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TRIGGERED EXPLODING WIRE DEVICE

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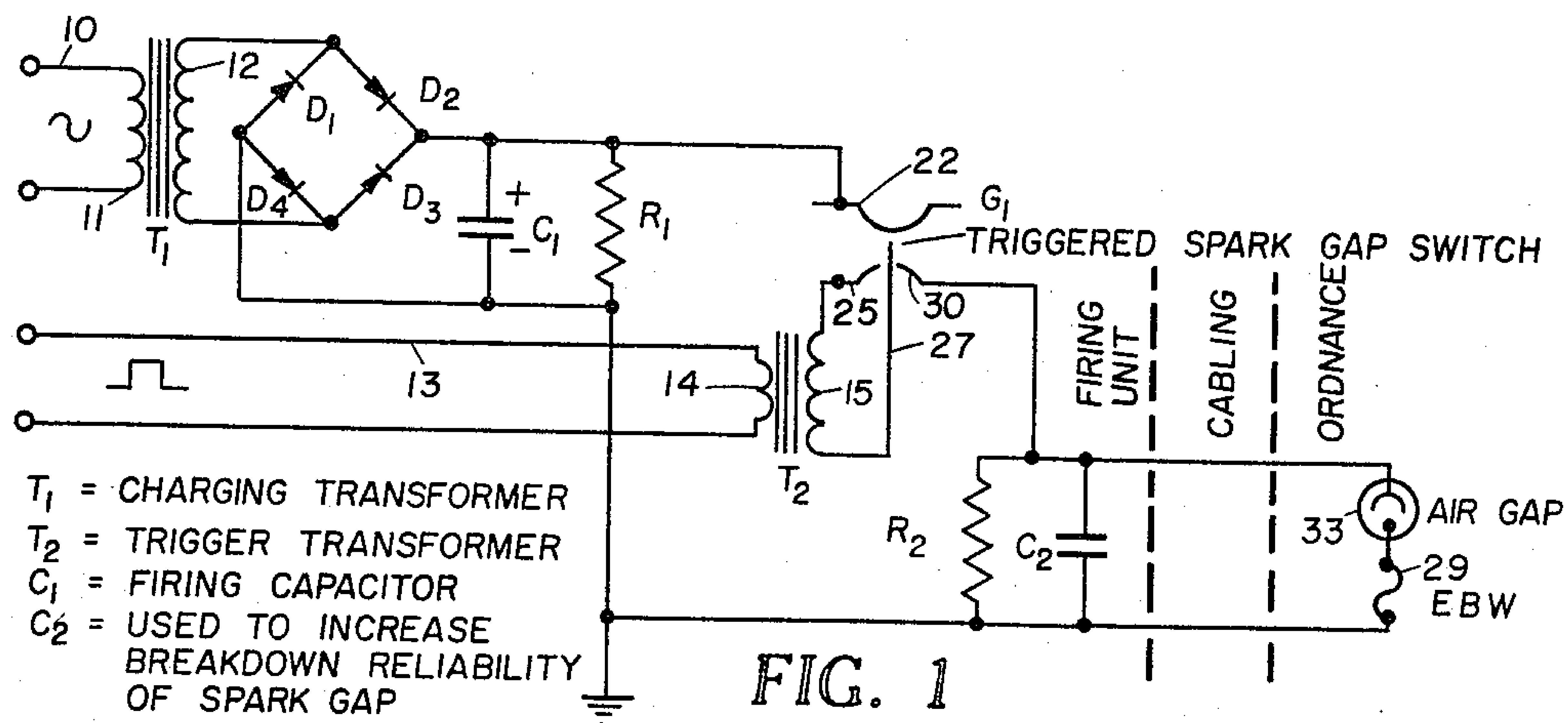

FIG. 1

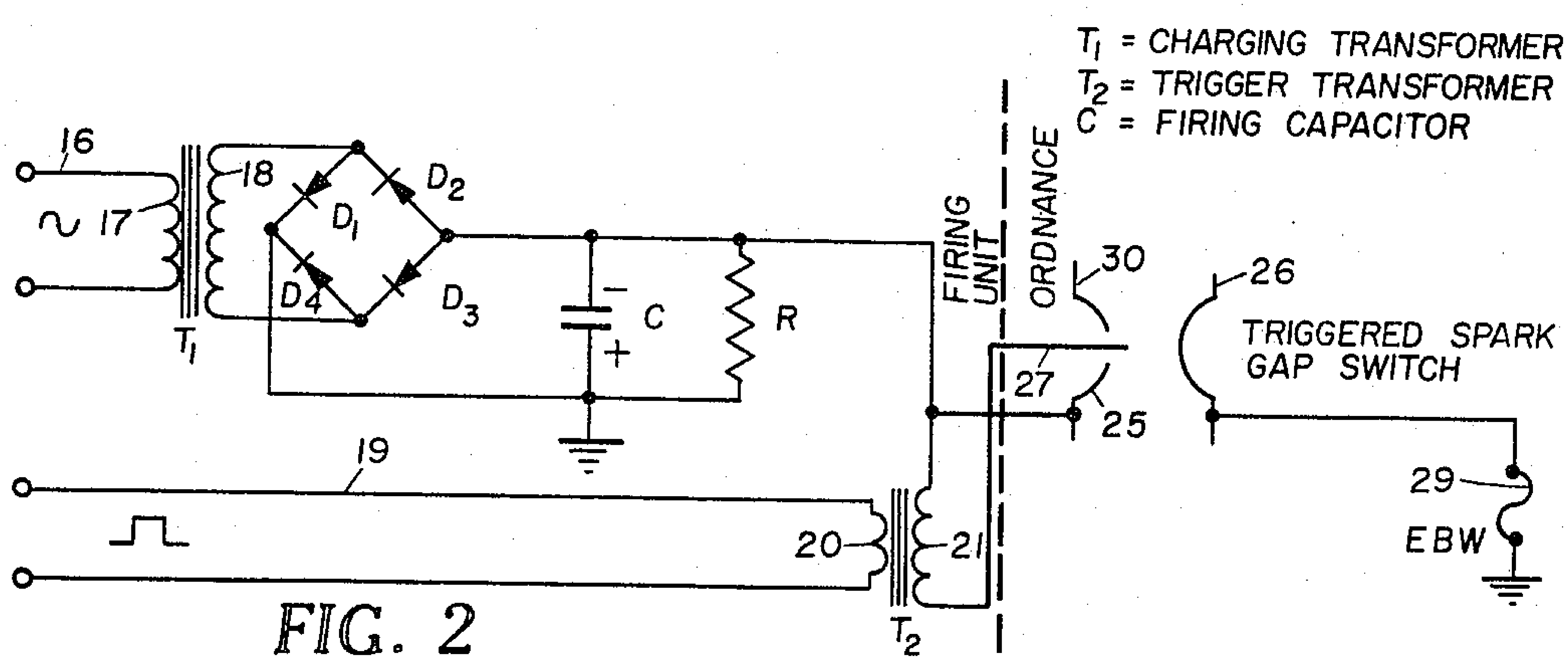

FIG. 2

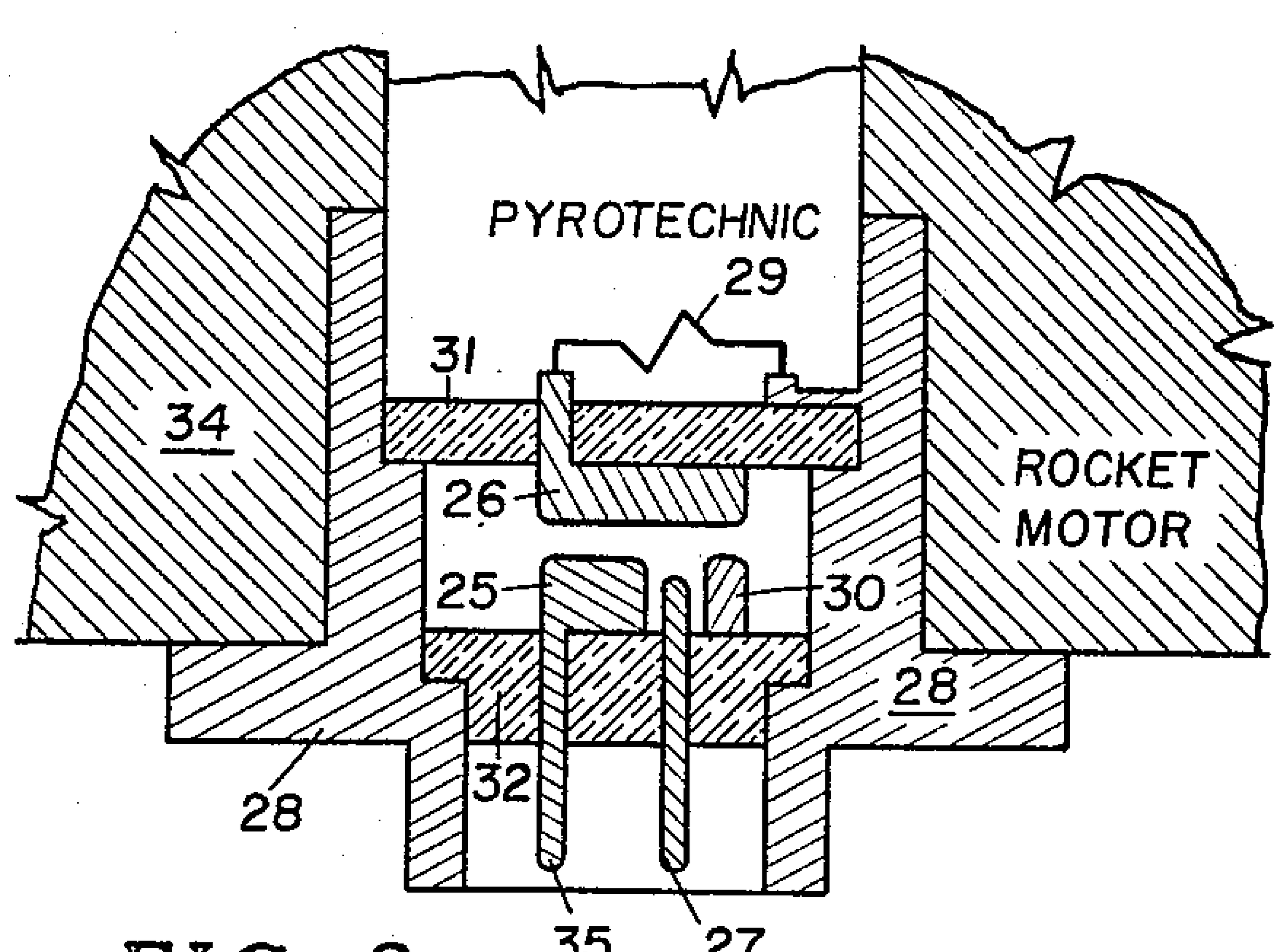

FIG. 3

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TRIGGERED EXPLODING WIRE DEVICE

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4 Claims. (Cl. 102—70.2)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates generally to electroexplosive apparatus for initiating certain types of explosives with and exploding wire and more particularly to an improved triggered spark gap-bridge wire arrangement which is an integral part of an ordnance component and especially adapted for use in an electrical firing circuit.

Exploding bridge wire (EBW) firing systems presently used require certain safety features which must necessarily be incorporated therein to prevent inadvertent firing of the EBW when extraneous A.C. and D.C. voltages of certain amplitudes are applied thereto. The present invention represents a novel improvement over these systems by providing safety features with higher reliability and increased safety factors over safety features of prior art firing systems while eliminating some of the circuit components heretofore necessary to prevent inadvertent firing of the EBW. The precise improvement over the prior art will become more fully apparent in the following detailed description of the invention and the prior art firing system of FIG. 1.

An object of the invention is to provide an exploding bridge wire firing system having improved safety features designed to prevent inadvertent firing of the bridge wire, said safety features exhibiting a substantial improvement in simplicity and reliability over those safety features presently used in exisiting firing systems.

Another object is to provide a novel triggered spark gap bridge wire arrangement in a single ordnance component which may be energized using conventional circuitry of the prior art.

A further object is to provide a novel combination of bridge wire and firing means therefor which requires fewer components than the prior art systems while achieving a high degree of safety with regard to the inadvertent firing of the bridge wires.

Other objects and novel features of the present invention will become more fully apparent from the following description of the annexed drawings in which:

FIG. 1 illustrates the type of exploding bridge wire firing circuit presently used;

FIG. 2 is a schematic diagram of the system embodying the present invention; and

FIG. 3 shows the structural arrangement of components which form the triggered spark gap bridge wire combination especially adapted for firing in the arrangement shown in FIG. 2.

The EBW system is currently used for rocket motor initiation in gas generator activation, rocket stage separation, rocket thrust termination, and vehicle destruction. In their basic concept, EBW detonators do not require sensitive primary explosives. As a result EBW detonation systems are essentially immune to premature initiation during all phases of the logistics train and such immunity substantially eliminates the need for out of line safing mechanisms.

EBW systems are also used where sensitive primary explosives are required and these systems may include firing circuitry such as is shown in FIG. 1. To retain the safety

inherent in using insensitive explosives, a circuit interruption in the form of an air gap **33** has been incorporated between the firing circuit and the EBW and prevents firing of the EBW in the event of an inadvertent application of extraneous D.C. voltages up to approximately 500 volts and A.C. voltages up to approximately 120 volts across the EBW.

The firing circuit of FIG. 1 includes transformer T_1 having an input winding **11** for receiving an A.C. voltage and having an output winding **12** connected to a diode bridge rectifier for converting the input A.C. voltage to a D.C. voltage. An RC circuit C_1R_1 is connected to the output of the diode bridge rectifier D_1 through D_4 to provide a stored charge capable of being transferred via the triggered spark gap to the EBW. It is this source of power that provides a current through the bridge wire **29** when the spark gap is triggered into conduction. A source of trigger pulses is provided at **13** and coupled through transformer T_2 for applying a trigger pulse between cathode **25** and trigger probe **27**. By the application of a trigger pulse **13** between the probe **27** and cathode **25**, the gas within the triggered spark gap becomes sufficiently ionized to cause breakdown between cathode and anode, resulting in current flow in the parallel RC circuit R_2C_2. This latter circuit was included in the prior art system of FIG. 1 in order to develop a voltage across the EBW and air gap **33** sufficient to cause breakdown in air gap **33** once a trigger pulse is applied at **13**.

The pulse generated from the cathode-anode breakdown which is intended to explode the bridge wire will easily breakdown the gap **33** when the RC circuit R_2C_2 is present in the firing circuit of FIG. 1. The characteristics of this parallel RC circuit, however, become very critical in firing the EBW of FIG. 1 and it would be desirable, if possible, to eliminate this circuit and to eliminate the dependence of the EBW firing upon the characteristics thereof.

The present invention has eliminated the need for an individual air gap **33** to protect the bridge wire from inadvertent A.C. and D.C. voltages applied thereacross, it has eliminated the need for a second parallel RC circuit connected across the bridge wire to provide a sufficient voltage to initiate conduction therethrough, and has eliminated the need for a transmission line between the ordnance and the firing unit as shown in FIG. 1. By connecting the bridge wire as shown in FIG. 3 directly between cathode and ground (casing **28**) and by adjusting the width of the triggered spark gap to provide a breakdown potential sufficient to shield the EBW against inadvertent A.C. and D.C. voltages, the above cited components of FIG. 1 can be eliminated. In the system shown in FIG. 2 the D.C. voltage at the output of the RC circuit is applied between the cathode **25** and ground. However, in this embodiment the EBW is connected directly between anode and ground as shown in FIG. 3 and the triggered spark gap may now be included as an integral part of the ordnance component. A trigger pulse is applied at the input winding **20** of transformer T_2 to provide a potential between probe **27** and cathode **25** for initiating conduction in the triggered spark gap.

The structural arrangement shown in FIG. 3 includes an outer casing **28** having a pair of support members **31** and **32** extending from opposing walls thereof and enclosing a gas filled space within the casing **28**. Anode **26** is mounted on one side of support member **31** and has a portion thereof extending through the support member to the outside of the enclosed gas filled space. The cathode is annular in shape and includes a first cross-section **30** within the gas enclosed space shown on one side of the support member **32** and a second cross-section **25** likewise enclosed in the gas filled space and having a pin-like member integral therewith extending through the support member 32 to the outside of the gas filled space. Pin member 35 is aligned for plug-in purposes with probe electrode 27 which extends through the support member 32 into the gas filled space and between portion 25 and portion 30 of the cathode.

The cylindrical casing 28 enclosing the extending pin members 27 and 35 forming the probe and cathode electrodes of the spark gap respectively has been combined with the bridge wire to form a single ordnance component which may be plugged into the firing unit of FIG. 2 and thus eliminates the need for any cabling between the firing unit and the bridge wire. Support members 31 and 32 are ceramic insulators and the space enclosed by these support members is filled with a gas which becomes ionized by the application of a potential between trigger probe 27 and the trigger dome cathode 25.

The unit shown in FIG. 3 may be mounted directly on a rocket motor or component to be detonated or ignited and the firing unit may be mounted directly over the structural apparatus of FIG. 3 or may, if desired, be connected by cable to the former. The ceramic supports 31, 32 are usually strong enough so when the pyrotechnic explodes it will not blow back into the firing system. However, if it does, the ceramic supports may be constructed of metal-to-ceramic type feed throughs. The metal casing 28 is electrical ground for the circuit.

The foregoing description of the invention clearly indicates that the inclusion of the triggered spark gap in the ordnance component eliminates one or more components from the firing unit, eliminates one gap from the two now in series as shown in FIG. 1 and provides safety in the event of an inadvertent application of both A.C. and D.C. voltages to the EBW at much higher levels than now protected against. This is due to the increased breakdown potential in the triggered spark gap switch over the air gap. In addition the present invention, like the prior art systems, requires that potentials be applied to more than one terminal simultaneously to explode the bridge wire. The system of FIGS. 2 and 3 illustrates how the firing unit may be closely coupled to the EBW thereby eliminating many of the transmission line problems now encountered. The system further provides increased reliability by the elimination of one series air gap in the transmission line.

Various modifications are contemplated and may obviously be resorted to by those skilled in the art without departing from the spirit and scope of the invention. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. A firing system for exploding an electrical bridge wire comprising

means forming a triggered spark gap having an anode, cathode and probe electrode,
a conductive casing surrounding said spark gap,
a pair of insulating support members extending between opposite walls of said casing and enclosing a gas filled space within said casing,
said anode being mounted within said gas filled space one one of said support members and having a portion thereof extending through the member and outside of said gas filled space,
said cathode consisting of a ring having an annular opening therein and a pin member integral therewith and extending through said other support member and outside of said gas filled space,
a conductive probe extending from outside said gas filled space through said other support member into said annular opening in said ring,
a bridge wire connected between said conductive casing and said anode in closely spaced adjacent relationship with said anode and said conductive casing,
a first circuit means for providing a first potential between said cathode and said anode for supply current to said bridge wire,
second circuit means connected between said probe electrode and said cathode for establishing a potential between said probe electrode and said cathode to ionize the gas within said enclosed space.

2. The system of claim 1 wherein said first circuit means includes

a first transformer means having input and output windings thereon,
a rectifying circuit connected to the output winding of said transformer for converting the A.C. voltage applied to the input winding to a D.C. voltage output,
a parallel RC charging circuit connected to output of said bridge for providing a D.C. output voltage,
means for connecting the output of said RC circuit between the cathode of said triggered spark gap and said casing,
said second circuit means including a second transformer having input and output windings thereon for coupling a trigger pulse between probe and cathode electrodes for initiating conduction in said triggered spark gap and enabling current to flow from said rectifying circuit to said bridge wire.

3. The system in claim 1 wherein said second circuit means includes

a transformer having input and output windings thereon,
said input winding connected to receive a trigger pulse and said output winding directly connected between said probe electrode and said cathode for coupling said trigger pulse therebetween to initiate conduction in said triggered spark gap and allow current flow from said first circuit means to said electrical bridge wire.

4. A unitary ordnance device adapted to be mounted on a component to be detonated or ignited and adapted to be energized from an independent firing system comprising

a conductive casing,
electrically insulating support means structurally affixed to the interior walls of said casing,
a cathode, anode and probe electrodes mounted on said support means and within said casing in a fixed spaced relationship,
said support means enclosing a gas filled space within said casing,
said anode, cathode and probe electrodes each having a portion thereof extending within and without said gas filled space,
an exploding bridge wire connected between said anode and said casing and adjacent a pyrotechnic to be detonated whereby
said probe and cathode electrodes extending outside said gas filled space form terminals which may energize to cause electrostatic breakdown between said anode and cathode for firing said exploding bridge wire, detonating said pyrotechnic, and destroying said component.

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