April 7, 1959 J. F. MENKE ET AL 2,880,672

ELECTRIC FUZE

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Fig. 1.

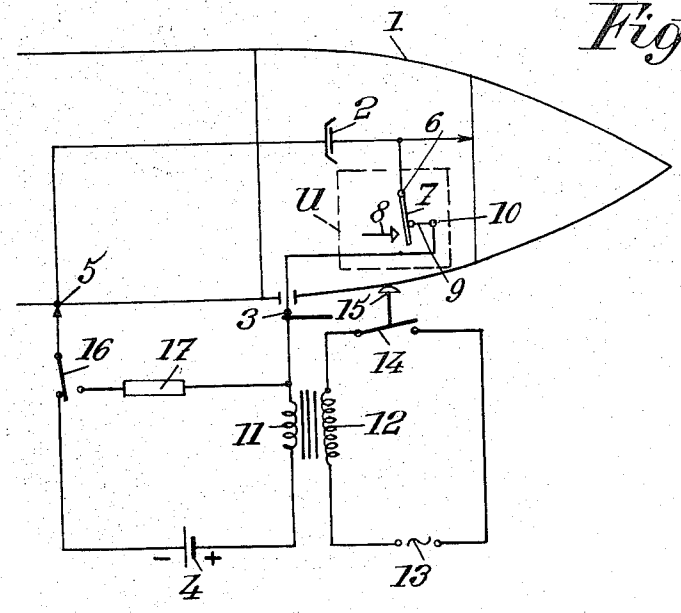

Fig. 2.

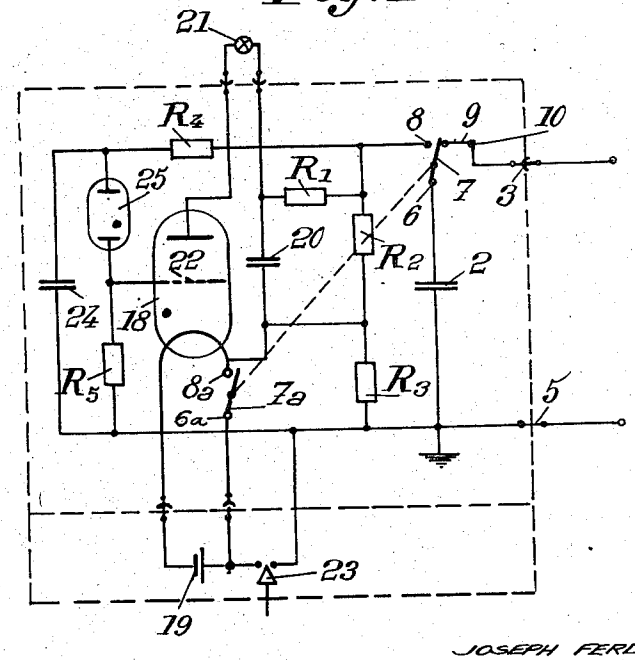

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Fig. 3.

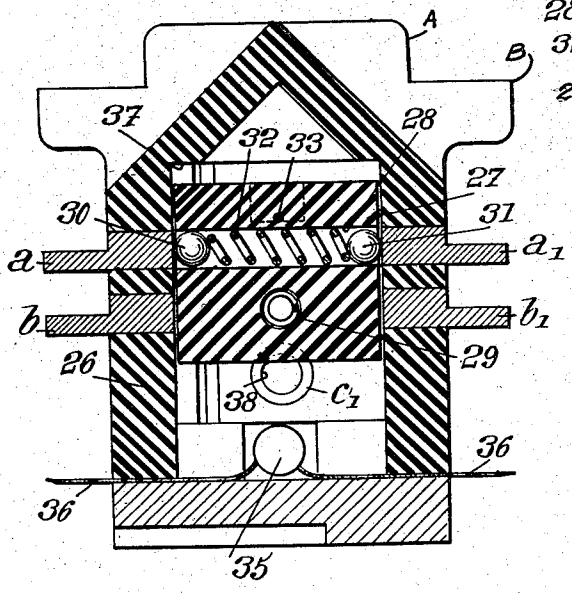

Fig. 4.

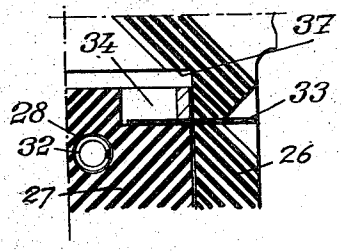

Fig. 5.

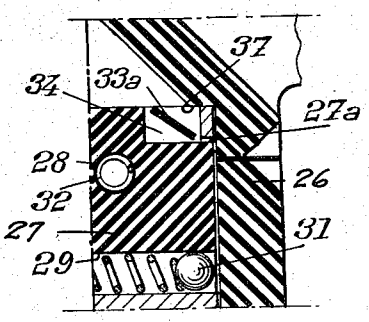

Fig. 7.

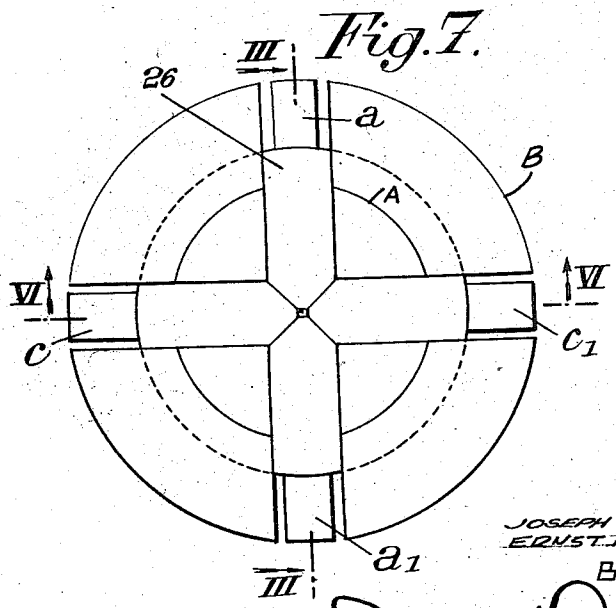

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Fig. 6.

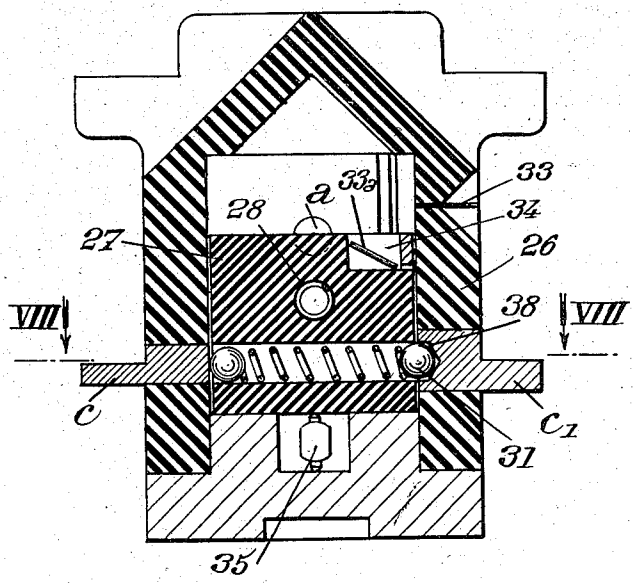
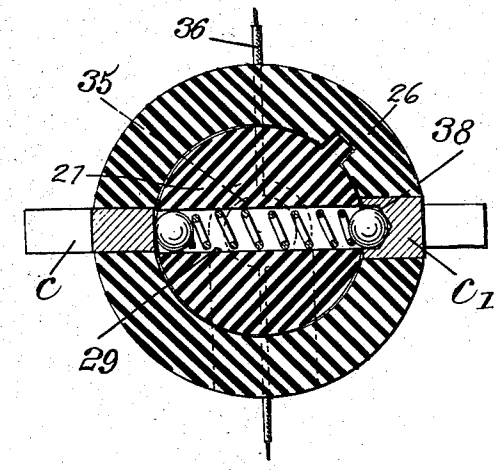


Fig. 8.



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United States Patent Office 2,880,672 Patented Apr. 7, 1959

2,880,672

ELECTRIC FUZE

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Application June 28, 1954, Serial No. 439,832

Claims priority, application Luxembourg June 29, 1953

10 Claims. (Cl. 102—70.2)

The present invention relates to projectiles, and in particular self-propelling projectiles such as rockets, and it is more especially but not exclusively concerned with such projectiles fitted with an electric fuze, that is to say a fuze the detonator of which is fired by an electric igniting device.

It is known to control the arming of the fuze by means of two devices which are successively brought into play and the first of which keeps the second one inoperative for a time. This first device serves to prevent the fuze from being armed before the projectile is launched and during the handling thereof, in particular during its transportation. The second device, which serves either to release the arming means proper or to prepare or start the operation thereof, is arranged in such manner that the fuze cannot be armed as long as the projectile has not travelled a given distance from its launching apparatus (which may be constituted by a gun, launching track, etc.), whereby explosion of the projectile in or on the launching apparatus is impossible.

According to our invention, the first mentioned device is arranged to be rendered inoperative by an electric impulse which is automatically produced by contacts the operation of which (in particular the closing of which) is produced by a short initial movement of the projectile, when the projectile has not yet left its launching apparatus.

According to another feature of our invention, which is applicable to the case where the fuze is an electric one supplied with current from voltage accumulating means carried by the projectile (and preferably constituted by a condenser), said voltage accumulating means is charged from a source carried by the launching apparatus and through the circuit connection and contact means which serve to transmit the electrical impulse which is to render inoperative the first mentioned device. In particular, said circuit connection may be provided between a source of direct current which serves to charge the voltage accumulating means and a source of alternating current serving to produce the above mentioned electrical impulse which renders the first device inoperative.

According to still another feature of our invention, the first device consists of an element capable of being sheared and constituted for instance by a wire, a small bar or a rod, this element being sheared by the explosion of a small primer.

Preferred embodiments of our invention will be hereinafter described with reference to the accompanying drawings given merely by way of example and in which:

Fig. 1 diagrammatically shows the front part of a projectile fitted with an electrical fuze and arranged according to the present invention.

Fig. 2 shows the lay-out of the electrical fuze itself.

Fig. 3 is an axial section on the line III—III of Fig. 7, showing the switch means of the electric system of a projectile according to the invention, the movable portion of said switch means being in the first position.

Figs. 4 and 5 are part axial views with the movable element of the switch means respectively in the locked position and after it has been first released.

Fig. 6 is an axial section of the same switch means, on the line VI—VI of Fig. 7, the movable element of the switch means being in the position corresponding to the arming of the fuze.

Fig. 7 is a diagrammatic plan view of the above mentioned switch means.

Fig. 8 is a sectional view on the line VIII—VIII of Fig. 6.

Our invention will now be more particularly described as applied to a self-propelling missile, such as a rocket, fitted with an electric fuze, that is to say a fuze the detonator of which is fired by an electric igniting device.

The projectile 1 itself, as diagrammatically illustrated on Fig. 1, is of any suitable construction whatever, with the exception of its fuze and of the means for charging and arming this fuze. The fuze includes voltage accumulating means constituted for instance by a condenser 2. In order to charge condenser 2 before the projectile is fired off, we provide a contact 3 insulated from the envelope of the projectile and which may be connected to a source of direct current 4. The charging circuit is closed through the conducting envelope of the projectile cooperating with a contact 5.

When the projectile is fired off, condenser 2 must be cut off from contact 3, by means of a switch U which will be hereinafter described in detail, this condenser being then connected to several circuits of the fuze system which are to be fed from said condenser. This switch U includes, as diagrammatically shown by Fig. 1, a movable arm 7 pivoted about axis 6 and cooperating with a contact 8. This switch U cuts off, before the projectile is launched, any connection between condenser 2 and the circuits of the electric fuze which are to be fed from said condenser. Fig. 1 diagrammatically shows this position, where arm 7 is not in contact with stud 8 which is connected to said circuits. Arm 7 has an inertia such that it prevents rotation thereof toward contact 8 as long as the acceleration of the projectile has not reached a value sufficient to overcome the inertia of the mass of said arm. Furthermore, before the projectile is launched, the movable arm 7 of the switch is kept, by a first holding device, in the position shown by Fig. 1. According to a particular feature of our invention, said holding device consists of a fusible wire 9 extending between arm 7 add a fixed point 10. This wire 9 is inserted in series between contact 3 and condenser 2.

In order to melt wire 9 and thus to render the first locking device inoperative, a current impulse of sufficient intensity is sent through the connection between condenser 2 and source 4. Furthermore, in order to be able to pass through condenser 2, this impulse is an alternating current impulse, whereas the condenser is charged, as already known, by means of direct current. The alternating current impulse passes through contacts which are closed by the initial displacement of the projectile when it is being fired off. For instance, contact 3 may be cut off from the direct current source 4 by this initial displacement and it may be arranged to pass, for a short time, along another contact (not shown on the drawings) connected with a source of alternating current or with a condenser charged at a relatively high voltage.

However it seems particularly advantageous to insert, between the direct current source 4 and contact 3, the secondary 11 of a transformer the primary 12 of which is inserted in a circuit fed from an alternating current source 13. This last mentioned circuit includes a switch 14 which is normally open and which is to be closed in response to the initial movement of projectile 1. For this purpose a push-rod 15, connected with the movable

arm of switch 14, is arranged to bear against a portion of the envelope of projectile 1 which is so shaped that it closes switch 14 through said push-rod 15 when the projectile starts moving. In the construction illustrated by Fig. 1, the portion of the envelope of projectile 1 which cooperates with push-rod 15 is the wall of the ogive-shaped front portion of the projectile.

Of course we might use a capacitive coupling instead of the above described inductive coupling constituted by transformer 11, 12.

Before the projectile is fired off, condenser 2, which is for instance an electrolytic condenser, is charged by source 4. During this charging operation, the current must be limited to a value such that the fusible wire 9 inserted in the charging circuit does not melt. This can be obtained by inserting a resistance, not shown by the drawing, in one of the connections extending from source 4 to condenser 2. Such a current limiting resistance may be constituted, in the construction of Fig. 1, by the secondary 11 of the transformer. It may also be constituted by the internal resistance of the direct current source.

Once condenser 2 is charged, the projectile is ready to be launched. If the projectile is launched, that is to say if there is no misfire, the initial movement of the projectile closes switch 14, whereby an alternating current impulse is supplied through transformer 12, 11 to the charging circuit connected to the condenser. This impulse melts wire 9, so that on the one hand the means for holding the movable arm 7 of switch U in inoperative position is eliminated and on the other hand condenser 2 is cut off from the charging contact 3.

If there is a misfire, switch 14 does not close and condenser 2 then remains connected with the charging contacts 3 and 5. It can then be discharged by means of switch 16 (Fig. 1) through resistance 17. When this has been done, the projectile can be examined without danger, to find the reason of the breakdown.

Fig. 2 shows the circuits to be fed from condenser 2 when switch arm 7, after having overcome its inertia owing to the acceleration of the projectile, shifts from the position shown by this figure to a position where it is applied on contact 8. Fig. 2 indicates by a dotted lines connection that arm 7 is coupled with a second switch arm 7*a* arranged to be applied on a contact 8*a* when arm 7 is applied against contact 8. As a consequence of this movement (closing of switch 7*a*, 8*a*), the cathode of a gas tube 18 of the so-called thyratron kind, is heated, the heating current being supplied from a battery element 19.

Among the circuits to be fed from condenser 2 after switch 7, 8 has been closed, there is the charging circuit of a condenser 20 called the ignition condenser. This condenser 20 is inserted in a circuit including also thyratron 18 and a device for firing the detonator, said device being for instance constituted by an electrically ignited primer 21.

Condenser 2 must also supply a negative bias voltage to the grid 22 of thyratron 18, whereby said thyratron cuts off the passage of current through its circuit until the detonator is fired. Explosion of primer 21 is produced by the movement of a member 23 or by an autodestruction device which causes the voltage of grid 22 to pass from a negative value to a positive value.

Member 23 is for instance inertia operated.

Still another circuit fed from condenser 2 is the charge circuit of a condenser 24 which serves to achieve autodestruction of the projectile.

Resistances R_1 and R_2 belong to the charge circuit of igniting condenser 20 and serve for instance to give the time constant in the charging of condenser 20 a value of about 0.25 second (this indication having no limitative character).

Resistance R_2 also acts, together with another resistance R_3, as a voltage divider. This resistance R_3, when

it is not short-circuited by member 23, supplies a negative bias to grid 22, as above mentioned.

The feed circuit of condenser 24 includes the charge resistance R_4, which is calculated so that the time constant corresponding to the charge of condenser 24 is for instance of about 5–6 seconds (this indication having no limitative character).

In shunt with condenser 24, there is a glow lamp 25 and a grid resistor R_5 in series.

This fuze system works as follows:

As soon as contacts 7, 8 and 7*a*, 8*a* are closed, ignition condenser 20 starts being charged and it is practically charged after 0.25 second approximately, so that after this delay, which serves to prevent any possibility of explosion in the gun or the launching apparatus, the fuze is armed. Then, when member 23 is operated and the negative bias of grid 22 is eliminated, the ignition current can pass from condenser 20 to primer 21 and ignite it. If, on the contrary, the projectile does not meet any target and therefore if member 23 is not actuated, condenser 24, after a delay of from five or six seconds, is sufficiently charged to supply glow tube 25 with its glow potential, and therefore in this case to supply a positive voltage to the grid 22 of the thyratron. Therefore condenser 20 discharges into primer 21 and the projectile is exploded.

According to a modification which is not shown by the drawing, we further increase protection against an accidental operation of the fuze by short-circuiting the ignition element 21 by means of a conductor mounted in parallel with said element and in which there is interposed a switch which is opened at the same time as switches 7, 8 and 7*a*, 8*a* are closed.

In the construction of switch U diagrammatically illustrated by Figs. 1 and 2, the mechanical safety means for normally holding said switch in cut-off position consists of a fusible wire 9 which is melted by a current impulse.

According to a preferred embodiment of our invention an example of which is shown by Figs. 3 to 8, said mechanical safety means is constituted by a locking member capable of being sheared and which is actually sheared by the explosion of a smaller primer produced by an electric current impulse fed to said primer.

Advantageously, said primer is mounted similarly to fusible wire 9, that is to say in the connection serving to charge condenser 2 so that explosion of said primer not only renders said mechanical locking member inoperative, but also cuts off condenser 2 from input contact 3. In the construction of Figs. 3 to 7, the switch includes an outer casing or chamber 26 made of an electrically insulating material. In the wall of this casing are disposed three pairs of contacts, to wit, in one axial plane (that of Fig. 3), two pairs of contacts *a*, a_1 and *b*, b_1, located above one another, and in another axial plane (that of Fig. 6) at right angles to the first mentioned one, a third pair of contacts *c*, c_1. In chamber 26 there is slidably mounted a piston 27 of substantial weight made of an insulating material. This piston 27 is provided with two diametral holes 28, 29 located respectively in two different axial planes at right angles to each other. In each of these holes there is provided a pair of contact balls 30, 31 and a spring 32 urging said balls away from each other so as to push them against the inner wall of casing 26.

In the position illustrated by Figs. 3 and 4, piston 27 is locked against axial movement by a safety wire 33 which extends across the wall of casing 26 and through a hole 27*a* of piston 27, the inner end of said wire projecting into a recess 34 provided at the top part of the piston, this wire constituting the above mentioned locking member. In this position of piston 27, balls 30, 31 and spring 32, which extend in the upper hole 28 of the piston, constitute a connection between contacts *a*, a_1 which are located in the charging circuit of condenser 2. For this position of the piston, condenser 2 can there-

fore be charged from the outside, through contact 3. The locking action of wire 33 must be sufficiently strong to prevent shocks as high as 200 *g* (*g*=acceleration of gravity) from causing the piston to move from its position shown by Figs. 3 and 4.

In order to eliminate the locking action exerted by wire 33 on piston 27, there is provided at the lower end of casing 26 a small detonator 35 containing a small amount of a material capable of exploding under the effect of a spark, for instance tricinate of lead (trinitroresorcinate of lead). This detonator is fed with current from a connection 36 which may constitute a portion of the connection serving to charge condenser 2, and in this case is in series with contacts *a*, a_1.

When the detonator is exploded under the effect of a current impulse, safety wire 33 is sheared off and piston 27 is projected upwardly from the position of Figs. 3 and 4 to that of Fig. 5. The top of the piston is then applied upon shoulder 37 provided inside chamber 26. At the end of this movement, the portion 33*a* sheared off from wire 33 is moved, under the effect of its inertia, away from the aperture 27*a* of the piston and passes into recess 34, so that there is no danger of its braking the movement of piston 27. The direction of the movement of the piston from the position of Figs. 3 and 4 to that of Fig. 5 is that of the projectile as it is being launched and it is therefore opposed to that of the movement that would tend to be imparted by the inertia forces to piston 27 inside chamber 26.

Once the projectile has been launched and when its acceleration has reached a sufficient value (for instance 30 *g*), piston 27 moves rearwardly in its chamber under the effect of its own inertia and passes from the position of Fig. 5 to that of Fig. 6. In this last mentioned position, the balls present in the upper conduit 28 form a connection between contacts *b*, b_1 and the balls present in the lower conduit 29 form a connection between contacts *c* and c_1. The groups of contacts *b*, b_1 and *c*, c_1 correspond to the elements 6, 8 and 6*a*, 8*a* of Fig. 2. The group of contacts *a*, a_1 corresponds to the contact elements 7, 9 of Fig. 1.

Advantageously, we provide a recess 38, at least in one of the inner walls of the chamber along the path of movement of contacts *b*, b_1, *c*, c_1, for instance of contact c_1, so as to obtain, by cooperation with contact balls 31, a locking of piston 27 in the position shown by Fig. 6.

In a general manner, while we have, in the above description, disclosed what we deem to be practical and efficient embodiments of our invention, it should be well understood that we do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What we claim is:

1. In combination, a projectile to be fired off from a launching apparatus, an electric fuze fitted on said projectile and including fuze arming means, electric voltage accumulating means carried by said projectile to feed electric current to said fuze arming means, switch means inserted between said fuze arming means and said accumulating means, safety means carried by said projectile for holding said switch means in cut off position between said accumulating means and said fuze arming means, an electric circuit in said projectile including in series a contact carried by the external wall of said projectile, said electric voltage accumulating means, said switch means in cut off position, said safety means and a contact, insulated from the first mentioned contact, carried by the external wall of said projectile, a fixed circuit carried by said launching apparatus including a source of direct current and having its terminals located on said two contacts respectively when said projectile is in said launching apparatus, whereby direct current is then fed before launching to said accumulating means through both of said circuits connected together, an electrical impulse responsive device carried by said projectile and inserted in said first mentioned circuit to make, when an electrical impulse is passed therethrough, said safety means inoperative and thus to cause said switch means to shift from cut off position to connecting position between said voltage accumulating means and said fuze arming means, a source of alternating current impulse carried by said launching apparatus and cooperating means carried by said projectile and said launching apparatus for temporarily coupling said last mentioned source with said fixed circuit in response to the initial launching movement of said projectile with respect to said launching apparatus.

2. In combination, a projectile to be fired off from a launching apparatus, an electric fuze fitted on said projectile and including fuze arming means, electric voltage accumulating means carried by said projectile to feed electric current to said fuze arming means, switch means inserted between said fuze arming means and said accumulating means, safety means carried by said projectile for holding said switch means in cut off position between said accumulating means and said fuze arming means, an electric circuit in said projectile including in series a contact carried by the external wall of said projectile, said electric voltage accumulating means, said switch means in cut off position, said safety means and a contact, insulated from the first mentioned contact, carried by the external wall of said projectile, a fixed circuit carried by said launching apparatus including a source of direct current and having its terminals located on said two contacts respectively when said projectile is in said launching apparatus, whereby direct current is then fed before launching to said accumulating means through both of said circuits connected together, an electrical impulse responsive device carried by said projectile and inserted in said first mentioned circuit to make, when an electrical impulse is passed therethrough, said safety means inoperative and thus to cause said switch means to shift from cut off position to connecting position between said voltage accumulating means and said fuze arming means, a third circuit, including a source of alternating current impulses, carried by said launching apparatus, a transformer having its primary in said third circuit and its secondary in said fixed circuit, a normally open switch in said third circuit, and cooperating means carried by said projectile and said launching apparatus for closing said switch in response to the initial launching movement of said projectile with respect to said launching apparatus.

3. A combination according to claim 1 further including, in said fixed circuit, a resistance, and switch means forming a short-circuit path for discharge of said voltage accumulating means through said resistance in case of failure of said projectile to be launched.

4. In combination, a projectile to be fired off from a launching apparatus, an electric fuze fitted on said projectile and including fuze arming means, electric voltage accumulating means carried by said projectile to feed electric current to said fuze arming means, switch means inserted between said fuze arming means and said accumulating means, said switch means including a fixed part and a movable part sensitive to the action of inertia so as to be urged by the inertia created by the launching of said projectile toward the position with respect to said fixed part where it connects said voltage accumulating means with said fuze arming means, safety means carried by said projectile for holding said switch part in cut off position where said accumulating means and said fuze arming means are out of contact with each other, an electric circuit in said projectile including in series a contact carried by the external wall of said projectile, said electric voltage accumulating means, said switch means in cut off position, said safety means and a contact, insulated from the first mentioned contact, carried by the external wall of said projectile, a fixed circuit carried by said launching apparatus including a source of direct

current and having its terminals located on said two contacts respectively when said projectile is in said launching apparatus, whereby direct current is then fed before launching to said accumulating means through both of said circuits connected together, an electrical impulse responsive device carried by said projectile and inserted in said first mentioned circuit to make, when an electrical impulse is passed therethrough, said safety means inoperative and thus to cause said switch movable part to shift under the effect of the starting acceleration of the vehicle from its cut off position to its connecting position between said voltage accumulating means and said fuze arming means, a source of alternating current impulse carried by said launching apparatus and cooperating means carried by said projectile and said launching apparatus for temporarily coupling said last mentioned source with said fixed circuit in response to the initial launching movement of said projectile with respect to said launching apparatus.

5. A combination according to claim 4 in which said safety means consist of a fusible wire mounted in said first mentioned circuit and normally holding said switch movable part in cut off position with respect to said switch fixed part.

6. A combination according to claim 4 in which said safety means include a locking wire normally holding said switch movable part in cut-off position with respect to said switch fixed part, said wire extending transversely to the direction of displacement of said movable part with respect to said fixed part so as to be sheared by said displacement, and a charge of explosive inserted in said first circuit and adapted to explode in response to the passage of said current impulse for moving said movable part with respect to said fixed part.

7. A combination according to claim 6 in which said fixed part is a cylinder and said movable part a piston slidable in said cylinder.

8. A combination according to claim 6 in which said fixed part is a cylinder and said movable part a piston slidable in said cylinder, said combination further including means for locking said piston in connecting position in said cylinder.

9. In combination, a projectile, an electric fuze fitted on said projectile and including fuze arming means, electric voltage accumulating means carried by said projectile to feed electric current to said fuze arming means, switch means inserted between said fuze arming means and said accumulating means, mechanical safety means carried by said projectile for normally holding said switch means in cut off position between said accumulating means and said fuze arming means, electrical impulse operative means carried by said projectile and connected with said safety means for making said safety means inoperative, and means operatively connected with said eectrical impulse operative means for feeding thereto an electrical impulse in response to the firing off of said projectile.

10. In combination, a projectile, an electric fuze fitted on said projectile and having an electric circuit which comprises a control switch, said switch including a fixed part carried by said projectile and a movable part capable of occupying either of two positions with respect to said fixed part, a locking member normally holding said movable part in one of said positions, said member being fixed to each of said parts in the direction of their relative movement and being so dimensioned and made of such material as to be shearable by a relative displacement of said parts from said last mentioned position toward the other one under the effect of a given thrust, said two parts fitting in each other so as to form between them a variable volume chamber, an explosive charge in said chamber capable by its explosion to supply such said thrust, and electric means connected with said explosive charge to explode it by an electric impulse.

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