(No Model.)

C. H. RUDD.

ELECTRICAL DETONATOR.

No. 556,902. Patented Mar. 24, 1896.

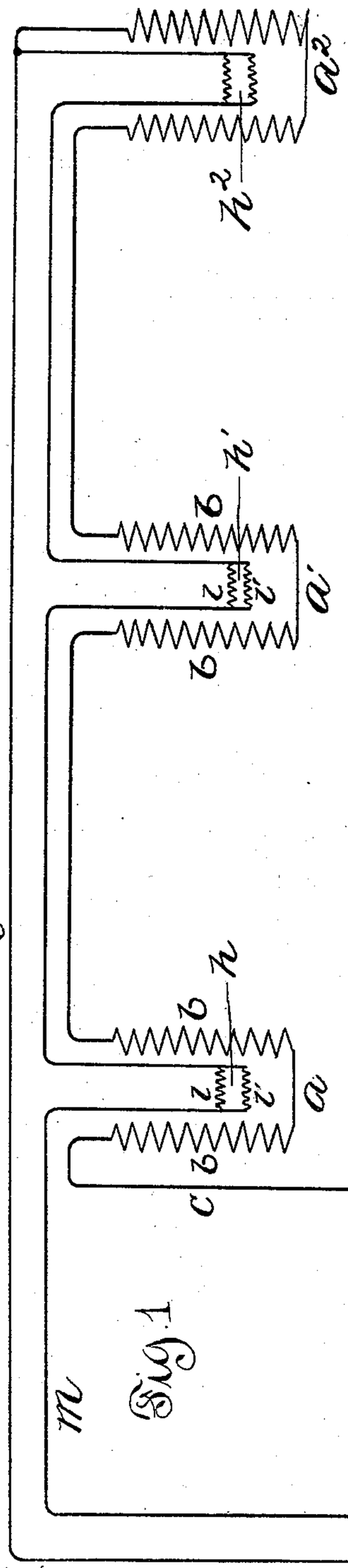

Fig. 1.

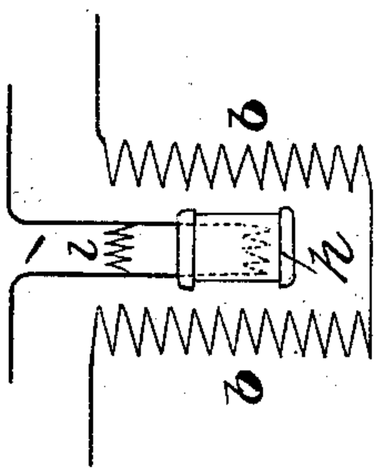

Fig. 3.

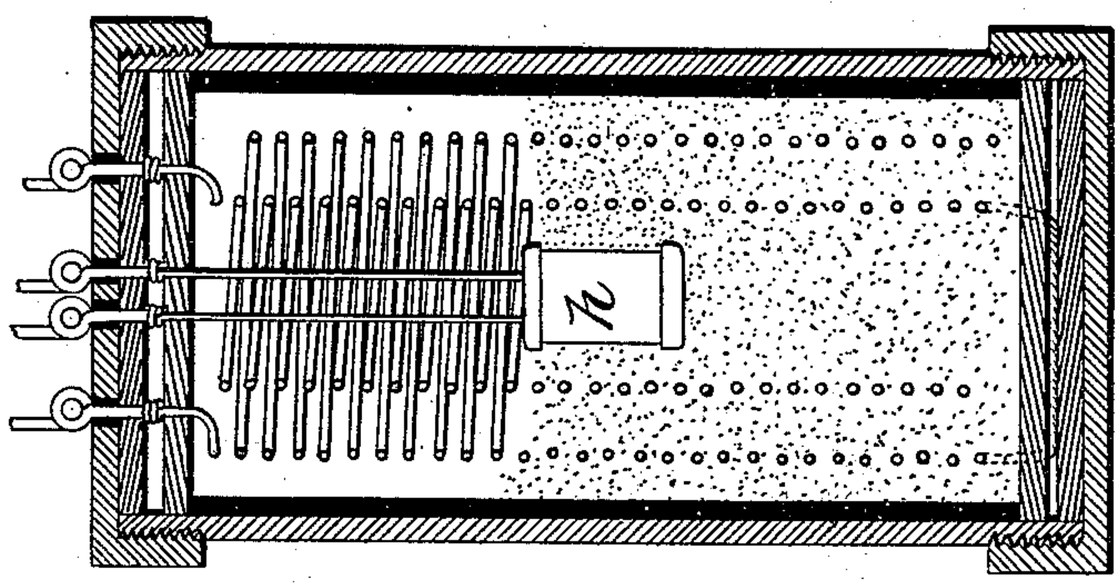

Fig. 2.

Witnesses:
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UNITED STATES PATENT OFFICE.

CHARLES H. RUDD, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

ELECTRICAL DETONATOR.

SPECIFICATION forming part of Letters Patent No. 556,902, dated March 24, 1896.

Application filed February 3, 1894. Serial No. 498,986. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. RUDD, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Electrical Detonators, (Case No. 33,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to electrical detonators; and its object is to effect the firing of a number of explosive cartridges at practically the same time.

In an application, Serial No. 494,725, filed December 27, 1893, I have described an explosive cartridge adapted to be fired through the agency of electricity, said cartridge comprising an explosive material and having embedded therein conductors of electricity through which an electric current may be passed to raise the explosive material to a desired temperature, at which time an igniter is adapted to fire the explosive material. The igniter comprises as the igniting element a wire adapted to be heated by the passage of an electric current to such a degree of temperature that the surrounding material is fired by the heat received therefrom. If these igniting-wires be connected in an electric circuit in series, it is evident that if one wire reaches the firing temperature and fuses in advance of another by an infinitesimal period of time the circuit through the igniting-wires of the remaining conductors will be broken, and the temperature of the igniting-wires of such cartridges not having been brought to the required degree of temperature, explosion of such cartridges does not result. For this reason I have heretofore connected the igniting-wires in circuit in multiple arc; but under some conditions of use—as, for instance, in firing cartridges under water—the multiple-arc system of firing is objectionable, as short circuits, resulting from leaks or falling of insulation resistance, sometimes cause premature explosions.

According to the present invention I am enabled to connect the igniting-wires in series and successfully effect the firing of all of the cartridges.

My invention, broadly considered, comprises two conductors connected in circuit in multiple, the one being of such resistance and current-carrying capacity relatively to the other that it will fuse at the required temperature to effect the ignition of the explosive material, while the other conductor will not fuse until later, if at all, current being thus conveyed by the latter conductor to the igniting-wires of the cartridges last fired, even though the igniting-wire of one cartridge fuse in advance of the others.

I will describe my invention more in detail in connection with the accompanying drawings, in which—

Figure 1 is a diagrammatic illustration of a number of cartridges connected for firing. Fig. 2 is a sectional view of a cartridge embodying my invention. Fig. 3 is a diagram illustrating a modification in which the current-carrying conductor is placed without the igniter-cap.

While I describe my invention in connection with cartridges as described in the application heretofore referred to, in which the temperature of the explosive material is uniformly raised before the igniters are brought into operation, it is evident that my invention may be utilized in other connections, and I do not, therefore, limit myself to its association with any particular form of cartridge.

The cartridges a a' a^2 are provided each with conductors b b distributed throughout the explosive material of the cartridge, so that when current is sent through the conductors the temperature of the material may be raised. The conductors b b may be connected by wires c c' with a source of electricity d, a switch-arm e being provided for opening and closing the circuit at will.

The igniters h h' h^2 comprise each two conductors l l', connected in multiple with one another and in circuit with the conductors of the other igniters in series. With the exception of the conductors the igniters may be in all respects similar to those described in the application heretofore referred to, and may consist of a tube of paper, say, three-quarters of an inch in diameter and five inches long, and capped with paper caps, filled with a powder which is slow in burning

when lighted in the open air, but which, when heated and confined within the heated cartridge, acts spontaneously and gives the necessary impetus to fire the entire charge in which it is embedded. Within this charge of the igniter are placed the two conductors *l l'* above referred to. The conductors are so proportioned relatively as to resistance and current-carrying capacity that the one will fuse before the other to effect the ignition of the charge of the igniter and the explosion of the cartridge, while the other, not fusing until later, if at all, serves to carry the necessary current to the igniting-conductors of igniters, which are ignited later.

For the purpose of this specification I will hereinafter designate the conductor which by its advanced fusion or rise in temperature effects the ignition of the igniter as the "igniting-conductor" and of the other conductor as the "current-carrying conductor."

I have found that iron wire may be advantageously employed as the igniting-conductor, while copper wire of the same gage may be used as the current-carrying conductor, and when so employed, the iron possessing practically six times the resistance of copper, the iron wire may be made one-sixth the length of the copper wire, equal resistances being thus secured in the two parallel branches. The carrying capacity of the iron wire being less than that of the copper wire, the iron wire will be the first to fuse, while the copper wire, even when carrying the additional current resulting from the opening of the parallel circuit through the iron wire, will carry the current for a time sufficient to effect the ignition of all of the igniters. Other materials may, however, be employed, and when properly proportioned the two conductors may be made of the same material, the only requisite being that the current-carrying conductor may remain intact for an instant after the fusion of the igniting-conductor to convey the current to the igniting-conductors of the remaining igniters.

The conductors of the several igniters may be connected in series by a wire *m*, one end of which may be connected with one side of the source of electricity *d*, while the other end terminates in the contact-points of a rheostat. The resistances of the rheostat may be so arranged that when the switch-arm *e* rests upon the first contact-point *m'* the current through the conductors of the igniters is insufficient to raise the igniting-conductors to the fusing temperature. When it is desired to fire the cartridges, the switch-arm *e* is moved over the contact-points, cutting out resistance and permitting the current to increase to fire the cartridges.

It will be observed that before any of the igniters have operated the current finds two parallel paths through each igniter. If through this resistance the current be of a value sufficient to raise the igniting-conductors to the temperature of fusion—say twelve ampères—the fusion of the igniting-conductor of one of the igniters in advance of the others will tend to cut down the current, since the current will then find but one path through such igniter, the resistance of the circuit being thereby increased. To bring the current back to its normal value I provide the rheostat, so that in the act of firing resistance may be cut out as the ignition of the cartridges proceeds. In practice the contact-arm of the rheostat is moved rapidly to the end of its stroke, the ignition of the cartridges taking place so rapidly that such movement of the contact-arm will serve to properly adjust the resistance of the circuit.

Instead of locating the current-carrying conductor within the igniter-cap it may be placed without, as shown in Fig. 3, in which case it may be located at any convenient position.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with explosive material, of fusible conductors for igniting said explosive material included in an electric circuit in series, and a shunt or by-path about each of said fusible conductors for carrying current to the conductors last to fuse; substantially as described.

2. The combination with explosive material of fusible conductors for igniting the same included in an electric circuit in series, and a shunt or by-path about each of said fusible conductors for carrying current to the conductors last to fuse, and means for preventing the falling of the current below the proper strength as the resistance of the circuit is increased by the fusing of the igniting-conductors; substantially as described.

In witness whereof I hereunto subscribe my name this 26th day of January, A. D. 1894.

CHARLES H. RUDD.

Witnesses:
W. CLYDE JONES,
GEORGE L. CRAGG.