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[54] **ELECTRONIC COUNTING FUZE**

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[52] **U.S. Cl.**..... **102/70.2 R;** 102/19.2; 102/70.2 GA

[51] **Int. Cl.**[2] **F42C 11/00**

[58] **Field of Search** ... 102/70.2 I, 70.2 A, 70.2 GA, 102/70.2 R, 19.2

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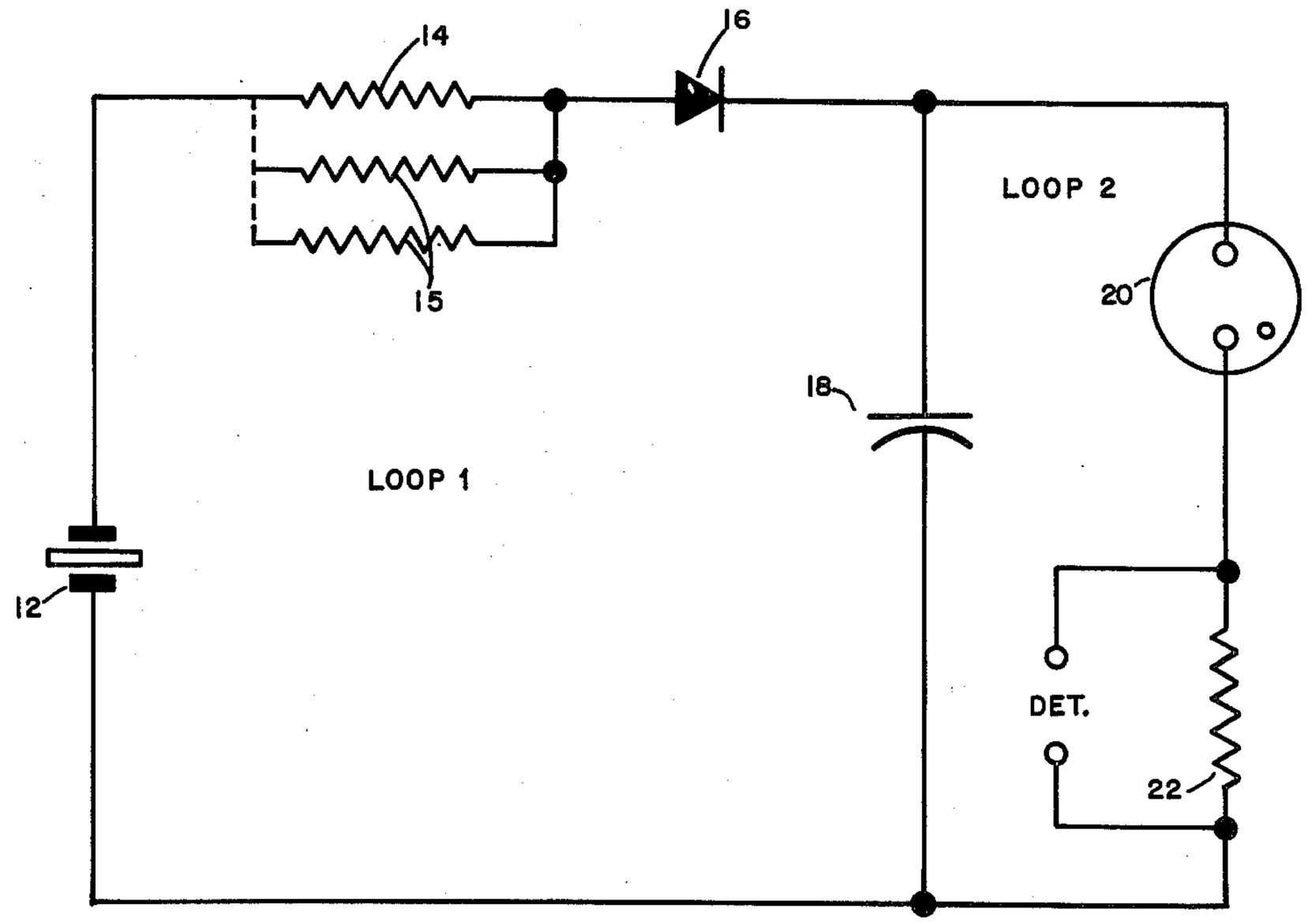
[57] **ABSTRACT**

A counting fuze for a land mine having a detonator, comprising: an electrical source unit providing an output only when subjected to pressure; a charge storage means, said storage means receiving a charge in pulse form from said electrical source unit upon each subjection of said source unit to pressure; and electronic gating means, said gating means connected intermediately between said storage means and said detonator, whereby said detonator will be activated after successive applications of pressure to said electrical source unit.

5 Claims, 3 Drawing Figures



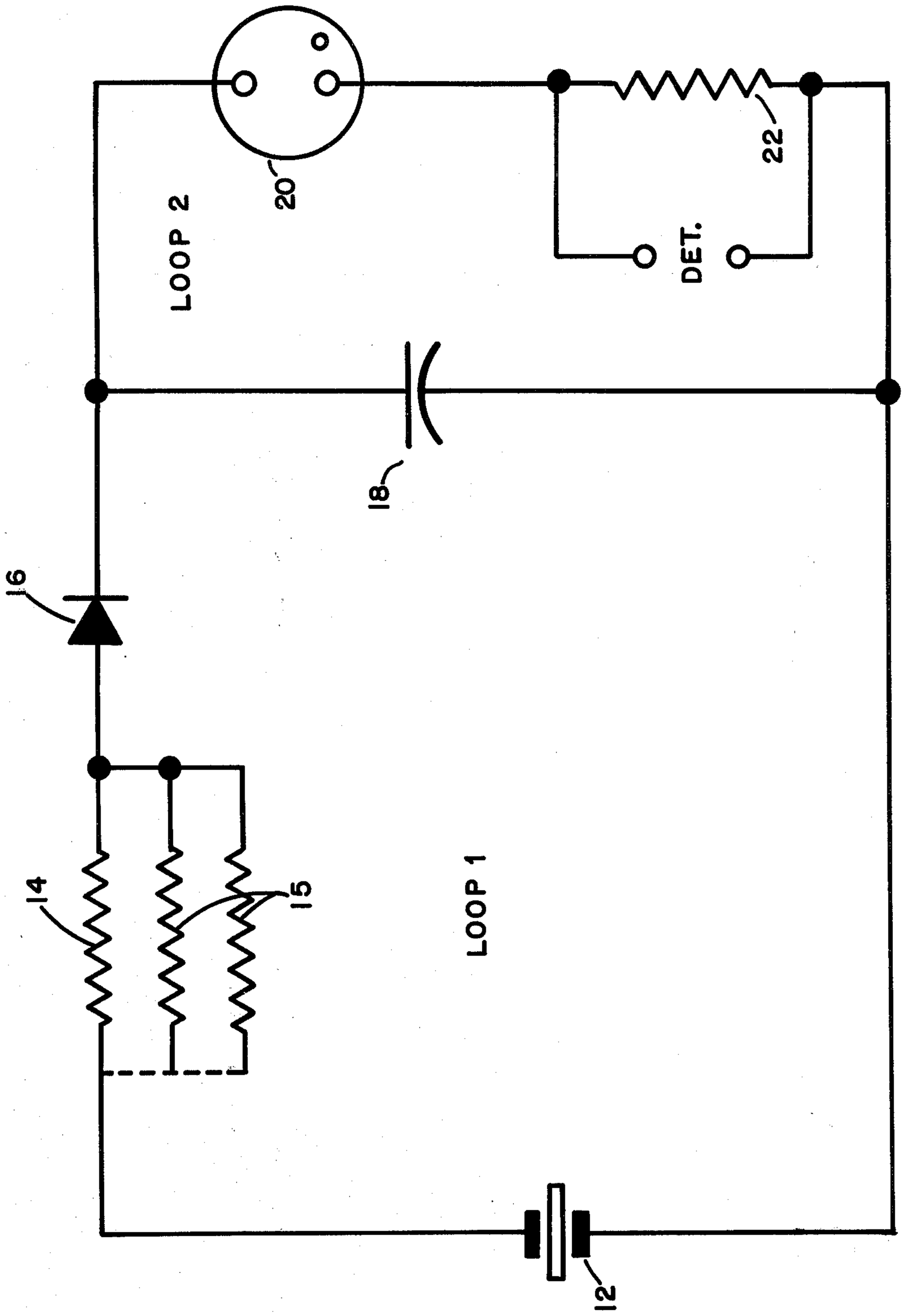


FIG 1

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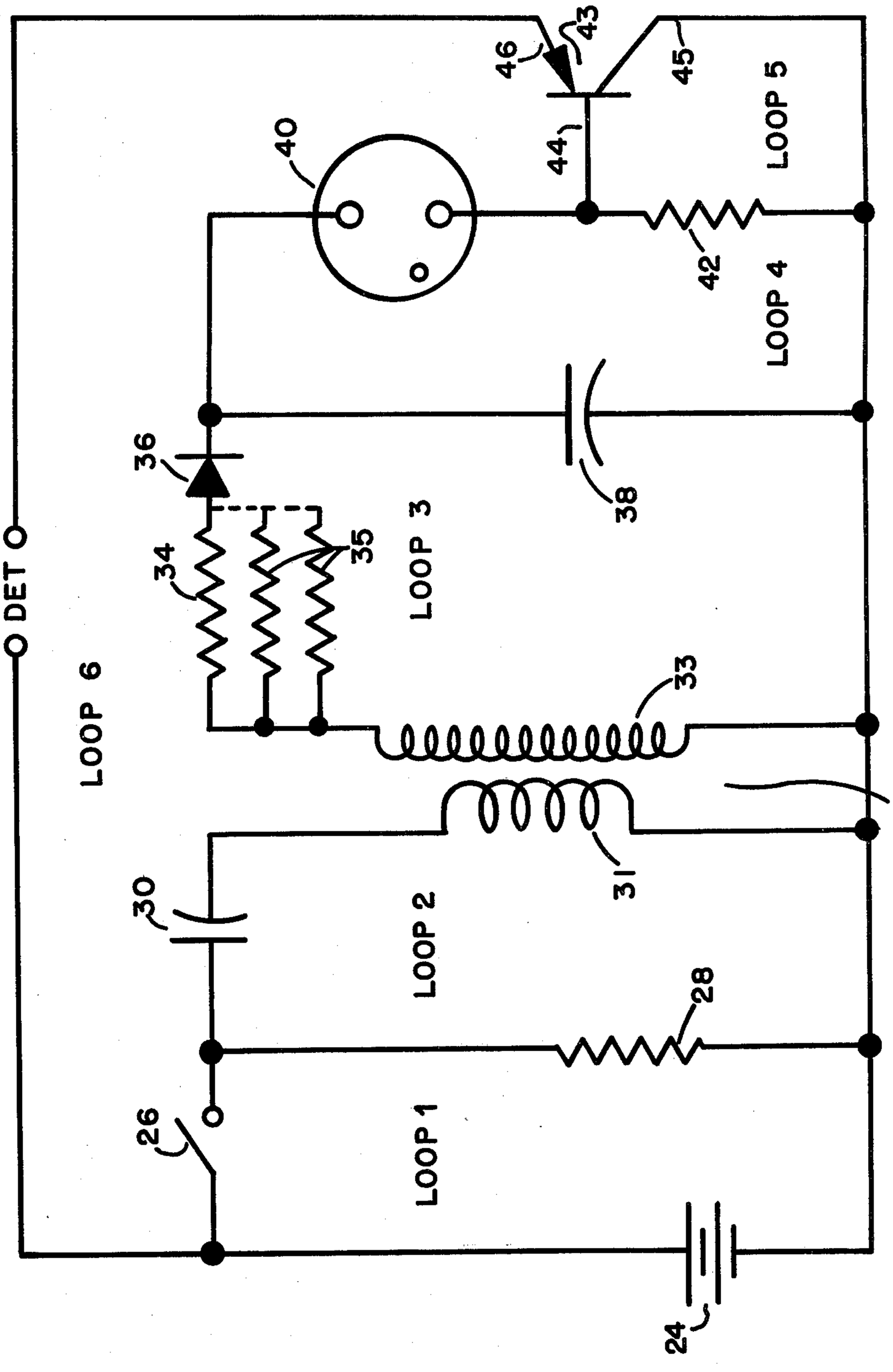

FIG 2

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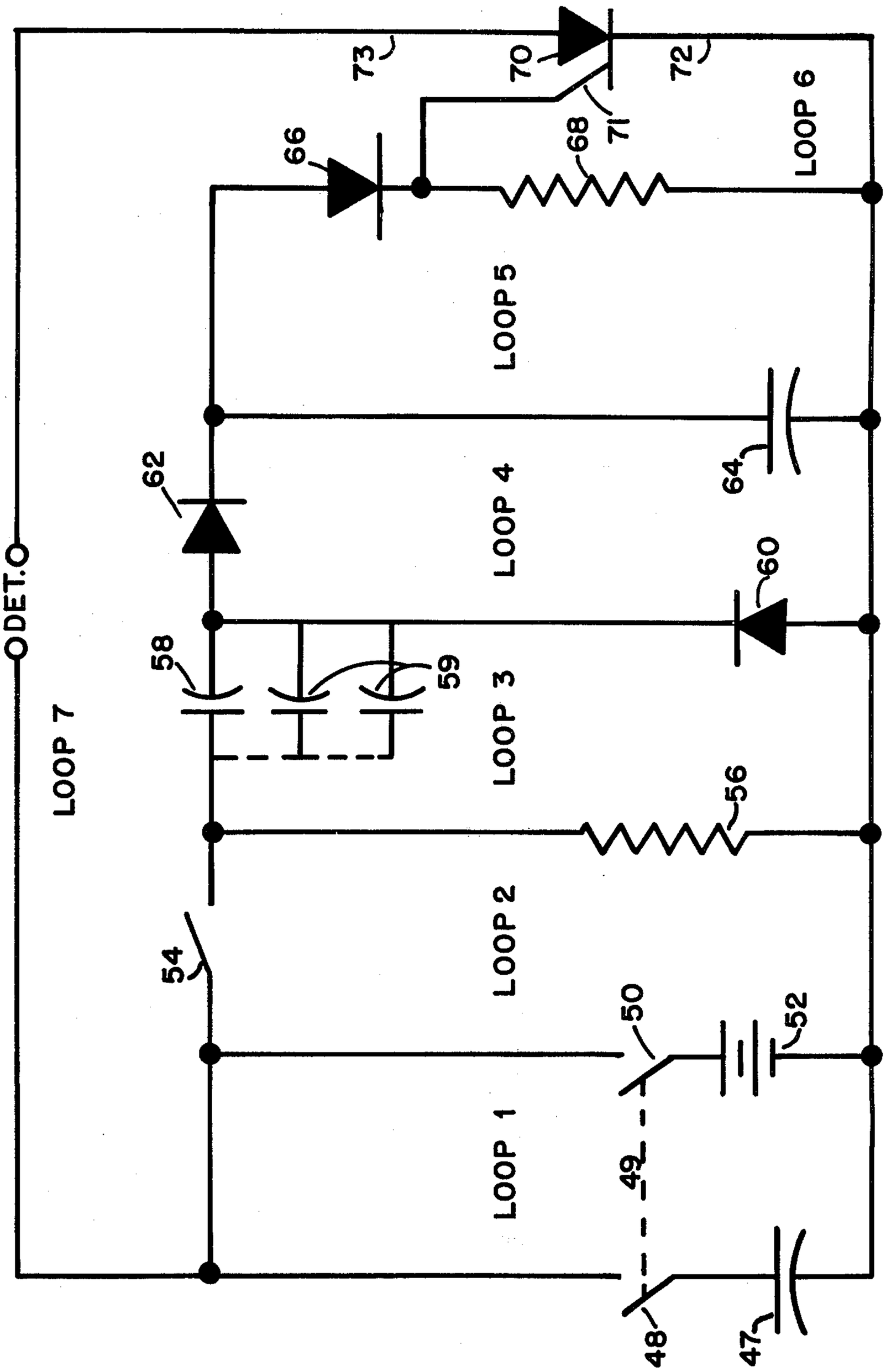

FIG 3

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ELECTRONIC COUNTING FUZE

The invention described herein may be manufactured, used and licensed by the Government for governmental purposes without payment to me of any royalty thereon.

BACKGROUND OF THE INVENTION

The present invention relates to the field of art dealing with electronic fuzes for land mines.

The fuze herein disclosed possesses a capability long desired in land mines. Namely, rather than detonating upon a single pressure input, detonation can now be obtained after N pressure inputs. This capability imparts the present invention with potential effectiveness against columns of soldiers or vehicles. With N equal to a suitable number, e.g., **20,** a mine equipped with the present fuze could detonate in the midst of a personnel or vehicle column.

SUMMARY OF THE INVENTION

An object of this invention is to provide an electronic fuze for a land mine, said fuze being capable of initiating a detonation after a given number of pressure inputs.

Another object is to provide an anti-intrusion device having an alarm said alarm capable of initiating after a given number of pressure inputs.

The present electronic counting fuze comprises an electrical source unit providing an output only when subjected to pressure; a charge storage means, said storage means receiving a charge in pulse form from said electrical source unit upon each subjection of said source unit to pressure; and electronic gating means, said gating means connected intermediately between said storage means and a detonator, whereby said detonator will be activated after successive applications of pressure to said electrical source unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a circuit diagram of a crystal-powered counting fuze.

FIG. **2** is a circuit diagram of a transformer-coupled counting fuze.

FIG. **3** is a circuit diagram of a capacitor-bridge counting fuze.

DETAILED DESCRIPTION OF THE INVENTION

One embodiment of the present invention is illustrated in FIG. **1** which shows a piezoelectric crystal-powered counting fuze. Said fuze is comprised of two circuit loops.

One loop comprises, in series relationship, a piezoelectric crystal pair **12,** a resistor **14,** a blocking diode **16** and a capacitor **18.** Different values of the resistor **14** can be substituted. These alternate values of resistor **14** are denoted as resistors **15** in FIG. **1.**

The second loop comprises said capacitor **18** in parallel with the series combination of a gas diode **20** and a resistor **22.** Said resistor is in parallel with the detonator, denoted DET in FIG. **1.**

Said crystal-powered counting fuze operates as follows: The application of force by a potential target to the crystal **12** generates a voltage pulse across the resistor-capacitor combination of elements **14** and **18.** When the force is relieved, a pulse of equal voltage and opposite polarity is generated. The blocking diode **16**

prevents the capacitor **18** from becoming discharged by the reverse pulse. When a sufficient potential has been built up in capacitor **18** by several positive pulses from the crystal **12,** the gas diode **20** will conduct a portion of the charge through the resistor **22.** The voltage across resistor **22** will initiate the detonator.

Satisfactory results have been obtained with the following values of the components in FIG. **1**: resistor **14,** 100 thousand ohms; capacitor **18, 0.1** microfarads; resistor **22, 10** thousand ohms.

The number of counts or input pulses needed to initiate the detonator can be changed by altering the value of resistor **14.** This procedure, which is termed count selection, is accomplished by providing a group of different value resistors **15** for element **14.**

It is to be noted that, as regards safety, since several counts would be needed for detonation, an accidental short of the detonator to the power source could not cause detonation.

The crystal-powered fuze, while enjoying the advantage of unlimited shelf life, is incapable of producing sufficient energy to initiate some higher energy detonators.

This problem was attacked through a second embodiment of the present invention which may be termed a transformer-coupled counting fuze. This fuze comprises six current loops. See FIG. **2.** Loop **1** comprises in series relationship a battery **24,** a sensor switch **26** such as a normally open pressure sensitive tape switch manufactured by Tapeswitch Corp. of America, **320** Broadhollow Rd., Farmingdale, N.Y., Model No. RBMA, or a normally open magnetic influence or proximity switch such as manufactured by Electro Products Laboratories, Inc., Chicago, Ill., Model No. **85,003,** and a resistor **28.** In the case of the pressure sensitive switch, the weight of troops and/or vehicles passing thereon is successively sensed. In the case of the magnetic influence switch, the presence or close proximity of magnetic material, such as vehicle frames or tank treads are being sensed. Loop **2** comprises in series relationship said resistor **28,** a capacitor **30,** and a transformer primary **31** of a transformer **32.** Loop **3** comprises in series relationship a transformer secondary **33** of said transformer **32,** a resistance **34,** a blocking diode **36** and a capacitor **38.** Loop **4** comprises in series relationship said capacitor **38,** a gas diode **40** and a resistor **42.** Loop **5** comprises the resistor **42** connected in parallel with two leads of a transistor **43**: A base **44** of the transistor is connected between gas diode **40** and resistor **42.** A collector **45** is connected between resistor **42** and capacitor **38.** Loop **6** comprises in series relationship the base lead **44** of said transistor **43,** an emitter **46** of said transistor, the detonator (denoted DET in FIG. **2**), the switch **26,** the capacitor **30,** the transformer **32,** the resistor **34,** the blocking diode **36** and the gas diode **40.** Count selection is obtained by providing a group of different valued resistors **35** which can be substituted for resistor **34.**

The transformer-coupled counting fuze employs the same principle of capacitor storage and gas diode to resistor discharge as is used in the crystal-powered fuze. The input in FIG. **2** derives from switch closures, as from a button or a tape switch. With each closure of switch **26,** the pulse from battery **24** is stepped up by transformer **32.** When a sufficient charge builds up across capacitor **38** the gas diode **40** will discharge into resistor **42.** The voltage pulse across resistor **42** acts as

the input to transistor **43**, which acts as a switch in initiating the detonator.

The capacitor coupling of elements **28** and **30** between the battery **24** and transformer **32** prevent damage to the battery in the event of a prolonged input switch closure.

Satisfactory results have been obtained with the following values of the components in FIG. **2**: battery **24**, **9** volts; resistor **28**, **10** thousand ohms; capacitor **30**, **100** microfarads; resistor **34**, **100** thousand ohms; capacitor **38**, one microfarad; and resistor **42**, **100** ohms.

The need for a fuze with an output pulse of longer duration, a feature essential for initiation of certain detonators, led to the development of a further modified design. This design is illustrated in FIG. **3** and is termed a capacitor-bridge counting fuze.

This fuze comprises seven circuit loops. See FIG. **3**. Loop **1** comprises in series relationship a capacitor **47**, one closure **48** of a double-pole single-throw arming switch **49**, a second closure **50** of said double closure switch, and a battery **52**. Loop **2** comprises in series relationship said battery **52**, said second closure **50**, a single-pole single-throw input switch **54** and a resistor **56**. Loop **3** comprises in series relationship the resistor **56**, a capacitor **58**, and a first blocking diode **60**. Capacitor **58** is provided with alternative capacitors **59** that can be switched into the circuit if a different number of counts is desired for detonation. Loop **4** comprises in series relationship said first blocking diode **60**, a second blocking diode **62** and a capacitor **64**. Loop **5** comprises in series relationship the capacitor **64**, a Shockley diode **66** and a resistor **68**. Loop **6** comprises the resistor **68** in parallel with two leads of a silicon control rectifier (SCR) **70**. The trigger **71** of the SCR is connected between the Shockley diode **66** and the resistor **68**. The cathode **72** is connected between the resistor **68** and the capacitor **64**. Loop **7** comprises in series relationship trigger **71**, anode **73** of the SCR **70**, the detonator (denoted DET in FIG. **3**), the single closure input switch **54**, capacitor **58**, second blocking diode **62**, and the Shockley diode **66**.

Closure of the input switch **54** after closure of switch **49**, as by arming, causes a charge to be built up on the capacitor voltage divider formed by capacitors **58** and **64**. During closure, resistor **56** is shorted across the battery **52**, but the resistor **56** is large enough to prevent a serious drain on the battery during the time that the switch **54** remains closed. Within milliseconds of closure the voltage across capacitors **58** and **64** equals that of the battery. The voltage on capacitor **64** after pulses will equal

$$E \quad 1 - [C1/(C1 + C2)]^N ,$$

where E equals the voltage of the battery **52**, C1 equals the capacitance of capacitor **64**, and C2 equals the capacitance of capacitor **58**. This formula is derived by open-circuit-short-circuit analysis.

Successive input pulses will cause voltage buildup on capacitor **64** as indicated in the above equation. When the voltage across this capacitor exceeds the breakover voltage of the Shockley diode **66**, the capacitor discharges through the resistor **68**, causing the SCR **70** to be forward biased. Since the detonator is in series with the SCR, the detonator will receive a pulse of about the voltage of battery **52** for as long as the battery is able to conduct.

Satisfactory results have been obtained with the following values for the elements illustrated in FIG. **3**: capacitor **47**, **100** microfarads; capacitor **58**, **0.05** microfarads; capacitor **64**, **0.2** microfarads; battery **52**, **30** volts; resistor **56**, **100** thousand ohms; and resistor **68**, **2.7** thousand ohms.

It is to be noted that a magnetic influence switch can be readily substituted for sensor switch **26** or input switch **54**. Certain combat environments would require such a switch.

A range of values for capacitor **58** incorporated into the design will provide users with a capability of selecting the number of counts needed to detonate a mine. Switch **49** is the safe and arm switch which isolates the battery from the circuit during storage to prevent both premature detonation and drainage of the battery. Capacitor **47** provides a low impedance energy source to fire the detonator; its leakage resistance (about 5×10^7 ohms) will not cause a serious drain on the battery during normal shelf life. To prevent the SCR **70** from triggering accidentally when the switch **49** is moved to the armed position, it may be necessary to place the small capacitor in parallel with the SCR.

Three alternate methods are suggested for modifying the counter so that it will automatically reset itself if input pulses are too infrequent:

a. Using a controlled leakage resistance capacitor such as capacitor **64**,
b. Using diodes **60** and **62** with specified reverse leakage currents, and
c. Adding a large resistance in parallel with capacitor **64**.

The proper selection of these components will depend on the user's requirements. The selection of a power source depends on its shelf life and temperature sensitivity. Various available power sources with shelf lives of **2** to **4** years would be suitable for a system in which the battery is changeable. For a system where the battery is to be potted in the same package as the counter, a longer life is necessary. At present, one source is available, a solid-ion type battery, which has a **10**-year shelf life and can withstand high temperature environments.

Also, it should be noted that the present invention could easily be microminiaturized and constructed on a chip.

Finally, cognizance should be taken of the fact that by means of a substitution of an alarm for the detonator, an effective anti-intrusion device is obtained.

It is thus seen that the objects set forth above are among those made apparent from, and efficiently attained by, the preceding description.

I wish it to be understood that I do not desire to be limited to the exact detail of construction shown and described for obvious modification will occur to persons skilled in the art.

What I claim and desire to be secured by Letters Patent of the United States is:

1. A counting fuze for a land mine having a detonator, comprising:

an electrical source unit providing an output only when subject to pressure which includes:

a pressure-sensitive switching means; and

a source of electrical power, said source connected to said switching means, said source of electrical power activated and inactivated by respective closings and openings of said pressure-sensitive switching means;

a charge storage means, said storage means receiving a charge in pulse form from said electrical source unit upon each subjection of said source unit to pressure; and

electronic gating means, said gating means being connected intermediately between said storage means and said detonator, whereby said detonator will be activated after successive applications of pressure to said electrical source unit.

2. The counting fuze of claim **1** wherein said pressure-sensitive switching means comprises a tape switch.

3. An electrical counting fuze for a land mine having a detonator comprising three circuit loops,

one loop comprising in series connected relationship, piezoelectric crystals, a first resistor, a blocking diode and capacitor;

a second loop comprising in series connected relationship, said capacitor, a gas diode, and a second resistor;

a third loop comprising said second resistor connected in parallel with said detonator.

4. An electrical counting fuze for a land mine having a detonator, comprising six circuit loops,

a first loop comprising in series connected relationship, a battery, a pressure-sensitive switch, and a first resistor;

a second loop comprising in series connected relationship, said first resistor, a first capacitor, and a transformer primary of a transformer;

a third loop comprising in series connected relationship, a transformer secondary of said transformer, a second resistance, a blocking diode and a second capacitor;

a fourth loop comprising in series connected relationship, said second capacitor, a gas diode, and a third resistor;

a fifth loop comprising in series connected relationship, said third resistor, a collector of a transistor and a base of said transistor; and

a sixth loop comprising in series connected relationship, said base of said transistor, an emitter of said transistor, said detonator, said pressure-sensitive switch, said first capacitor, said transformer, said second resistor, said blocking diode and said gas diode.

5. An electrical counting fuze, for a land mine having a detonator comprising seven circuit loops.

a first loop comprising in series connected relationship, a first capacitor, one closure of a double-pole single-throw switch, a second closure of said double-pole single-throw switch, and a battery;

a second loop comprising in series connected relationship, said battery, said second closure, a single-pole single-throw switch and a first resistor;

a third loop comprising in series connected relationship, said first resistor, a second capacitor, and a first blocking diode;

a fourth loop comprising in series connected relationship, said first blocking diode, a second blocking diode and a third capacitor;

a fifth loop comprising in series connected relationship, said third capacitor, a Shockley diode, and a second resistor;

a sixth loop comprising in series connected relationship, said second resistor, a trigger of a silicon control rectifier, and a cathode of said silicon control rectifier; and

a seventh lead loop comprising in series connected relationship, said trigger, an anode of said SCR, said detonator, said single-pole single-throw switch, said second capacitor, said second blocking diode, and said Shockley diode.

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