

[54] **IGNITER FOR ELECTRIC PRIMER**
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[58] Field of Search ...**340/256, 276; 102/8, 18, 19.2, 102/70.2**

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ABSTRACT

An igniter for an electric primer, applicable notably to the firing of mines, comprising a two-wire flexible trapping line disposed across the trapping area and short-circuited at one end, and a controlled semi-conductor element or "thyristor" connected in series with said electric primer and a source of electric current, said two-wire trapping line being connected to said controlled semi-conductor element so as to cause same to become conductive and thus fire the primer when the two-wire line is broken.

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4 Claims, 5 Drawing Figures

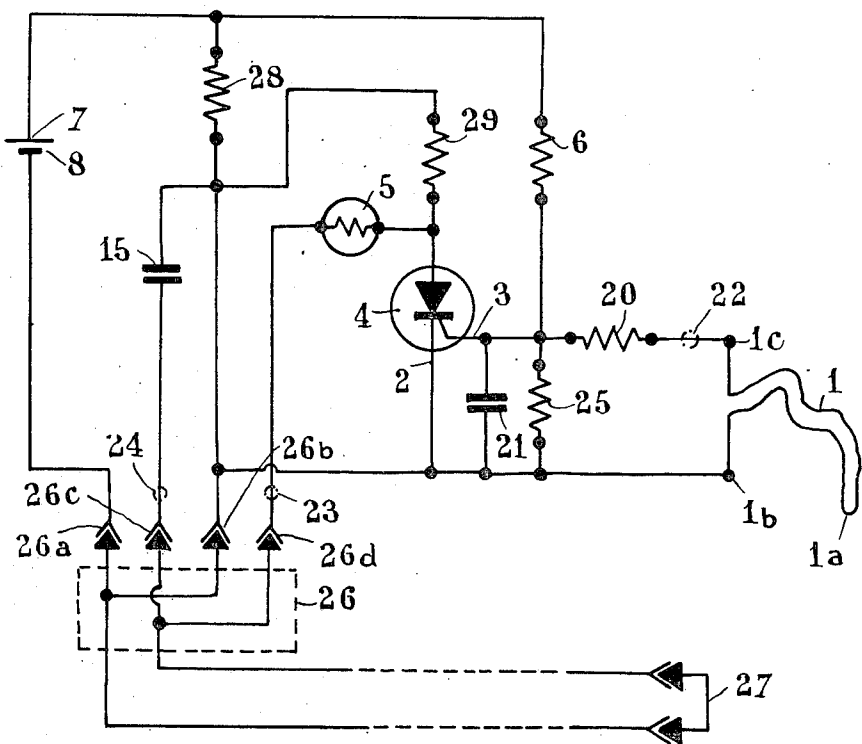


Fig.1.

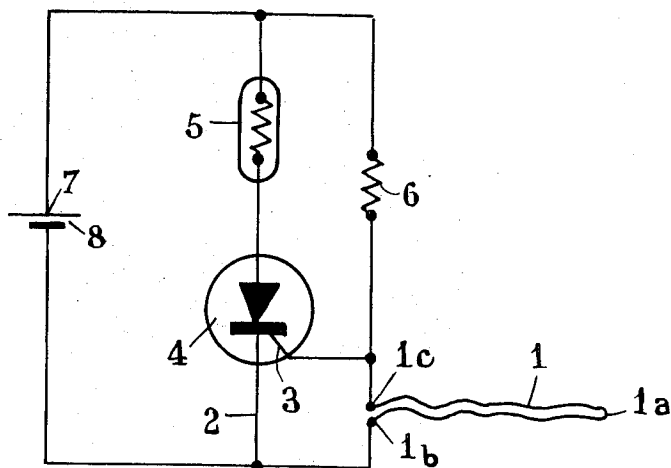


Fig.2.

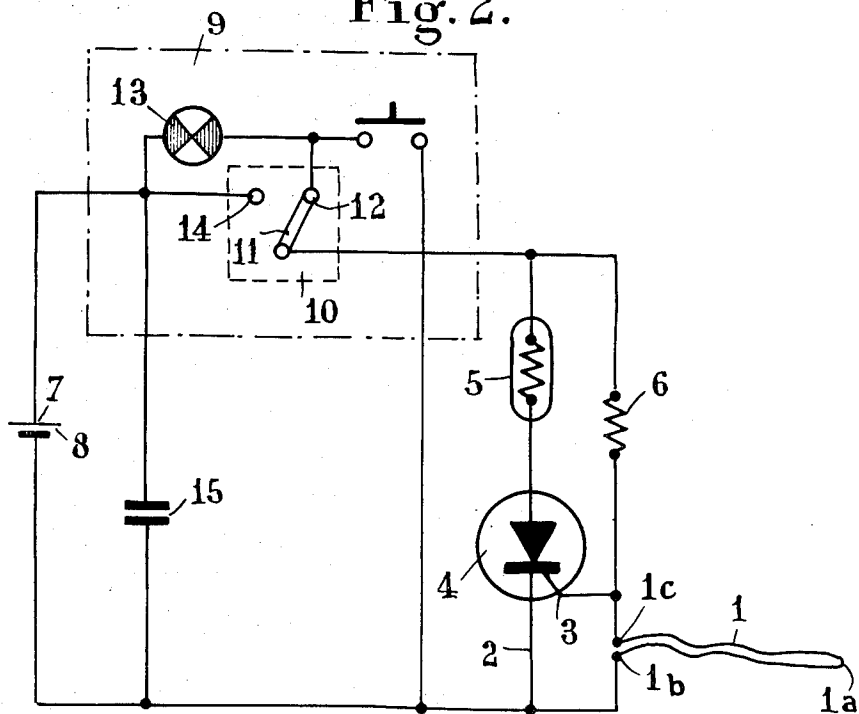
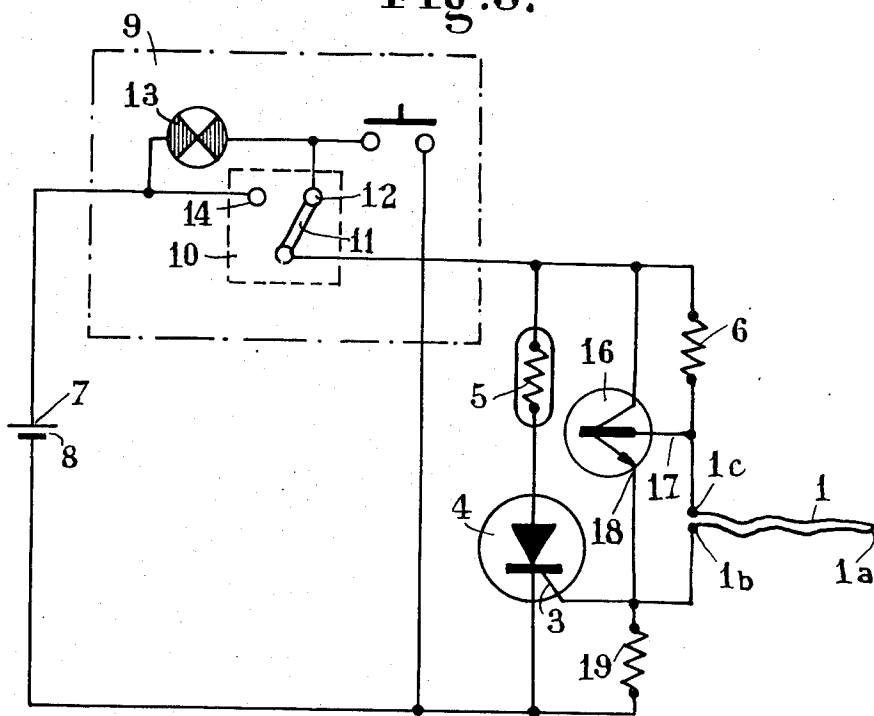
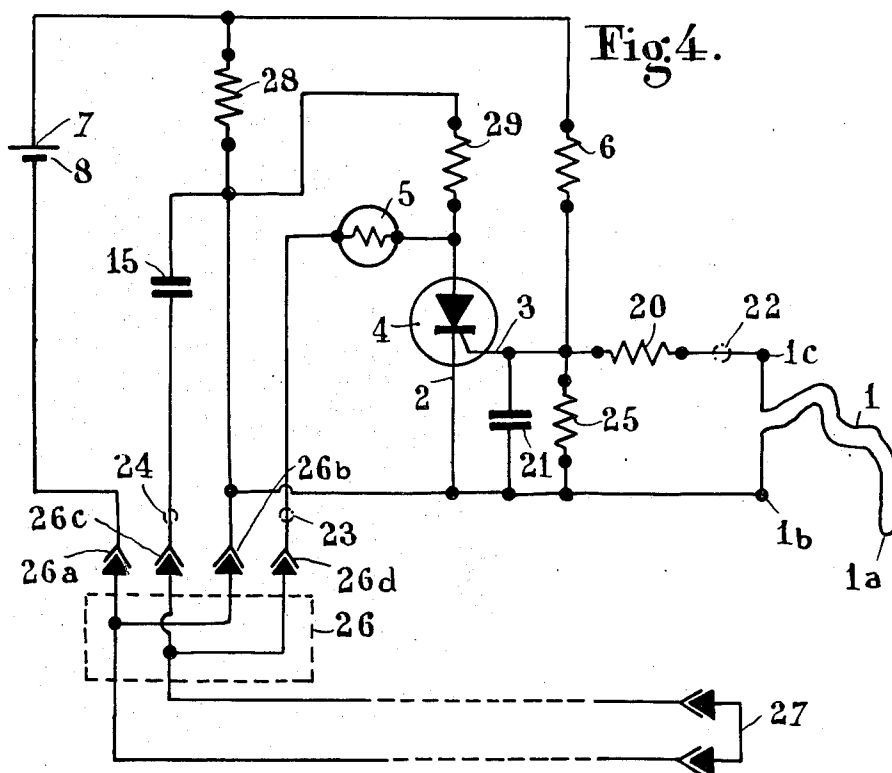
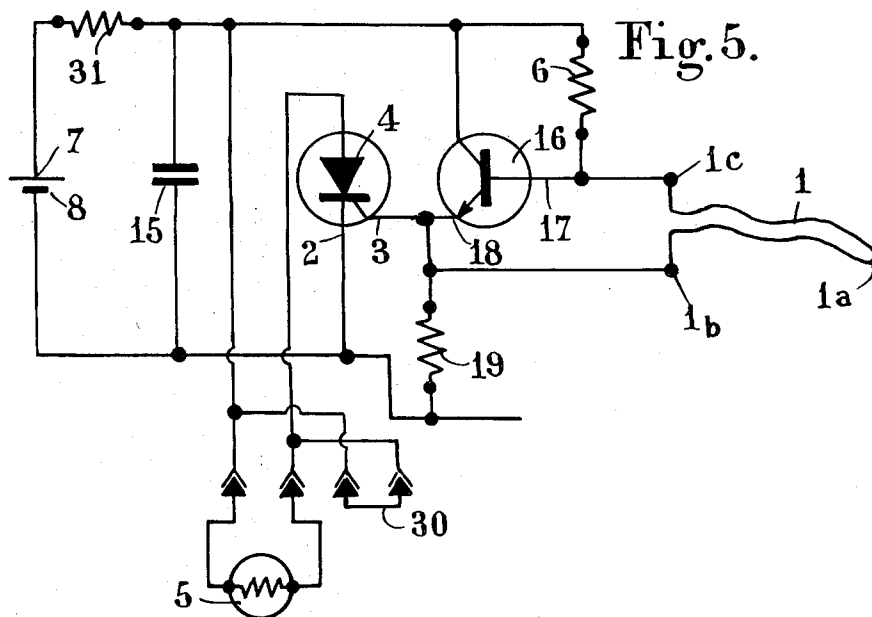


Fig.3.





IGNITER FOR ELECTRIC PRIMER

BACKGROUND OF THE INVENTION

The present invention relates in general to igniting devices and has specific reference to a device of this character for electric primers, which is applicable notably to the firing of mines of all kinds, such as anti-personnel mines, anti-tank mines, etc.

Igniters for wire-controlled mines now in use consist as a rule of mechanical traction systems, wire-tearing or wire-releasing systems; however, these devices are scarcely reliable and lack selectivity, so that a burst of wind or a natural obstacle such as a branch, grass, etc. are sometimes sufficient for pulling these wires and causing an untimely explosion.

SUMMARY OF THE INVENTION

It is the essential object of the present invention to avoid these inconveniences by providing a device characterized by a completely reliable operation.

To this end, the igniter according to this invention for an electric primer, applicable notably to the firing of mines, is characterized in that it comprises a two-wire flexible trapping line disposed across the trapping area and short-circuited at one end, and a controlled semi-conductor element or "thyristor" connected in series with said electric primer and a source of electric current, said two-wire trapping line being connected to said controlled semi-conductor element so as to cause same to become conductive and thus fire the primer when the two-wire line is broken.

The essential advantage characterized by the device of this invention is that it avoids any untimely firing of the mine by the primer since the electric trapping line must be broken for firing the primer.

Besides, due to the bifilar structure of the trapping line, this line has the same properties as a transmission line and is therefore definitely unsensitive to environmental electromagnetic and electrostatic disturbances, so that it cannot cause the untimely firing of the primer under the influence of these disturbances.

The primer igniter according to this invention can be used for firing mines of all types, such as anti-personnel mines, anti-tank mines, etc. It is also suitable for use as a protection and alarm device in any passage area, for in this case the firing of the primer may be used to control either an optical alarm device (parachute flare or Very light, illuminating mine), or a sound signal (detonator, etc.).

The device according to this invention is also suitable for the repeated firing of a series or string of illuminating mines, the end of the combustion of one mine causing the next mine downstream to be fired, by combustion and breakage of its trapping line.

BRIEF DESCRIPTION OF THE DRAWING

Various forms of embodiment of this invention will now be described by way of examples with reference to the attached drawings, in which:

FIG. 1 is a wiring diagram of an igniter for electric primer, according to this invention;

FIGS. 2, 3, 4 and 5 are wiring diagrams concerning various modifications of the device constituting the subject-matter of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, the wiring diagram illustrated therein depicts the theoretical principle of this invention. A very flexible two-wire line 1 is disposed across the area to be trapped. This line may be disposed according to any conventional and known trapping method, for instance tensioned between a pair of supports, camouflaged, disposed along a zig-zag path on the ground, etc. However, an essential advantage characterizing the device of this invention is that the flexible line must be broken for firing the mine; therefore, all the uncertainties and hazards characterizing conventional devices, of which the untimely or undesired priming is very frequently caused by natural phenomena such as wind, etc., are eliminated. The two-wire line 1 is short-circuited at one end 1a. Its other two ends 1b and 1c are connected the former to the cathode 2 and the latter to the control electrode or gate 3 of a thyristor 4. This thyristor may be indifferently of the positive or negative control type. The bifilar structure of line 1 impart thereto the properties of a transmission line, thus making this line and therefore the device unsensitive to external electromagnetic and electrostatic disturbances.

The thyristor 4 is adapted to feed electric current through its anode circuit to an explosive primer 5; its control electrode 3 is connected through a resistor 6 having a value R_1 to the positive terminal 7 of a d.c. current source 8. The line resistance of 1 must be so selected that the resistance R available between points 2 and 3 be very low in comparison with the resistance R_1 of the aforesaid resistor 6. Under these conditions, if V_a denotes the voltage of the d.c. current source 8, the difference of potential V between the cathode and the control electrode of thyristor 4,

$$V = V_a \times \frac{R}{R_1 + R}$$

is kept to a value very lower than the diffusion voltage of the junction between the cathode and the control electrode 3. The thyristor 4 is kept in its non-conducting state and the primer circuit remains open. When the line 1 is broken the voltage of the control electrode is brought instantaneously to value $+V_a$, thus causing the thyristor 4 to become conductive and the combustion of primer 5.

According to a modified form of embodiment, the primer 5 may also be connected between the negative terminal of source 8 and the cathode 2 of thyristor 4.

In order to afford a clearer understanding of this invention, a specific firing device with line trapping system will be described with reference to FIG. 2. A sub-assembly 9 is provided for checking the continuity of the trapping line 1 during the arming period; it also constitutes a safety factor during the mine-laying operations. This sub-assembly may be disposed indifferently on the mine body proper or connected thereto through a flexible cable easily camouflaged after use. A switch 10 engaging with its movable contact arm 11 a contact stud 12 in the unarmed condition permits of inserting a pilot light 13 or to constitute a simple electric connection with the circuit for energizing the thyristor and the primer. When the mine is laid in the desired

position, the contact arm 11 is in position 12 and locked therein; the passage of this contact arm 11 to the other position 14 will require for example the preliminary removal of a safety pin or any other suitable locking means. The pilot light 13 is of the testable type, for example a pressure-testable bulb as used for example in photographic flash-lights.

It will be assumed that the flexible line was sectioned during a trapping operation; thus, the contact arm 11 will compulsorily be in position 12, and the broken line is denoted by the pilot light 13. In fact, the thyristor is then energized and a closed circuit comprises the current source 8, the pilot light 13, the primer 5 and the thyristor 4; however, the primer is not ignited and only the pilot light 13 is energized. In fact, in the device according to the present invention the electrical characteristics of the pilot light 13 are so selected that the current then flowing through the primer 5 is considerably weaker than the current necessary for igniting this primer. Thus, during the arming period (i.e., with contact arm 11 in position 12) any breaking of the flexible line 1 is of no consequence as far as the risks of explosion are concerned, but this condition is displayed by the energization of pilot light 13. When the continuity of the trapping line 1 is effective, the pilot light 13 is not lighted, as the thyristor 4 remains non-conductive; the proper operation of the pilot light must then be ascertained either by depressing the bulb if the pilot light is of the above-mentioned pressure-testable type or by using any other suitable or available auxiliary testing means, such as auxiliary energy source, etc. If this last-named test is positive, the mine arming operation is completed by simply moving the contact arm 11 of switch 10 to position 14; then, the pilot light is out of circuit. When the flexible line 1 is broken the current flowing through the primer 5 is sufficient for firing same.

A capacitor 15 connected in parallel to the electric current source 8 is provided for preventing the undesired consequences of a failure of this current source 8 at low temperatures; in fact, at low temperatures the internal resistance of this source becomes rather considerable and reduces its output. Therefore, when the line is broken, the current flowing through the primer may not be sufficient for causing its combustion. Under these circumstances the capacitor 15 is discharged and provides the additional energy required for firing the primer.

FIG. 3 illustrates a modified form of embodiment of the device of this invention. A major inconvenience of the device illustrated in FIG. 2 lies in its energy consumption in the armed condition. In fact, a current $i = V_0/R_1$ flows permanently through the circuit of line 1; now the resistance R_1 of resistor 6 should not be too high so that the thyristor 4 may become conductive when the line 1 is broken; the aforesaid current i then assumes a far from negligible value and this current output assists in reducing the current consumption of the igniter. The addition of an active semi-conductor having an appreciable current gain, permits of tolerating but a very moderate permanent current in resistor 6; thus, the energetic autonomy of the igniter is greatly increased. Therefore, the use of an NPN-type transistor 16, having its emitter 18 connected to the control electrode 3 of thyristor 4, and its collector connected to the

contact arm 11 of switch 10, permits of selecting for R_1 a value of about 50 k Ω , as contrasted with the optimum value of the device shown in FIG. 2 which is about 10 k Ω ; thus, the current consumption is reduced to a considerable degree. The flexible line 1 of which the ends 1c and 1b are connected to the base 17 and emitter 18 of transistor 16, respectively, will short-circuit the base-to-emitter junction, thus blocking this transistor and preventing any conductivity of thyristor 4. When the flexible line 1 is broken, the biasing of the base-emitter junction of transistor 16 determined by resistor 6 rises above the diffusion voltage, thus causing the transistor 16 to become conductive. The voltage then obtained across the terminals of a resistor 19 connected between the control electrode 3 and the cathode of thyristor 4 and the primer is thus ignited.

Now reference will be made to FIG. 4 showing another specific form of embodiment of the device according to this invention.

In this modified arrangement the line 1 is connected to the gate 3 via a resistor 20 forming in conjunction with a capacitor 21 a high-frequency filter adapted to avoid disturbances caused by electromagnetic radiations. Ferrite beads 22, 23 and 24 are also provided to constitute complementary barriers against these same disturbances. A resistor 25 connected between the gate 3 and its cathode sets the gate potential and promotes the flow of electrostatic charges likely to be picked up by the trapping line 1 and cause the untimely energization of thyristor 4. A double jumper 26 is provided for properly connecting the igniter. This jumper 26 is adapted, through a first pair of contact studs 26a and 26b, to connect the negative terminal of the current source 8 to the cathode 2 of thyristor 4, and through another pair of contact studs 26c and 26d, to connect the capacitor 15 to the primer 5. By simply removing the jumper 26 the device can be stored and transported with the desired safety, whether the device is equipped or not with the current source 8. A safety jumper 27, adapted if desired to be temporarily replaced by a control box for checking the electrical continuity of the trapping line and the condition of the "tank" capacitor 15, short-circuits the contact studs 26a and 26c, i.e., said capacitor 15, thus preventing the operation of the igniter; under these conditions, the device is ready for use when the jumper 27 is removed.

Two cases of trapping line breakage may arise:

1. The trapping line 1 is broken before the safety jumper 27 is removed, for example during the storage, transport, laying, or like operations.

The double jumper 26 being fitted, the voltage differential created across the cathode 2 and control electrode 3 of thyristor 4 is such that said thyristor 4 is conducting. Now capacitor 15 can only be charged if the safety jumper 27 is fitted. Therefore, the current delivered by the source of current 8, which is limited by a resistor 28 connected in series between the positive terminal 7 and the anode of thyristor 4, is not sufficient to ignite the primer 5 (this current being lower than the safety measure current of primer 5).

Removing the safety jumper 27 is attended by a very low charging of capacitor 15, considering the mutual magnitudes of resistor 28 and of the resistance of primer 5. As this charge is inoperative due to the connection of capacitor 15, the device cannot operate, and the operator's safety is preserved.

2. The trapping line 1 is not broken when the safety jumper 27 is removed, thus, this removal will charge capacitor 15.

As the breaking of trapping line 1 causes the energization of thyristor 4, capacitor 15 is discharged through the circuit and therefore causes the ignition of primer 5.

A resistor 29 connected in series between resistor 28 and the anode of thyristor 4 for preventing poor contacts, faults in the manufacture or connections, likely to occur in the primer 5 and/or the double jumper 26 from causing an extremely hazardous delayed operation of the explosive associated with the device.

In the modified form of embodiment illustrated in FIG. 5, a transistor 16 controls the thyristor 4 as in the case illustrated in FIG. 3, in order to increase the energetic autonomy and safety of use of the device. A "tank" capacitor 15 prevents the failures of the current source 8, notably when using the device at low temperatures. A safety jumper 30 is adapted to short-circuit the primer 5 so that its presence prevents the ignition of said primer. Under these conditions, the device cannot be put into service unless the safety jumper 30 is not removed.

Two cases of trapping line breakage may arise:

a. The trapping line 1 is broken before the safety jumper 30 is removed.

The breakage of line 1 is attended by the release of transistor 16 and therefore by the energization of thyristor 4. The capacitor 15 is discharged through the circuit comprising: jumper 30, thyristor 4. The source of current 8, except for the leakage voltage of thyristor 4, is short-circuited and therefore rapidly damaged.

The igniter cannot operate, even when the jumper 30 has been removed, due to the severe damages suffered by the source of energy 8, so that the safety of use is increased considerably.

b. The trapping line 1 is not broken when the safety jumper 30 is removed.

When the source of current 8 is fitted to the device the capacitor 15 is charged to a voltage difference equal to that of said source 8. Thus, a breakage of trapping line 1 occurring after the removal of this safety jumper 30 is attended by the release of transistor 16 and therefore by the energization of thyristor 4. Thus, capacitor 15 is discharged through the primer circuit and the primer 5 is ignited.

According to a modified form of embodiment a re-

sistor 31 connected to the terminal 7 of the current source and adapted to limit the current of the source of energy 8 may be provided in order to increase considerably the safety of use of the device. In fact, in case of accidental breakage of trapping line 1, the use of a source of current 8 particularly sturdy and/or insufficiently damaged by the short-circuit might be attended by the ignition of primer 5 when removing the jumper 30, although capacitor 15 is not charged. This accidental ignition would be produced by the source 8 proper; now this occurrence is definitely precluded by the provision of the aforesaid resistor 31.

What we claim is:

1. An igniter for electric primer, applicable notably to the firing of mines, which comprises a two-wire flexible trapping line disposed across the trapped area and short-circuited at one end, a source of electric direct current, and controlled semi-conductor element, comprising an anode, a cathode and a gate, which is connected in series with the electric primer and said electric current source, said two-wire trapping line being connected to said controlled semi-conductor element in order to release said element to its conductive state and therefore fire the primer when said two-wire line is broken; said igniter comprising further a capacitor, a first resistor connected to the positive terminal of said source of electric direct current, another resistor connected to the anode of said controlled semi-conductor element, a double jumper comprising four contact studs, namely a first contact stud connected to the negative terminal of said source of electric current, a second contact stud connected to the cathode of said controlled semi-conductor element, to one end of said first resistor, to one end of said other resistor and to one plate of said capacitor, a third contact stud connected to the other plate of said capacitor and a fourth contact stud connected to the primer proper connected to the anode of said controlled semi-conductor element.

2. A device as set forth in claim 1, which comprises a safety jumper for short-circuiting said first and third contact studs of said double jumper.

3. A device as set forth in claim 1, which comprises a safety jumper for short-circuiting said primer.

4. A device as set forth in claim 1, which comprises a current-limiting resistor connected in series with said primer.

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