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F. R. SEAVEY

2,248,587

EXPLOSIVE

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Fig. 1.

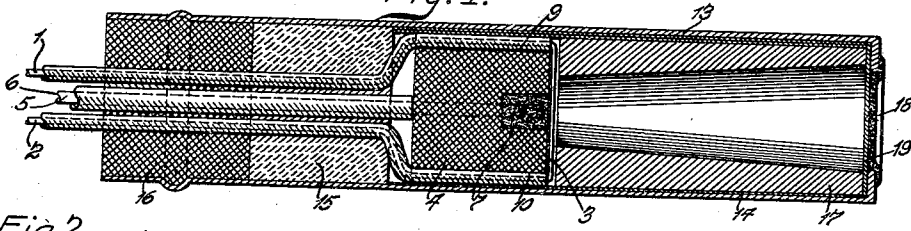


Fig. 2.

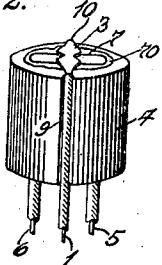


Fig. 3.



Fig. 4.

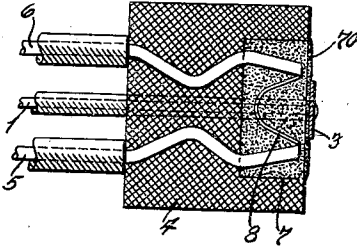


Fig. 5.

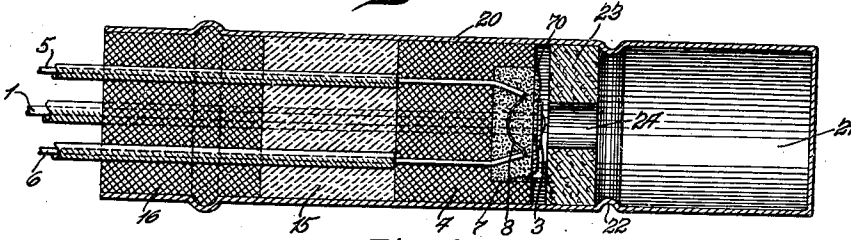


Fig. 6.

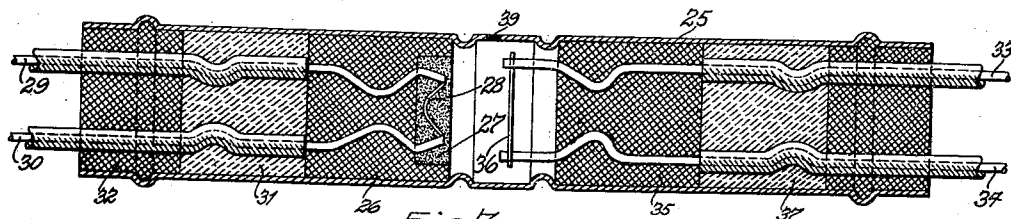
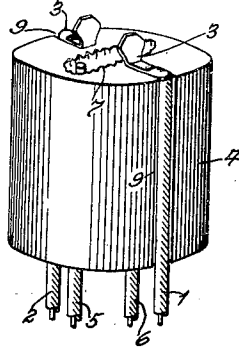


Fig. 7.



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2,248,587

EXPLOSIVE

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13 Claims. (Cl. 102—5)

This invention relates generally to circuit breakers, or time break caps, of a type actuated through an explosive charge. The time break caps of the present invention are particularly adapted for use in connection with oscillograph operations, such as employed in the seismographic method of prospecting for oil.

In oscillograph operations, such as are employed in the seismographic method of prospecting for oil, it is desired to obtain on the oscillograph record a definite reference point either concurrently with, or a constant time interval from, the detonation of the main explosive charge. Heretofore this has been accomplished by running an electrical circuit in proximity to an explosive charge, such as a common blasting cap. Such circuit is ordinarily energized and connected so as to show its variations upon the oscillograph and is adapted to be broken so as to produce a sharp break upon the oscillograph record pursuant to detonation of the explosive charge which it is associated with.

The use of explosive charges or devices, such as ordinary electric blasting caps in association with an energized circuit for interrupting the circuit has proved to be dangerous. Accidents have occurred resulting in the loss of life and property.

The object of the present invention, generally stated, is to provide an explosive actuated circuit breaker of the type which will be positive in its action and withal safe to handle and use.

A further object of the invention is to provide an explosive actuated circuit breaker in which a relatively small charge of explosive is coordinated and arranged so as to effect the breaking of an electrical circuit.

A more specific object of the present invention is to provide a unitary explosive actuated circuit breaker which may be initiated by an electrical charge, and which is arranged with a secondary electrical circuit so as to effect a positive breaking of the secondary electrical circuit either concurrently with, or within a substantially constant time interval from, the detonation of the explosive charge.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawing, in which—

Figure 1 is a longitudinal sectional view of an explosive actuated circuit breaker constructed in accordance with one embodiment of the present invention;

Figure 2 is a perspective view of the component of the circuit breaker illustrated in Figure 1 which

confines the explosive charge and maintains the secondary circuit in proximity thereto;

Figure 3 is a detail view of the secondary lead wire adjacent the explosive charge in the device shown in Figure 1;

Figure 4 is a sectional view of the component shown in Figure 2, such section being taken at right angles to the section shown in Figure 1;

Figure 5 is a longitudinal sectional view of an explosive actuated circuit breaker constructed in accordance with another embodiment of the present invention;

Figure 6 is a longitudinal sectional view of an explosive actuated circuit breaker constructed in accordance with a further embodiment of the present invention; and

Figure 7 is a perspective view showing particularly the relation of the ends of the secondary circuit after operation of the device shown in Figures 1 and 5.

In accordance with the present invention, generally stated, an electrical lead wire is arranged to be broken by an explosive charge which latter is set off by an electric current separate from the current which may be conducted by the lead wire to be broken. The electrical lead wire to be broken is, for brevity, herein referred to as the secondary circuit.

The present invention particularly contemplates the arrangement of a part of the secondary circuit in such association and coordination with an explosive charge that the force of the explosive charge may be efficiently directed toward breaking the secondary circuit part and so that excess explosive energy may be maintained at the minimum. Consequently the energy of the entire explosive charge will be dissipated in such manner as to avoid damage to persons or property in the vicinity of the same when it is operated. Many arrangements of the various components of a device of the character referred to may be employed, and consequently several embodiments of the explosive actuated circuit breaker contemplated by this invention are shown in the accompanying drawing and described herein.

The present invention contemplates specifically a suitable arrangement of parts whereby a secondary circuit is disposed so as to receive the force of an electrically initiated explosive charge; the secondary circuit is arranged and coordinated with the explosive charge so as to be positively broken by detonation of the explosive charge; and the components are arranged together so that a substantial current may be passed through the secondary circuit without affecting the explosive.

In general a small charge of suitable brisant explosive arranged to be electrically set off may be employed in combination with any suitable means for holding a secondary lead wire in position to receive the force of, and be broken by, the explosion.

In the case of electrically actuated circuit breakers intended particularly for seismograph work, and other work where the current in the secondary circuit is not large, it is desirable that the explosive charge be one having a relatively low ignition temperature. On the contrary, where relatively large currents may be handled and the parts are arranged so that the current traversing the secondary circuit is liable to heat the explosive charge, it is desirable to use an explosive charge having a relatively high ignition temperature. It will be understood that in any case the explosive charge or an increment thereof must be sufficiently brisant to effect the breaking of the secondary circuit. In cases where the gases resulting from the explosion come into actual contact with the part of the secondary circuit which is broken, the explosive materials are preferably so chosen that no metallic decomposition product will be formed at a location where it might reestablish the broken secondary circuit.

Referring now particularly to Figures 1 to 4 inclusive, of the drawing for one illustrative embodiment of the present invention, a pair of lead wires 1, 2 which comprise the secondary or oscillograph circuit and which are intended to be broken by the device, are arranged together so that a part 3 connecting lead wires 1, 2 may receive the force of, and be broken by, the explosive charge.

As illustrated in the drawing, the explosive charge is contained in a sulphur plug 4 which has been molded about lead wires 5, 6 (of the explosive actuating circuit) and which is provided with a cavity 7 arranged to receive the charge of explosive. Across the ends of the wires 5 and 6 a resistance bridge wire 8 may be provided. The parts 4, 5, 6, 7, and 8, or their equivalents, may be arranged together in any suitable manner, such as common in electric blasting caps as disclosed in United States Patent No. 1,605,688 to Olin and Schuricht, or United States Patent No. 2,133,119 to Smith, Seavey and Taylor, or any other well known construction.

It will be observed, however, as clearly shown in Figure 4, that the bridge wire 8 is bent so as to lie substantially deep in the cavity 7. This may be accomplished by bending the ends of wires 5 and 6 in cavity 7 toward each other, as clearly shown in Figure 4. Such an arrangement of parts not only assures that the ends of leads 5 and 6, as well as the bridge wire 8 will be definitely out of contact with the adjacent parts of the secondary circuit, but also assures that a part at least of bridge wire 8 will be in contact with explosive mixture which has not been affected by any sealing composition which may be used thereon.

The explosive employed in cavity 7 may be an explosive material, explosive mixture, or series of explosive increments whose explosion is capable of being initiated (the word "initiated" is here used in the sense of starting an explosive decomposition by the application of an extrinsic force) by the heating of bridge wire 8. For example, loose, dry, lead styphnate may be employed, about one-third grain being sufficient, in the embodiments illustrated in the drawing to accomplish the desired result. Other explosive materials and

explosive mixtures may, however, be employed, it being understood that in addition to being capable of being initiated by the heating of bridge wire 8, the explosive, or at least one increment of an explosive mixture, or series, should be a material of sufficient brisance to effect a breaking of part 3 of the secondary circuit. For example, a material such as tetracene which would be readily initiated by the heating of bridge wire 8 might be supplemented with a small charge of lead azide to provide the necessary brisance to effect the breaking of the secondary circuit. The lead azide and tetracene might be used either in mechanical mixtures, or in layered charges, it being understood that the tetracene would be arranged in position to respond to the heating of bridge wire 8 and the lead azide arranged in position to be set off by the tetracene. A great variety of other explosives, mixtures thereof, and layered charges will, of course, present themselves to those skilled in the art, and may be used in lieu of the materials specifically described.

After the cavity 7 is filled with the explosive material, it may be sealed in place with any suitable material which will not interfere with the activity of the explosive charge. For example, the charge may be covered with a drop of cellulose acetate lacquer which, when dry, forms a sufficiently strong film 70 to retain the explosive in position, and also insulates secondary lead wire part 3 from the explosive charge.

In the embodiment shown in the drawing, the plug 4 is provided with a pair of longitudinally extending grooves 9, 10, in the exterior surface thereof for the accommodation respectively of secondary lead wires 1 and 2. The lead wires 1 and 2 may be a continuous piece of wire having an intermediate part 3 arranged so as to be readily ruptured by the explosive charge 7, or alternatively the secondary wires 1 and 2 may be bridged by a separate element arranged to be ruptured by the explosive. In the embodiment shown in Figures 1 to 4, inclusive, however, the part 3 is arranged adjacent the explosive charge as an integral part of lead wires 1 and 2. The part 3, however, has had the usual insulation removed from it and has been operated upon so as to provide an enlarged surface area to receive the force of the explosion as well as a constricted region which will be readily ruptured, but which will, nevertheless, be capable of carrying the required current for the necessary period of time. For example, the part 3 may be operated upon to produce a region such as shown in Figure 3, where the intermediate part of the wire has been flattened as shown at 11 and notched on opposite sides as shown at 12. Care should be taken, however, in such treatment of the wire to leave a cross sectional area at the constricted part capable of transmitting the required current for the required period of time without detrimental effect upon the unit. In actual practice it has been found that 25 gauge copper wire with a constriction of the type shown in Figure 3 having a width of 0.028 inch and having a thickness of from 0.0020 to 0.0025 inch is capable of carrying as much as 15 amperes for 5 minutes, and is capable of carrying 0.03 ampere for as much as 2 hours without interfering with the subsequent normal functioning of the device.

The arrangement thus far described provides an explosive charge adapted to be set off by the energization of bridge wire 8 and which, upon explosion, will be effective to interrupt the circuit through wires 1, 2 by breaking part 3 which, as

shown in the drawing, is held immediately in front of the explosive charge in cavity 7, separated therefrom only by the thin film of material such as cellulose acetate which not only retains the explosive in position in cavity 7, but insulates part 3 from it.

The parts thus far described are also employed in the embodiment shown in Figure 5 where the same reference characters are applied. The parts just described may be enclosed in suitable housing, such as a shell 13, which may be of metal or any suitable insulating material of strength sufficient to retain the parts in position. The material is however, preferably one which will substantially prevent the ingress of moisture. As shown in the drawing, the shell 13 is of tubular configuration, but it will be understood that any desirable shape may be employed. The plug 4, after being assembled with the various wires and other components hereinbefore described, may be inserted in shell 13 and seated within the same. In order to insure that the secondary circuit will be insulated from shell 13, the latter, if metallic, may be lined with a layer of suitable insulating material, such as fish paper. As shown in the drawing the layer of insulating material 14 extends entirely back of plug 4, but it will be understood that the insulating material may be shorter, provided it overlaps the region where the wires 1 and 2, stripped of their insulation, may be liable to contact with the inside of shell 13.

In order to retain plug 4 with its adjunct parts in position, the usual waterproofing components employed in electric blasting cap manufacture may be applied in the shell 13 about wires 1, 2, 5, and 6, as shown at 15, and finally the end of the shell may be closed with a molten sulphur filler 16, as common in electric blasting cap manufacture.

At the opposite end of the shell 13 an insulating sleeve 17 may be provided. Such a sleeve 17 may be formed of any suitable material having electrical insulating properties and, for example, may be composed of cellulose acetate plastic. The sleeve 17 is employed as a means of positively preventing the ruptured ends of part 3 from being propelled into contact with conductive material which might operate to short circuit the same even after being ruptured.

In the assembly of the parts the opening 18 in the end of shell 13 may be closed by a suitable waterproofing arrangement. For example, a disc 19 of material, such as paper or cellulose acetate film may be placed over the opening 18 and sealed in position with a suitable material, such as cellulose acetate lacquer, wax, or the like. In the interest of absolute safety it is desirable that the material employed for closing opening 18 may be of light weight so that the fragments will be of insufficient mass to act as dangerous projectiles. It will be understood, however, that any suitable waterproof closure may be provided for the end of the device. However, it is not essential that a perforated housing be employed, since the desired results may be attained by providing a suitable space into which the explosion gases may expand, the shell being made sufficiently strong so as not to be ruptured by the action of the small explosive charge.

For example, it will be observed in the embodiment now to be described that the end of the shell is not vented.

Referring now to Figure 5 for another illustrative embodiment of the present invention, it will be observed that the arrangement of part

secondary circuit and the explosive and sealing assembly is identical with that hereinbefore described. The enclosing shell, however, is, in this case, in the form of an imperforate cup 20. The cup 20 is provided with a groove 22 arranged so as to position an insulating washer 23 so as to provide therebeyond a space 21. The insulating washer 23 has a central aperture 24 of a size such as to embrace the constricted part 3 of the secondary lead wire and to provide a collar which will tend to concentrate the explosive force and also cause the broken ends of part 3 to be extended in parallelism as shown in Figure 7.

Referring now to Figure 6 for a further illustrative embodiment of the present invention, it will be observed that in this instance a shell 25 is provided at one end with an assembly of parts consisting of a sulphur plug 26 having a cavity 27 filled with suitable explosives and containing a bridge wire 28 connected to leads 29 and 30, all held in position by an increment of waterproofing compound 31 and the usual sulphur filler 32 common in electric blasting caps.

At the opposite end of shell 25 the secondary circuit is arranged. The secondary leads 33 and 34 are arranged in a molded sulphur plug 35 comparable to the sulphur plugs heretofore described and the ends of the secondary leads project inwardly beyond the sulphur plug 35, and are there connected by a rupturable element 36 which is arranged in position to receive the force of the explosive charge within the opposite cavity 27, and be interrupted thereby. The element 36 may be in the form of a wire, such as hereinbefore described, having a constricted part or may be in the form of a strip of metal foil or in any other form which is readily rupturable and arranged to receive the force of explosion of the charge in cavity 27 and be broken thereby.

The sulphur plug 35 may be retained in position by an increment of waterproofing compound 37 and a sulphur filler 38 in a manner corresponding to that hereinbefore described and common in the art of electric blasting cap manufacture.

If desired the shell 25 may be provided with a vent opening 39 which may, of course, be sealed with a suitable waterproofing compound.

From the foregoing description it should be apparent that the present invention accomplishes its objects and that an explosive actuated electrical circuit breaker is provided which is not only positive in its action but safe to handle and to use. In the actual test of a number of devices constructed in accordance with Figures 1 to 4 inclusive, it was found that no metal shell was ruptured by the explosion of the explosive charge, and it was found further that the time lag between the application of current to the initiating circuit and the actual interruption of the secondary circuit was a constant within very narrow limits, it being found specifically (from ten shots) that the average time interval between the application of a five ampere current to the initiating circuit and the actual interruption of the secondary circuit was 0.00048 second, in no case being more than eight-tenths of a milli-second and in no case being less than three-tenths of a milli-second.

While in the foregoing description a full disclosure of several embodiments of the explosive actuated circuit breaker of the present invention has been made, it is realized that many variations in the form and arrangement of parts will present themselves to those skilled in the art without departing from the spirit of this invention. It

is to be distinctly understood, therefore, that the invention is not limited to the specific features of the embodiments hereinbefore described, but that such modifications and the use of such individual features and combination of features as do not depart from the spirit of this invention are, although not specifically described herein, contemplated by and within the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. An explosive actuated device for interrupting a secondary electrical circuit comprising, in combination, a case, an explosive charge within the case, electrical means for initiating the explosive charge, and a secondary conductor associated with the case and having a part, structurally weaker than the remainder, disposed to receive the force of the explosion of said charge and be broken thereby.

2. A device of the kind described comprising, a housing, an explosive charge within the housing, electrical means for initiating the explosive charge, a secondary conductor associated with the case and having a part, structurally weaker than the remainder, and means for maintaining said part in position to receive the force of the explosion of said charge and be broken thereby, said explosive charge being sufficient to break said part but insufficient to rupture said housing.

3. A device of the kind described comprising, a housing, an explosive charge in the housing, electrical means for initiating the explosive charge, a secondary conductor associated with said housing, and means for maintaining a part of said conductor in position to receive the force of the explosion of said charge and be broken thereby, said explosive charge being sufficient to break said part but insufficient to rupture said housing.

4. A device of the kind described comprising, a housing, an explosive charge in the housing, electrical means for initiating the explosive charge, a secondary conductor associated with said housing and having a part, structurally weaker than the remainder, means for maintaining said part in position to receive the force of the explosion of said charge and be broken thereby, and an insulating annulus having an orifice adjacent said part on the opposite side thereof from said explosive charge.

5. A device of the kind described comprising, a housing, a cavitated plug on the interior of said housing, an explosive charge in the cavitated plug, a resistance wire embedded in said explosive charge and having electrical connections arranged to be energized, a secondary conductor provided with electrical connections separate from the connections for said resistance wire, and means for holding said conductor within said housing with a part thereof adjacent the loaded cavity of said plug.

6. A device of the kind described comprising, a housing, a cavitated plug on the interior of said housing, an explosive charge in the cavitated plug, a resistance wire embedded in said explosive charge and connected to be energized, a secondary conductor, means for holding said conductor within said housing with a part thereof adjacent the loaded cavity of said plug, and means insulating said secondary conductor from the explosive charge.

7. A device of the kind described comprising, a

housing, a cavitated plug on the interior of said housing, an explosive charge in the cavitated plug, a resistance wire embedded in said explosive charge and connected to be energized, said plug having a pair of longitudinally extending passages, a secondary conductor in said passages and having a part adjacent the explosive charge.

8. A device of the kind described comprising, a housing, a cavitated plug on the interior of said housing, an explosive charge in the cavitated plug, a resistance wire embedded in said explosive charge and connected to be energized, said plug having a pair of longitudinally extending passages, a secondary conductor in said passages and having a part adjacent the explosive charge but out of direct engagement with the explosive charge.

9. A device of the kind described comprising, a body member having a space, an explosive charge in the space, two pairs of lead wires, means for holding one pair of lead wires with a connecting part adjacent but out of direct contact with the explosive charge, and means for holding the other pair of lead wires with a connecting part embedded in the explosive charge.

10. A device of the kind described comprising, a housing, a cavitated plug sealed in position within and intermediate the ends of said housing, an explosive charge in said cavitated plug, electrical means arranged to initiate said explosive charge and having lead wires entering said housing at one end, a secondary conductor entering said housing from the end opposite said electrical means and sealed in position therein, said secondary conductor having a part disposed to receive the force of explosion from said charge.

11. A device of the kind described comprising, a cup shaped housing, an explosive charge sealed in said housing in spaced relation from the bottom thereof, and a conductor part arranged between said explosive charge and the bottom of the cup, electrical connections extending from said conductor to the exterior of said housing, all being hermetically sealed within said cup.

12. An explosive actuated device for interrupting an electrical circuit comprising, in combination, a housing, an explosive charge within the housing, means for initiating the explosive charge, a line conductor associated with said case and forming a part of the circuit to be interrupted, said conductor having a part arranged to receive shock and be broken upon detonation of said explosive charge, and said explosive charge being so coordinated with respect to said conductor part that the force of said explosive charge is sufficient to break said conductor part, but insufficient to subject environs to substantial shock.

13. An explosive actuated device for interrupting an electrical circuit comprising, in combination, a housing, an explosive charge within the housing, means for initiating the explosive charge, a line conductor associated with said case and forming a part of the circuit to be interrupted, said conductor having a weakened part arranged to receive shock and be broken upon detonation of said explosive charge and said explosive charge being so coordinated with respect to said weakened conductor part that the force of said explosive charge is sufficient to break said weakened conductor part, but insufficient to subject environs to substantial shock.

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