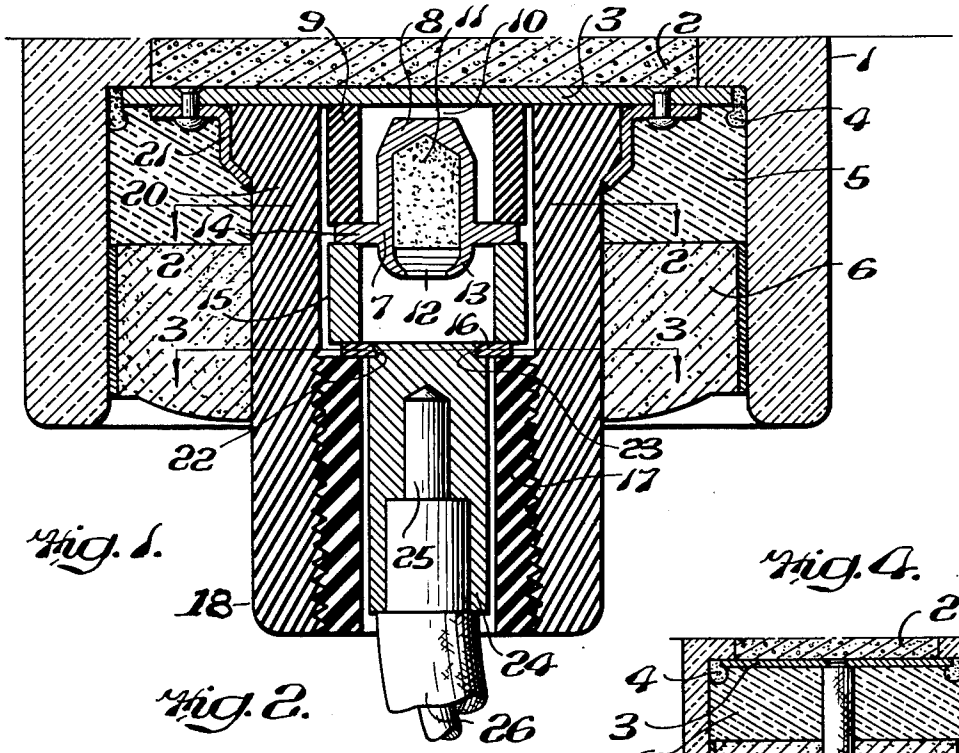


Fig. 1.

Fig. 2.

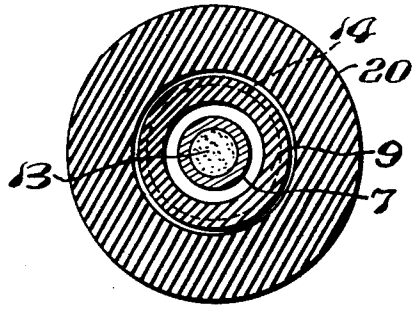


Fig. 3.

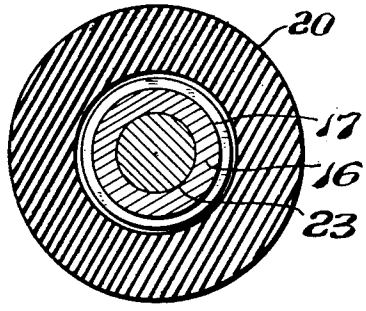
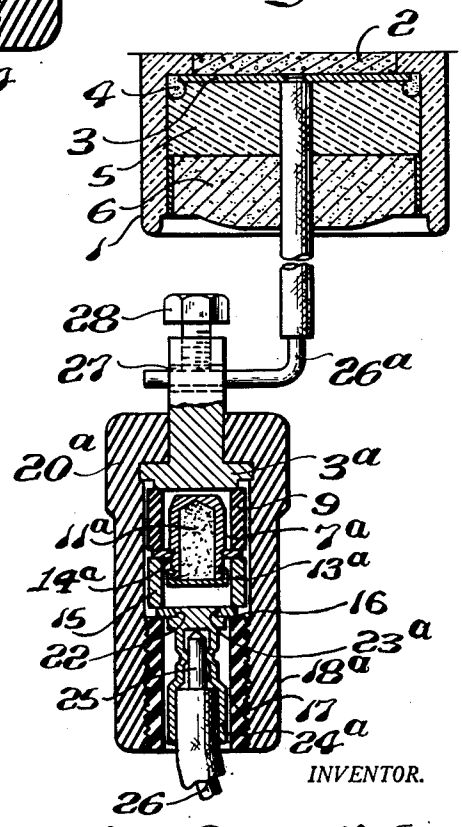


Fig. 4.



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Patented July 3, 1951 2,559,024

UNITED STATES PATENT OFFICE

2,559,024

ELECTRICAL DISCONNECTOR

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Application July 19, 1944, Serial No. 545,644

2 Claims. (Cl. 200—113)

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My invention is an electrical disconnector permitting the flow of heavy surges of current of brief duration but interrupting the flow of dynamic currents such, for example, as those flowing to ground through a lightning arrester which has become defective in use by sintering, accumulation of moisture or other fault.

My invention is particularly designed to interrupt flows of dynamic current to ground following a lightning discharge through a failed arrester, and which dynamic follow currents are of insufficient magnitude to blow up the failed arrester under the following general conditions, viz.,

1. Where the flow of follow current, which is insufficient to blow up the failed arrester, plus the normal current flowing in the circuit is more than that required for the operation of circuit breakers or fuses controlling or limiting maximum current through the circuit. Under this condition the circuit breakers will open and fuses will blow. When breakers are reclosed or fuses replaced they will again operate. The circuit under these conditions will therefore be out of service until such time as the failed arrester is located and disconnected therefrom. In the interim users are without power and the operator is subjected to inconvenience, trouble and expense.

2. Where the flow of follow current is so diminished by the characteristic element of the arresters, by circuit and ground conditions and by other factors, that its magnitude makes the total circuit current less than that required for the operation of circuit breakers or fuses controlling or limiting maximum current through the circuit. Under this condition the continued flow may damage equipment connected with the circuit (due, for example, to low voltage on a portion of the circuit), or may cause radio interference or other troubles detrimental to the circuit or to consumers connected to the circuit, or both.

My improved disconnector is primarily designed for incorporation in standard types of lightning arresters, such, for instance, as those illustrated in my Letters Patent No. 1,763,667, but disconnectors embodying my improvements may be housed in a separate housing and connected with an arrester or other equipment and with ground by conductors of any desired relative lengths.

My improved disconnector provides a conducting path containing spaced electrodes forming an arc gap interposing little impedance to the flow of surge current; the arc gap being of such width

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that it is readily arced over by such surge current and the arc maintained by a minimum flow of dynamic current.

In accordance with my invention, the heat resulting from the maintenance of such arc is utilized to interrupt the current flow without separating the gap electrodes and is transmitted to a thermally responsive substance. Preferably the flow-interrupting means includes a displaceable conductor and a heat responsive gas-generating substance, which are activated responsively to current in a period of time less than that required for the actuation of the line circuit breaker or fuse under the particular operating conditions of a particular circuit. The energy of the arc transmitted to the thermally responsive substance is insufficient to operatively affect such substance within the period of time normally required for the extinction of the arc by a properly operating lightning arrester in series and coordinated therewith, or even within a half cycle of the dynamic current.

The heat of the arc formed between the fixed gap electrodes whose positions are unaffected by the operation of the disconnector is preferably utilized to effect the combustion of combustible material in close proximity to the arc. The arc is initiated between the spaced gap electrodes of the disconnector by a discharge of abnormal surge current or lightning whose duration or amount is insufficient to initiate the combustion of the combustible material. The follow current is normally interrupted by the arrester before combustion of the combustible material is initiated. Upon failure of an arrester, the magnitude of follow current flow is generally insufficient to effect instantaneous (within a half cycle) operation of a circuit cut-out but the heat of the arc formed by the flow to ground is sufficient to initiate combustion of the combustible material within a time less than that required for the operation of the line circuit breaker or fuse, whose time lag is proportioned inversely to the magnitude of current flowing therethrough.

In a preferred embodiment of my invention, the heat responsive, gas-generating substance is an explosive of sufficient force to displace a conductor forming a part of the current path without separating the gap electrodes and the gas-generated by the explosion creates a pressure and turbulence assisting in the extinguishment of the arc drawn by the displacement or parting of the conductor.

One of the arc gap electrodes preferably consists of a cartridge comprising a thermally and

electrically conducting shell forming a container for the gas-generating or explosive substance, and the other of the electrodes may consist of the conducting end plate of a lightning arrester on which is supported a characteristic element, such as silicon carbide, designed to normally diminish the flow of dynamic current sufficiently to permit the interruption thereof by an arc gap or gaps in the arrester before the flow has persisted long enough to operate the disconnector.

In many cases, I find it desirable to employ a cartridge containing two types of explosive, viz., an "ignitor" charge and an "explosive" charge. The ignitor, used generally in small amount, is chosen to fire at a temperature which can be closely predetermined. When this fires, it detonates the explosive or major gas forming element. While it is not necessary in all cases to employ these two types of explosive for the proper operation of my invention, I have found that by so doing it is possible to build disconnectors having much more critical temperatures of operation than would otherwise be possible and by so doing to have such disconnectors more closely coordinated with the current characteristics of the circuit on which they are installed.

The conductor displaceable by the detonation of the explosive is normally held in electrical conducting relationship with the cartridge by a readily detachable support, such, for instance, as an incised, flexible, or frangible member made of conducting material or having a conductor associated therewith to facilitate flow of surges to ground. The force of the explosion is sufficient to detach the displaceable conductor from its support by shearing, buckling or breaking the support and permit the conductor to drop and interrupt the flow of dynamic current to ground. Preferably the support is positioned by a sleeve surrounding the displaceable conductor and composed of or containing a substance, such as hard fibre or borax, which generates deionizing gas when subjected to the heat of an arc drawn by the parting conductor. Such deionizing gas facilitates the extinguishment of the arc.

The characteristic features and advantages of my improvements will further appear from the following description and the accompanying drawings in illustration thereof.

In the drawings, Fig. 1 is a transverse sectional view of a disconnector embodying my invention integrally incorporated in the base of a lightning arrester; Fig. 2 is a transverse sectional view taken on the line 2—2 of Fig. 1; Fig. 3 is a transverse sectional view taken on the line 3—3 of Fig. 1; and Fig. 4 is a transverse sectional view of a modified form of disconnector embodying my invention inserted in the ground lead of a lightning arrester.

In Figs. 1, 2 and 3, I have shown my improved disconnector forming an integral part of a lightning arrester, such as that shown in my Letters Patent No. 1,763,667 having an insulating casing 1 containing a characteristic element 2, such as discrete particles of silicon carbide, supported on an end electrode preferably consisting of a brass plate 3 which is held in position and sealed by a gasket 4 and the layers of cement 5 and 6.

A cartridge 7 has its closed end 8 spaced from the electrode 3 by a ring 9 of insulating material, such as steatite, to provide an electrode complementary to the electrode 3 and form therewith an arc gap 10. The cartridge 7 is preferably formed of metal of low electric resistivity and high thermal conductivity, as for instance, copper, and

contains a primer or gas-generating explosive 11 susceptible of detonation by ignition or heat and characterized by a wave of combustion, such for instance as mercury fulminate or black powder, or nitro-cellulose. The action of such explosive may be augmented by the inclusion in the cartridge of an explosive or explosives characterized by an explosive wave of decomposition and detonated by concussion, as, for instance, smokeless powder or nitro-glycerine products. The explosive is compacted in the cartridge by wads 12 which may be secured in place by the converging lips 13 of the cartridge.

The cartridge 7 is mounted on a disk or flange 14 which may be formed integrally with the cartridge and is held between the insulating ring 9 and a conducting ring 15, preferably of brass, which is supported on a brass disc or washer 16. The disk 16 is supported by a collar 17 preferably made of hard fibre or of plastic lined with fibre and threaded into the bottom portion of the Bakelite housing 18. The housing 18 has an enlarged top shoulder 20 engaged and supported by a tapered ring 21 having clips riveted or welded to the electrode 3, or by other suitable means. This attachment serves the purpose of centering the housing 18 with respect to the electrode 3 and prevents sealing compound 5 from flowing between the top of the housing and the bottom of the electrode 3.

The disc 16 contains a downwardly tapered seat 22 in which is frictionally secured the dovetailed head 23 of a conducting plug 24 containing a socket for the reception of the terminal 25 of an insulated ground conductor 26.

The means disclosed in the drawings for positioning the plug is illustrative only. Any means that permits the expulsion of the plug 24 without causing separation of the electrodes 3 and 8 under operating conditions may be used.

In the ordinary discharge of lightning or surge currents from a dynamic circuit to ground, the high voltage discharge arcs over the usual arrester gaps (not shown) passes through the characteristic element 2, arcs over the gap 10, and is discharged to ground through the casing and flange of the cartridge 7, the conducting ring 15, disc 16, plug 24, terminal 25 and ground lead 26. The dynamic or follow current, tending to follow the surge discharge to ground is normally interrupted by the action of the arrester's characteristic element and arc gaps before the heat of the arc across the gap 10 detonates the explosive 11 or the igniter portion thereof in the cartridge 7.

If, however, the arrester's arc gaps and characteristic element fail to shut off the flow of the follow current, the continued flow or leakage of dynamic current to ground maintains the arc across the gap 10 until the heat generated thereby detonates the igniter portion of the explosive 11. The sudden expansion of gases from the explosive blows the dove-tailed head 23 through the tapered seat 22 of the disc 16 and expels the plug 24 and ground lead 26 connected therewith, thereby effectively interrupting the flow or leakage of dynamic current to ground without otherwise damaging the arrester or disconnector; the extinction of the arc drawn by the parting plug being accelerated by the pressure and turbulence caused by the explosion and expanding gases and preferably by the liberation of deionizing gases from the tube 17 which is preferably made of fibre, or of a substance provided with an inner lining of fibre, or other substance which contains

a gas generating substance which is activated by an arc to generate deionizing gases tending to extinguish an arc. The extinction of the arc drawn by the parting plug is accelerated by the pressure and turbulence caused by the explosion and expanding gases, as well as by the substantially concurrent voluminous generation and agitation of deionizing gas between the conducting elements without the necessity of parting them the maximum distance across which an arc would be normally maintained by the impressed voltage and the magnitude of the current flowing, or the danger of such arc moving into dangerous proximity with other objects.

The length of collar **17** may be varied in accordance with the voltage of the circuit on which the lightning arrester is installed and/or with the magnitude of current which the disconnector may be called upon to interrupt. For example, on a 2400 volt circuit with a given expected current flow through the disconnector under operation the length of collar **17** may be 1 inch; on a 15,000 volt circuit with a given expected current flow through the disconnector under operation the length of collar **17** may be 6 inches or more.

Disconnectors are ordinarily so designed that they will withstand without operating the maximum lightning or surge current that can be safely carried by the lightning arrester. Tolerances permissible and necessary in the manufacture of disconnectors will affect their operating characteristics, including their ability to carry lightning or surge current; likewise tolerances permissible and necessary in the manufacture of lightning arresters will affect their operating characteristics, including their ability to carry lightning or surge currents; and the characteristics of lightning and surge currents discharged into lightning arresters from the circuits to which they are connected vary widely as to voltage, current, wave shape and duration.

It may therefore be expected that with the most highly developed type of disconnector, conditions in service may occasionally occur where the disconnector may operate under lightning conditions not severe enough to damage the lightning arrester of which it is a part. The ability to readily dis-assemble my disconnector, inspect internal parts, determine whether or not the lightning arrester itself has been damaged and if not to reassemble the unit and put it back into service again in such cases as the foregoing overcomes the possibility of discarding an otherwise operative arrester, with consequent economies incident thereto.

In the embodiment of my invention illustrated in Fig. 4, a gap electrode **3***a* is molded in the upper portion of an insulating shell or housing **18***a*, and has a shank or wire molded in and projecting through the cap **20***a* of the housing. A conducting cartridge shell **7***a* is seated in a conducting disk **14***a* which is spaced from the electrode **3***a* by an insulating collar **9** and is supported on the conducting ring **15** which rests on a conducting washer **16** held in place by a threaded fibre sleeve **17** as hereinbefore described in connection with Figs. 1 to 3. The sleeve **17** is composed of or lined with a substance, such as fibre or borax, which is nonexplosive but which liberates deionizing gases under the influence of heat generated by an arc. The cartridge shell **7***a* is filled with one or more explosives **11***a* which are held in place by a gasketed cap **13***a* spun over the mouth of the cartridge shell. The bevelled seat **22** of the washer **16** has seated therein the bevelled head **23***a* of a terminal **24***a* which encloses the end of the cable **26** and has a median section crimped on the wire **25** of such ground lead. The shank of the electrode **3***a* may be connected in any convenient manner with the ground terminal of a lightning arrester, as, for instance, by inserting the arrester's ground lead **26***a* in a terminal slot **27** of the shank of the electrode **3***a* and clamping it in place by a bolt **28**. The disconnector may, however, be provided with a wire directly attached to a usual ground clamp of an arrester or to a ground lead thereof by means of a usual service connector.

In operation this form of my invention operates in the same manner as described in Figs. 1 to 3, and there is avoided any shattering of the housing of the arrester or disconnector and the dangling conductor **26** and terminal **24***a* provide visual indication that the arrester has failed to interrupt the flow of follow current and that the disconnector has been operated.

Having described my invention, I claim:

1. An electrical disconnector comprising an insulating housing having an electrode sealed therein, a cartridge shell spaced from said electrode and forming therewith an arc gap, said cartridge containing an explosive, an insulator spacing said electrode and shell, a fibre tube carried by said housing, a conductor support mounted on said fibre tube, a conducting member electrically connecting said support and shell, and a conductor connected with said support and separable therefrom by the detonation of said explosive.

2. An electrical disconnector comprising a cartridge flanged intermediate its ends having a conducting shell and containing an explosive, an electrode complementary to said shell and forming an arc gap therewith, a non-conducting spacer between said electrode and the flange of said cartridge spacing said electrode and shell, said explosive being set off as a result of arcing at said gap, a conductor support spaced from said shell, a conducting spacer between said shell and support, and a conductor detachable from said support by the detonation of said explosive.

JOHN ROBERT McFARLIN.

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