(No Model.)

C. H. RUDD.

ELECTRICAL DETONATOR.

No. 556,903. Patented Mar. 24, 1896.

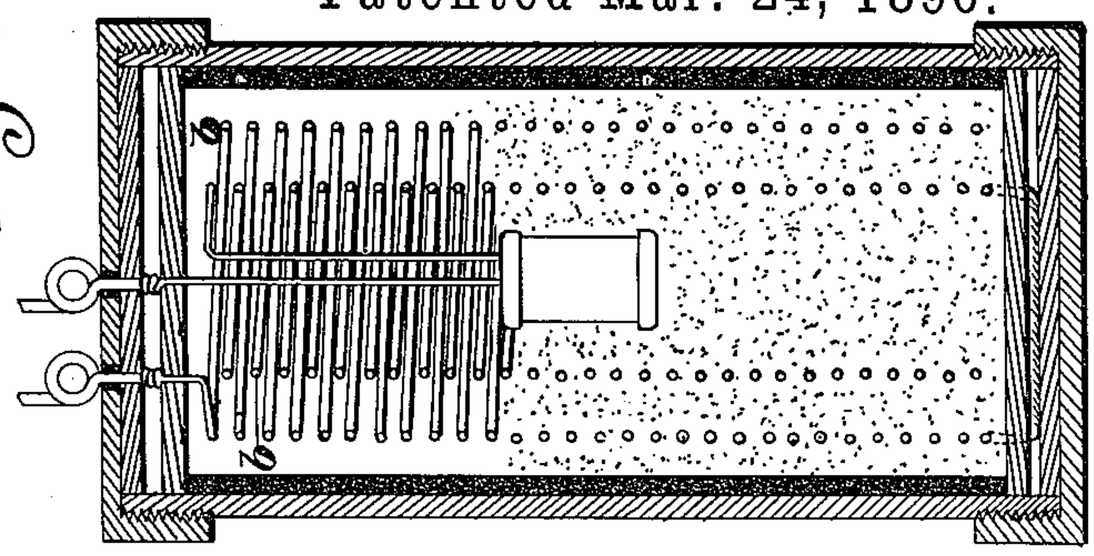
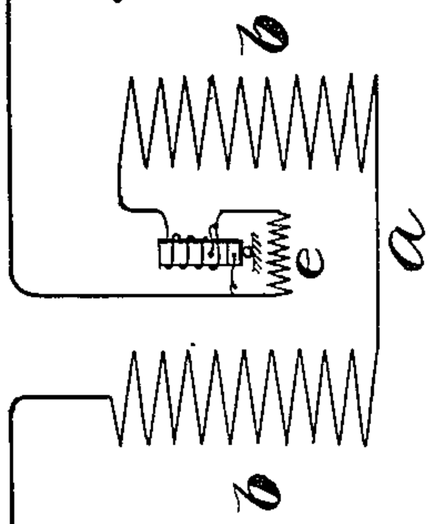


Fig. 4.



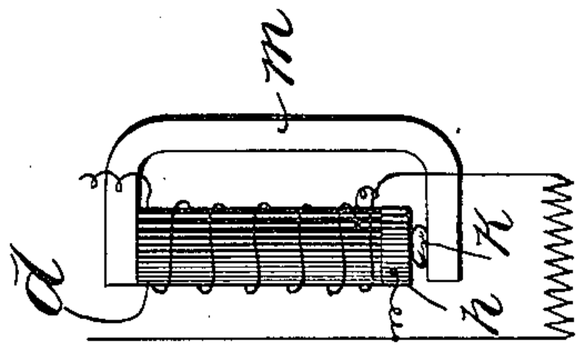
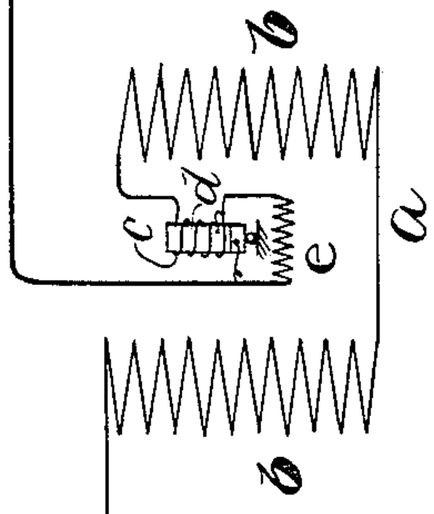


Fig. 3



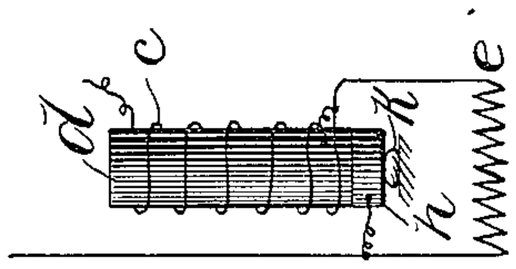


Fig. 2

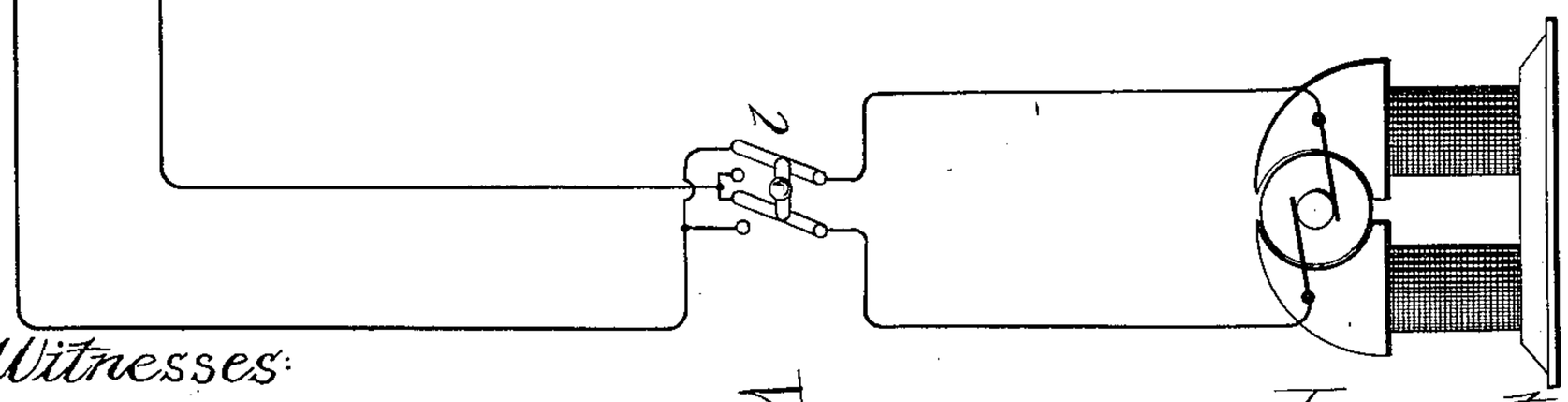


Fig. 1.

Witnesses:

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Inventor:
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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. 556,903, dated March 24, 1896.

Application filed February 3, 1894. Serial No. 498,987. (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. 34,) 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 explosive material by electricity and to reduce to a minimum the amount of wiring necessary for carrying the current.

In an application, Serial No. 494,725, filed December 27, 1893, I have described an explosive cartridge comprising an explosive material in which are embedded 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, comprising a wire adapted to be heated to an igniting temperature, is adapted to fire the explosive material. In an application, Serial No. 498,988, filed February 3, 1894, I have described and claimed broadly means for connecting the heating and igniting conductors in a single circuit, and my invention herein embodies a specific form of said broad invention, and so far as matter shown herein is covered by the claims of said application, this application is to be considered subsidiary thereto.

My invention in its preferred form comprises an igniting-conductor normally located in a parallel branch of the circuit and so adjusted that under normal conditions the current diverted therethrough is insufficient to raise the temperature to the igniting degree, means being provided for increasing the resistance of that portion of the circuit with which said igniting-conductor is in parallel when it is desired to fire the cartridge, thereby increasing the strength of the current traversing the igniting-conductor and raising the temperature of the same to the igniting degree.

I preferably secure the increase of resistance of the parallel portion of the circuit by providing a soft-iron core surrounded by a helix adapted to be traversed by the current to impart polarity to the soft-iron core, an armature of soft iron or of steel being placed opposite the pole of the core, the circuit of the parallel portion of the circuit being through the surface of contact of the armature and core. The resistance of the parallel portion of the circuit is such that the current diverted through the igniting-conductor is insufficient to raise the temperature of the same to the igniting degree. When it is desired to fire the explosive material, the direction of the current is reversed, thus changing the polarity of the soft-iron core which kicks the armature, since the magnetic inertia of the soft-iron armature prevents the immediate reversal of its magnetism, while the steel armature assumes permanent polarity, corresponding to the original polarity of the iron core. The repulsion of the armature may serve to decrease the force of contact between the armature and core, thus increasing the resistance of the parallel portion of the circuit, or it may break the contact between the armature and the core entirely, thus increasing the resistance to infinity.

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

Figure 1 is a diagrammatic view of several cartridges connected for firing after the manner of my invention. Fig. 2 is a diagrammatic view of the igniting mechanism. Fig. 3 is a detail view of a preferred form of igniting mechanism. Fig. 4 is a sectional view of a cartridge embodying my invention.

Like letters refer to like parts in the several figures.

Each of the cartridges *a a* is provided with heating-coils *b b*, through which current is adapted to be passed to raise the temperature of the explosive material to the required degree. In series with the heating-coil *b* is provided a helix *c*, which surrounds a core of soft iron *d*. The circuit, continuing, passes through the igniting-conductor *e*. The end of helix *c* is in electrical contact with the iron core *d*, while the armature *h* is in electrical contact with the circuit beyond the igniting-conductor *e*, so that when the armature is in contact with the iron core the igniting-conductor is

shunted by the parallel branch through the iron core and the armature. The armature may be made of soft iron or of material, such as steel, capable of assuming permanent magnetism, and is normally held against the end of the iron core by a piece *k* of paraffine, solder, or the like, which will readily fuse under the influence of heat.

When it is desired to fire the cartridges, current is turned on, traversing the heating-coils *b b* and raising the temperature of the explosive material to the required degree. The armature *h* resting against the iron core *d*, the igniting-conductor *e* is shunted and the current passing therethrough is insufficient to raise the same to the igniting temperature. The passage of the current through the helix *c* imparts polarity to the soft-iron core *d*, which attracts the armature *h*. The armature *h* also assumes magnetic polarity, though the polarity when of steel is permanent. The heating of the explosive material by the heating-coils and the passage of the current through the armature cause the fusion of the paraffine *k*, and thus leaving the armature suspended from the end of the iron core *d*.

When it is desired to ignite the explosive material, the current is reversed by a reversing-switch *l*. The reversal of the current reverses the polarity of the iron core *d*, causing it to repel the magnetized armature *h*.

When the armature is of steel or other permanently-magnetizable material, it assumes polarity under the influence of the original polarity of the iron core, so that when the polarity of the core is changed the armature is permanently repelled.

When a soft-iron armature is used, it assumes polarity, though not permanent, under the influence of the original polarity of the iron core; but when the polarity of the core is reversed by the reversal of the current the magnetic inertia of the armature prevents the reversal of the polarity of the armature in unison with the reversal of the polarity of the core, and consequently at the instant the magnetism of the core has fallen to zero and changes sign, the magnetism of the armature being of the original sign, the armature is repelled. The repulsion of the armature *h* breaks the shunt-circuit around the igniting-conductor, thus causing all of the current to traverse the igniting-conductor to raise the temperature to the igniting degree and cause the explosion of the explosive material.

Instead of so arranging the armature that the shunt-circuit is entirely broken upon reversal of the current, the armature may be so mounted that the reversal of the polarity of the core serves only to lessen the force of contact of the core and armature, thus diverting increased current through the igniting-conductor, and I consider any means for thus increasing the resistance of the parallel circuit around the igniting-conductor to effect the firing as within the purview of my invention, broadly considered.

When the soft-iron armature is used, it is not necessary to employ a reversing-switch, as a circuit-breaking switch may be used to open the circuit and de-energize the soft-iron core, which will thus release its armature and open the shunt-circuit about the igniting-conductor. The circuit may then be closed by the switch, and the whole current necessarily traversing the igniting-conductor the same is brought to the fusing temperature to fire the explosive material.

In Fig. 3 I have illustrated an economical manner of arranging the igniting mechanism. Between the ends of a U-shaped piece of magnetic material *m* may be arranged in line the soft-iron core *d*, the armature *h*, and the fusible material *k*. Upon the passage of the current the fusible material is fused; but the attraction between the magnetic material *m* and the end of the iron core *d* maintains the core and armature in position until the current is reversed, when the armature is kicked from the end of the core.

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

1. The combination with explosive material, of an igniting-conductor in an electrical circuit, a shunt or by-path about said igniting-conductor, and means for increasing the resistance through said by-path to cause an increased current to flow through said igniting-conductor; substantially as described.

2. The combination with explosive material, of an igniting-conductor in an electrical circuit, a shunt or by-path about said igniting-conductor, and means for opening the circuit through said by-path to cause an increased flow of current through said igniting-conductor; substantially as described.

3. The combination with explosive material, of an igniting-conductor in an electrical circuit, a shunt or by-path about said igniting-conductor, and means operated by the reversal of the current in said circuit for increasing the resistance through said by-path to cause an increased flow of current through the igniting-conductor; substantially as described.

4. The combination with explosive material, of an igniting-conductor and a helix included in an electric circuit, a soft-iron core encircled by said helix, an armature normally resting against said core and completing a parallel circuit about said igniting-conductor, and means for reversing the current through said helix; substantially as described.

5. The combination with explosive material, of an igniting-conductor *e*, a helix *c*, a soft-iron core encircled by said helix, a permanently-magnetizable armature *h* normally resting against said iron core and completing a parallel circuit about said igniting-conduc-

tor and fusible material *k* for maintaining the said armature and soft-iron core in contact in the first instance; substantially as described.

6. The combination with explosive material, of the igniting-conductor *e*, the piece *m* of magnetic material, soft-iron core *d*, helix *c* included in a parallel circuit with said igniting-conductor, armature *h* and the fusible material *k;* said core *d*, armature *h* and fusible material *k* being situated between the ends of said piece *m;* 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.