United States Patent [19]

Pintell

[11] **3,739,726**

[45] **June 19, 1973**

[54] **ELECTRONIC FUZE**

[75] Inventor: **Robert H. Pintell,** New City, N.Y.

[73] Assignee: **Intron International, Inc.,** Congers, N.Y.

[22] Filed: **Aug. 17, 1970**

[21] Appl. No.: **64,297**

[52] **U.S. Cl.** ..... **102/70.2 R**

[51] **Int. Cl.** ... **F42c 11/04,** F42c 11/06, F42c 15/40

[58] **Field of Search** ..... 102/70.2 R, 70.2 P, 102/70.2 A

[56] **References Cited**

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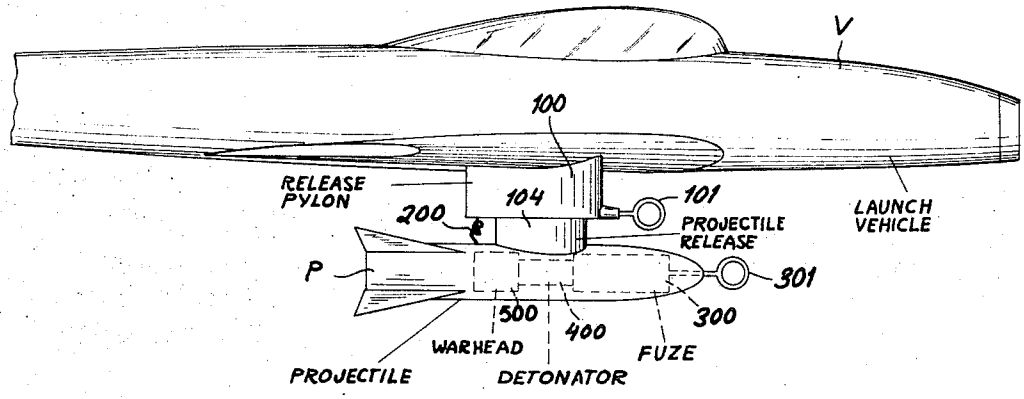
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Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—Thomas H. Webb
Attorney—Karl F. Ross

[57] **ABSTRACT**

A fuze for ordnance projectiles to be launched from a vehicle is armed, after separation from its launcher, by mechanical closure of switches with the aid of a delayed-action squib detonating by an electric charge stored on a capacitor. The fuze system includes means for charging the above capacitor at the time of launch, thus insuring the inert state of the fuze under conditions of storage, transportation and loading into the launch vehicle.

10 Claims, 9 Drawing Figures



Patented June 19, 1973 3,739,726

4 Sheets-Sheet 1

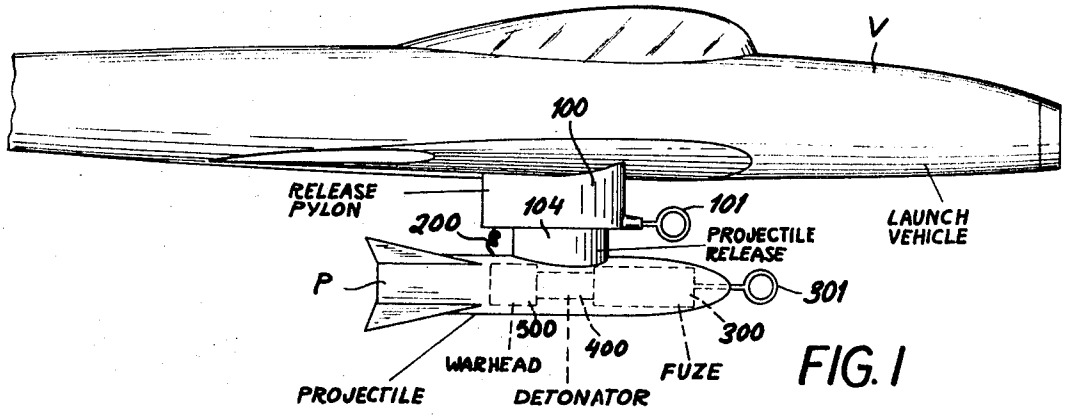


FIG. 1

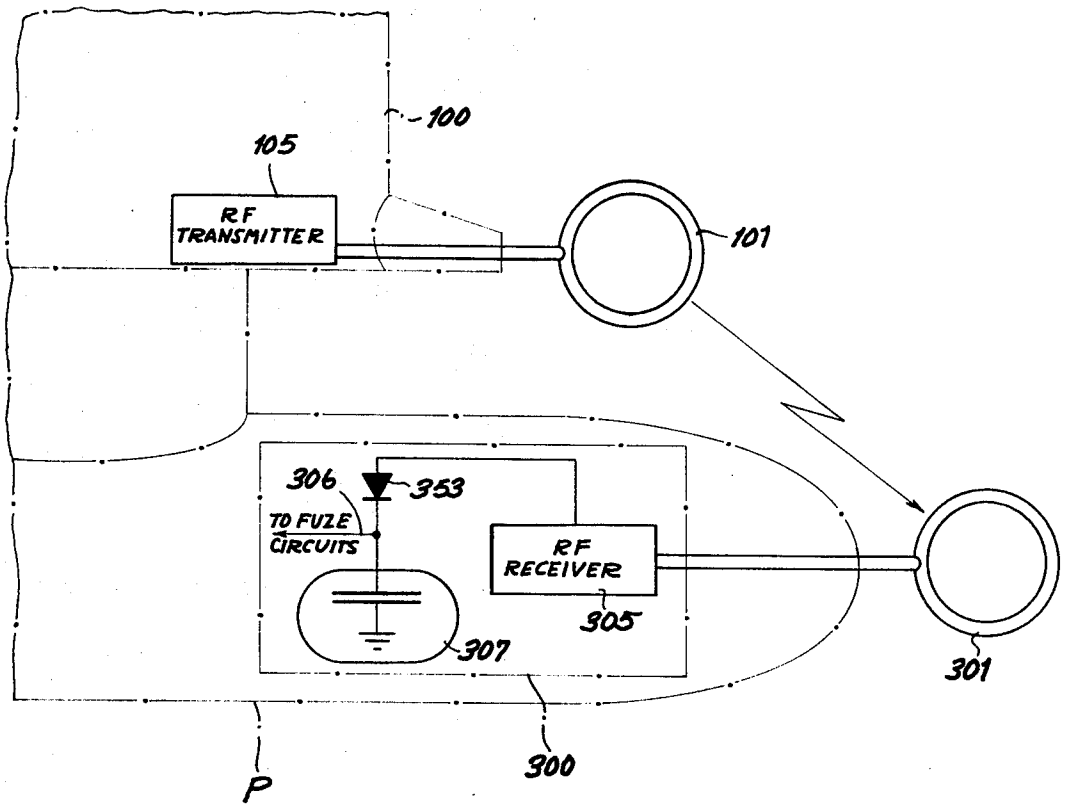


FIG. 4

Robert H. Pintell
INVENTOR.

BY

Karl F. Ross
Attorney

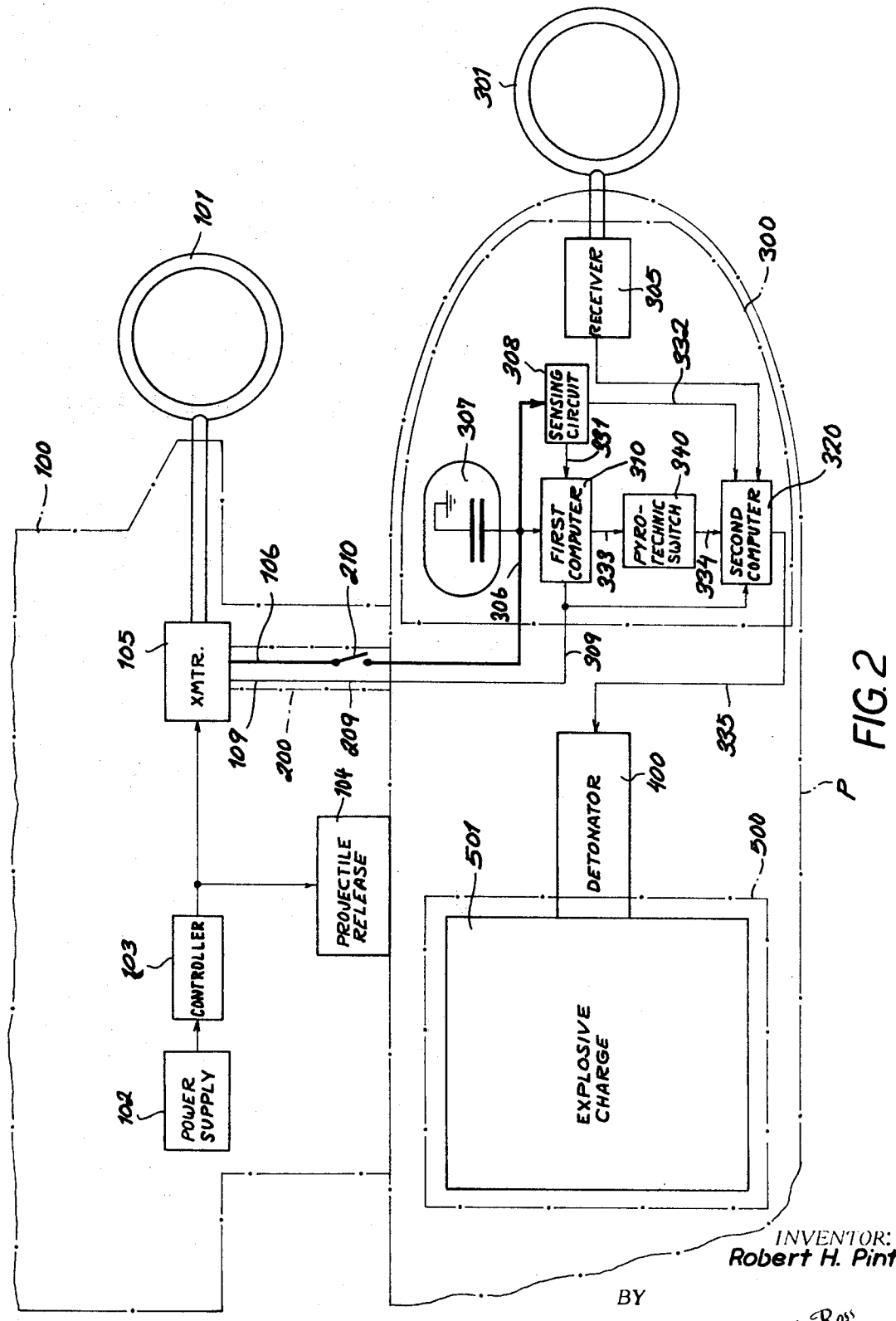


FIG. 2

INVENTOR:
Robert H. Pintell

BY

Karl F. Ross
Attorney

FIG. 6

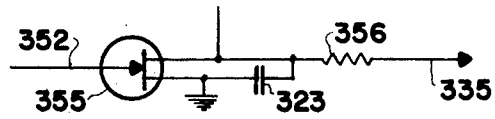


FIG. 7

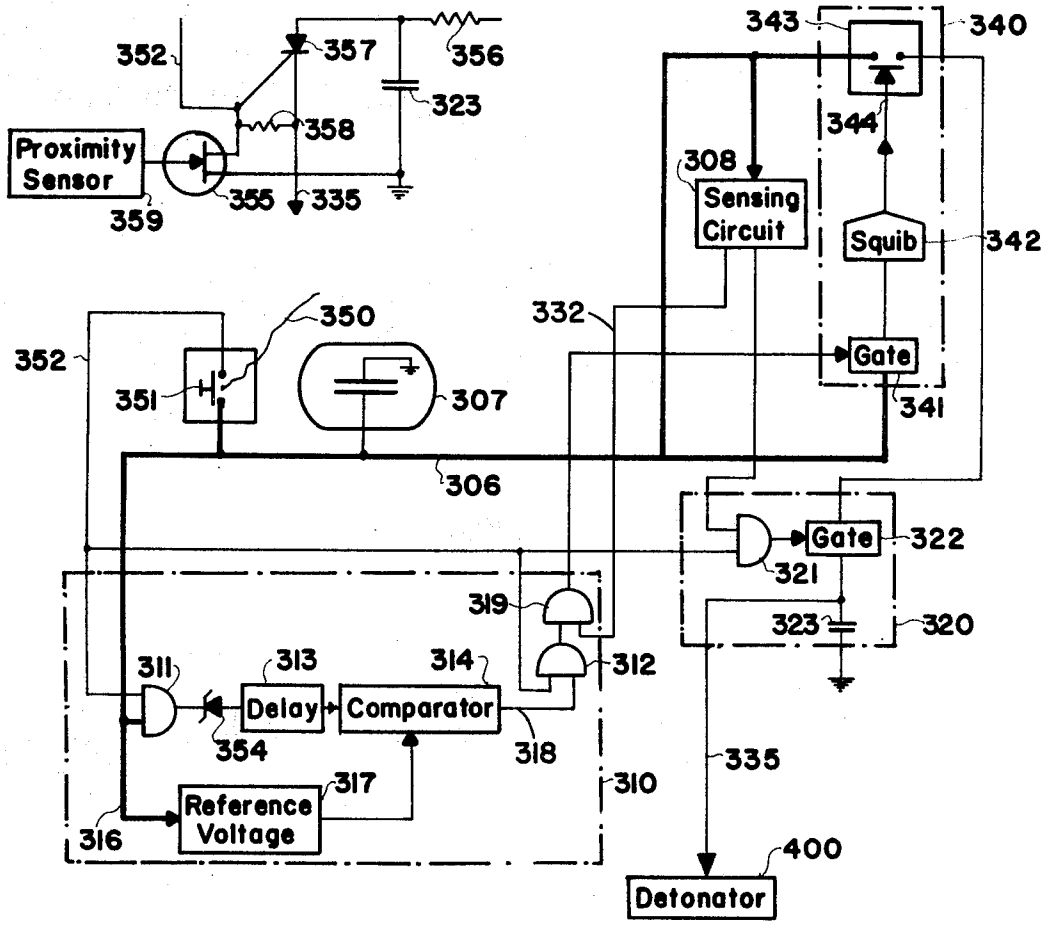


FIG. 3

Robert H. Pintell
INVENTOR.

BY *Karl G. Ross*
Attorney

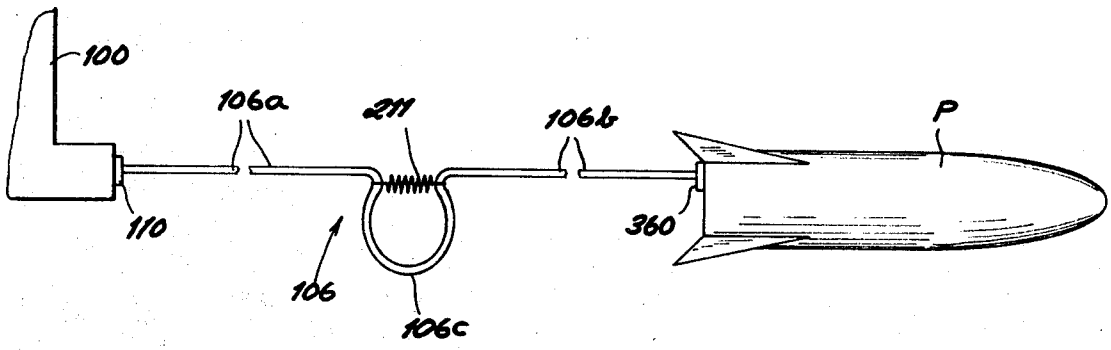


FIG. 5A

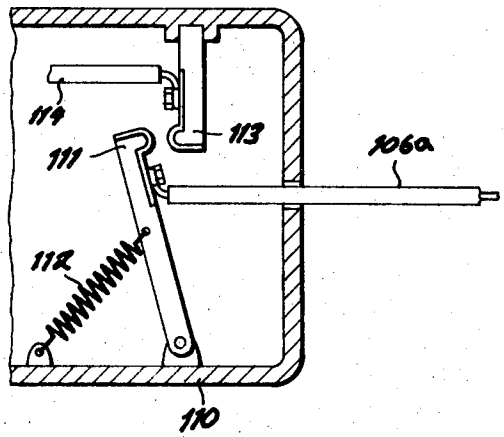


FIG. 5B

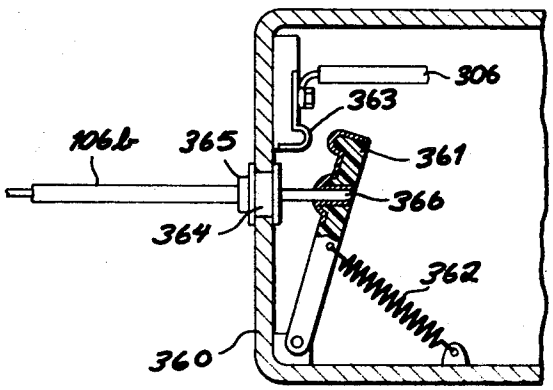


FIG. 5C

Robert H. Pintell
INVENTOR.

BY

Karl G. Ross
Attorney

ELECTRONIC FUZE

My present invention relates to a firing system for an explosive charge, hereinafter referred to as a fuze.

In the field of ordnance technology the function of a fuze is to ensure the safety of the weapon and its crew up to and during the launching of the projectile with its warhead. As a rule, therefore, the fuze is provided with means for inhibiting the detonation of the explosive charge in the vehicle or weapon in which it is carried, and for some time after it is launched from its carrier on its flight toward the target.

One of the prime characteristics of the ideal fuze is, consequently, its inertness under conditions of storage, transportation and preparation for launching or firing. Many of the conventional fuze designs are deficient in this respect. Powered by electrical or mechanical means for storing the energy required for their functioning, they are susceptible to actuation by external influences such as shock, vibration, stray electrical or magnetic fields and, ultimately, deliberate action of an enemy, e.g. in the form of electronic countermeasures. As a consequence of this unreliability factor, fuzes are frequently handled apart from the warheads they are meant to actuate and are only brought into the projectile assembly at the last possible moment, e.g. by insertion into an artillery shell just prior to its loading into the gunbarrel.

It is, therefore, the general object of my present invention to provide an improved fuze system which is safe from premature activation and foolproof in operation.

A related object is to provide a system of this character allowing a projectile so equipped to carry its warhead during transportation and handling without risk of accident.

In accordance with this invention I provide, in a fuze comprising an activating circuit for a detonator aboard a projectile to be launched from a carrier, one or more condensers serving as capacitive storage means for detonating energy, no other supply of such energy being present on the projectile. At the time of launch, i.e. upon incipient separation of the projectile from its carrier, the storage capacitor or capacitors are charged by the transfer of electrical energy from a current source on the carrier.

Advantageously, pursuant to another feature of my invention, the activating circuit includes a pyrotechnic switch in which an ancillary charge, only sufficient to close an initially open mechanical circuit breaker, is set off with a certain delay upon the charging of the storage capacitor. Even if, accidentally, this ancillary charge should be detonated prematurely, the main detonator associated with the warhead will not go into action unless the capacitor is fully charged and other conditions are fulfilled, e.g. the verification of certain operating parameters by a computer aboard the projectile. As a particular safety measure, a protective switch closed only upon the tensioning of a rupturable lanyard may prevent untimely discharge of a firing condenser through the detonator of the warhead.

In accordance with a more specific feature of my invention, the storage capacitor can be charged at the time of launch by a switch or set of switches in series with a conductor forming part of an umbilical cord initially extending from the mother vehicle or carrier to the projectile. Alternatively, or in addition, this capacitor could be charged by magnetic induction or by radio-frequency wave transmission, the energy-transfer means in this case including a transmitter aboard the carrier and a corresponding receiver aboard the projectile. In any event, the capacitive storage of sufficient energy to activate the firing circuit is made possible through the use of solid-state electronic components in the fuze whose inherent low power consumption limits the dissipation of the stored energy.

Thus, the fuze embodying my invention is completely inert prior to activation and, aside from being safe to handle, has an unlimited shelf life.

The above and other features of my invention will now be described in detail with reference to the accompanying drawing in which:

FIG. 1 is a diagrammatic illustration of a launch vehicle with a suspended projectile incorporating a fuze according to the invention;

FIG. 2 is a diagram of the major components of the fuze system shown in FIG. 1;

FIG. 3 is a block diagram of the logic elements incorporated in the system of FIG. 2;

FIG. 4 is a diagram of an embodiment of a charging circuit for storage capacitor included in that system;

FIG. 5A is a diagrammatic view of a switching mechanism for the charging circuit of FIG. 4;

FIGS. 5B and 5C are sectional detail views relating to the mechanism of FIG. 5A; and

FIGS. 6 and 7 illustrate projective circuits for the fuze detonator.

In FIG. 1 I have shown a launch vehicle V with an integral release pylon **100** carrying a projectile P. A slack umbilical cord **200** extends from pylon **200** to the projectile which includes an initially deactivated fuze **300**, a detonator **400** controlled by the fuze, and a warhead **500** destined to be set off by the detonator. Pylon **100** contains a command circuit communicating with a logic network in fuze **300** via a transmitting aerial **101** and a receiving aerial **301** as well as by way of electrical circuits included in umbilical cord **200**.

FIG. 2 shows details of components **100, 200, 300, 400** and **500** referred to above. The command circuit of pylon **100** includes a power supply **102** feeding a controller **103** which, in response to a signal generated or received aboard the vehicle, actuates a conventional release mechanism **104** to launch the projectile P. Controller **103** also energizes a transmitter **105** equipped with antenna **101**. A power cable **106** extends from transmitter **105** within umbilical cord **200** to a bus bar **306** within fuze **300**, this bus bar being initially separated from cable **106** by a switching mechanism generally designated **210**; and advantageous construction of this mechanism will be described in greater detail hereinafter with reference to FIGS. 5A, 5B, 5C.

Bus bar **306** forms part of a charging circuit for an initially discharged storage condenser **307** and also extends to other circuit components aboard the projectile P, including a set of sensors **308** and a logic network **310** hereinafter referred to as a first computer. Command signals from transmitter **105** reach the computer **310**, as well as a similar network **320** hereinafter designated a second computer, via one or more leads **109** tied by a connection **209** within umbilical cord **200** to a similar lead or set of leads **309** in fuze **300**. Sensors **308**, which may be responsive to such external parameters as altitude, ground speed and the like, also deliver

signals to the first and second computers **310, 320** by way of conductors **331** and **332**, respectively.

An output lead **333** of computer **310** extends to a pyrotechnic switch **340** which, when set off, energizes a lead **334** to supply power to the second computer **320**. The latter, in response to information from sensors **308** and possibly to signals transmitted from mother vehicle V by way of antennas **101, 301** and a receiver **305** connected to the latter antenna, then sends a trigger pulse over a lead **335** to detonator **400** which thereupon fires a charge **501** in warhead **500**.

FIG. **3** shows details of computers **310, 320** and pyrotechnic switch **340**. A rupturable lanyard **350**, tied to mother vehicle V, terminates at an initially open safety switch **351** to close it upon being tightened just prior to rupture as the two vehicles separate; lanyard **350** may be independent of umbilical cord **200** or form part thereof. Switch **351** thereupon connects the main bus bar **306** to an ancillary bus bar **352** from which branches extend to two AND gates **311** and **312** in computer **310** and an AND gate **321** in computer **320**. AND gate **311** also has an input connected directly to bus bar **306**, by way of an extension **316** thereof, and works through a delay network **313** into a comparator **314** which also receives a reference voltage, derived from lead **316**, through a unit **317**, e.g. a potentiometer. The output lead **318** of comparator **314** terminates at AND gate **312** which energizes an input of a further AND gate **319**, another input of the latter AND gate being tied to the output lead **332** of sensing circuit **308**. AND gate **319**, like AND gate **321** in computer **320**, is representative of a more elaborate logic matrix designed to evaluate the various signals from sensing circuit **308**.

When AND gate **319** responds, i.e. upon receipt of the proper combination of signals from sensors **308** in the conductive state of AND gate **312**, it unblocks a normally blocked gate **341** in the power circuit leading from bus bar **306** to a squib **342** forming part of the pyrotechnic switch **340**. This pyrotechnic switch further includes a mechanical circuit breaker **343** which, via a piston **344** displaced by the detonation of squib **342**, is closed to supply power to computer **320** which includes another normally blocked gate **322**. AND gate **321**, which may already be conductive at that instant, opens the gate **322** to complete a charging circuit from bus bar **306** to a firing condenser **323** whose capacitance is considerably less than that of storage condenser **307**. Thus, the residual charge of condenser **307** (after energization of the various circuits fed from bus bar **306**) suffices to raise the potential of condenser **323** to the level required for activating the detonator **400** by way of output lead **335**.

The initial charging of storage capacitor **307** may be accomplished in various ways. As illustrated at FIG. **4**, high-frequency energy communicated from transmitter **105** to receiver **305** with the aid of antennas **101** and **301** can be rectified, in a circuit symbolized by a diode **353**, to apply a d-c voltage to bus bar **306** for the time necessary to accumulate a suitable charge.

Capacitor **307** may be precharged, to a level insufficient to set off the squib **342**, via lead **106** and switch **210** (FIG. **2**) which for this purpose may be closed for a limited period just prior to the severing of umbilical cord **200**; the transmission of *r–f* energy via aerials **101** and **301** is then required only to supplement the preliminary charge of the capacitor. Thus, an electronic breakdown device in series with delay network **313** (FIG. **3**), such as a Zener diode **354**, may serve to prevent operation of comparator **314** even upon closure of safety switch **351** if the condenser voltage has not been brought up to the specified level.

It is, however, also possible to rely exclusively upon the umbilical cord **200** for the charging of condenser **307** at the instant of separation. This has been illustrated in FIGS. **5A – 5C** where the pylon **100** is shown provided with a switch box **110** connected via the cable **106** with a similar switch box **360** on projectile P. Wire **106** has two sections **106*a***, **106*b*** interconnected by a loop **106*c*** which is spanned by a spring **211**. Switch box **110**, illustrated in detail in FIG. **5B**, contains an armature **111** biased by a spring **112** away from a confronting contact **113** which is connected to the end of a lead **114** emanating from power supply **102** and traversing the controller **103** of FIG. **2**. Switch box **360** (FIG. **5C**), similarly, has an armature **361** biased by a spring **362** away from a contact **363** connected to bus conductor **306**. Box **360** also comprises a jack **364** in which the output end of cable portion **106*b*** is frictionally held by a mating plug **365**.

With cable portion **106*a*** directly connected to armature **111** and jack **364** tied to armature **361** by a wire link **366**, the incipient separation of projectile P from its mother vehicle V reduces the slack of umbilical cord **200** so that cable **106** begins to stretch against the tensile force of spring **211**. Since springs **112** and **362** are weaker than spring **211**, contacts **111, 113** and **361, 363** close substantially simultaneously at this point to let the full output of power supply **102** (stepped down, if necessary, in controller **103**) charge the capacitor **307** over a low-resistance path whereby the condenser potential is brought to the desired level during the brief period available for this operation. As soon as the tension of spring **211** has reached a critical limit, plug **365** is withdrawn from jack **364** while conductive link **209** (FIG. **2**), representative of any number of leads not shown in FIGS. **5A – 5C**, is similarly severed. With bus bar **306** insulated from ground, the charge on condenser **307** remains trapped until released in the manner described above.

FIG. **6** illustrates an additional safety measure that may be used to prevent untimely activation of detonator **400**. Firing condenser **323** is here shown shunted by a clamp circuit including a field-effect transistor **355** whose gate, connected to lead **352**, is energized only upon the closure of circuit breaker **351** by lanyard **350** (FIG. **3**). A resistor **356** in the output lead **335** insulates the detonator against stray pulses.

FIG. **7** shows an alternate protective circuit including a controlled rectifier **357** whose gate-cathode circuit includes a resistor **358** bridged by the field-effect transistor **355**. In this instance, the gate of controlled rectifier **357** is connected to lead **352** whereas the gate of transistor **355** is energizable by a proximity sensor **357**. Resistor **356** is here connected in series with controlled rectifier **357** and firing condenser **323**. Thus, energization of lead **335** is blocked even in the presence of voltage on lead **352** so that condenser **323** cannot discharge into the detonator **400** (FIGS. **2** and **3**) as long as FET **355** is passive; only upon detection of the proximity of the target, by means of sensor **359**, can the warhead be exploded.

I claim:

1. A firing system for an explosive charge aboard a projectile to be launched from a carrier, comprising:

a detonator for said charge aboard said projectile;

an activating circuit for said detonator on said projectile, said circuit including capacitive storage means as its sole supply of activating energy;

a source of charging current for said storage means on said carrier;

transfer means operative only upon incipient separation of said projectile from said carrier for instantly charging said storage means with current from said source; and

sensing means independent of said transfer means on said projectile for completing a firing circuit to said detonator from said storage means, subsequently to the charging thereof, in response to external parameters.

2. A system as defined in claim 1 wherein said transfer means includes high-frequency radio transmission means on said carrier and corresponding receiving means on said projectile.

3. A system as defined in claim 1 wherein said transfer means includes a conductor extending slack from said carrier to said projectile and normally open switch means in series with said conductor momentarily closable upon a tensioning of the latter.

4. A system as defined in claim 3 wherein said switch means comprises a pair of switches at opposite ends of said conductor.

5. A system as defined in claim 1 wherein said activating circuit includes a normally open mechanical circuit breaker between said storage means and said detonator, and pyrotechnic switch means triggerable by said storage means upon a charging thereof for closing said circuit breaker.

6. A system as defined in claim 5 wherein said activating circuit further includes delay means inserted between said storage means and said pyrotechnic switch means for retarding the closure of said circuit breaker.

7. A system as defined in claim 1 wherein said activating circuit includes a firing condenser of a capacitance substantially less than that of said storage means, said condenser having a discharge path through said detonator.

8. A system as defined in claim 7 wherein said firing condenser is provided with protective circuitry including an initially open safety switch closable upon separation of said projectile from said carrier for blocking premature discharge of said condenser through said detonator.

9. A system as defined in claim 8 wherein said protective circuitry includes a clamping network in shunt with said condenser.

10. A system as defined in claim 8 wherein said safety switch is provided with a rupturable lanyard tied to said carrier for closing said safety switch upon incipient separation.

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