United States Patent [19]

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[11] **3,757,697**

[45] **Sept. 11, 1973**

[54] **REMOTELY CONTROLLED BLASTING MACHINE**

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[22] Filed: **Feb. 2, 1972**

[21] Appl. No.: **222,761**

[52] **U.S. Cl.** .... **102/70.2 R,** 317/80, 320/1

[51] **Int. Cl.** **F42c 13/00**

[58] **Field of Search** 320/1; 317/79, 80; 102/70.2, 22

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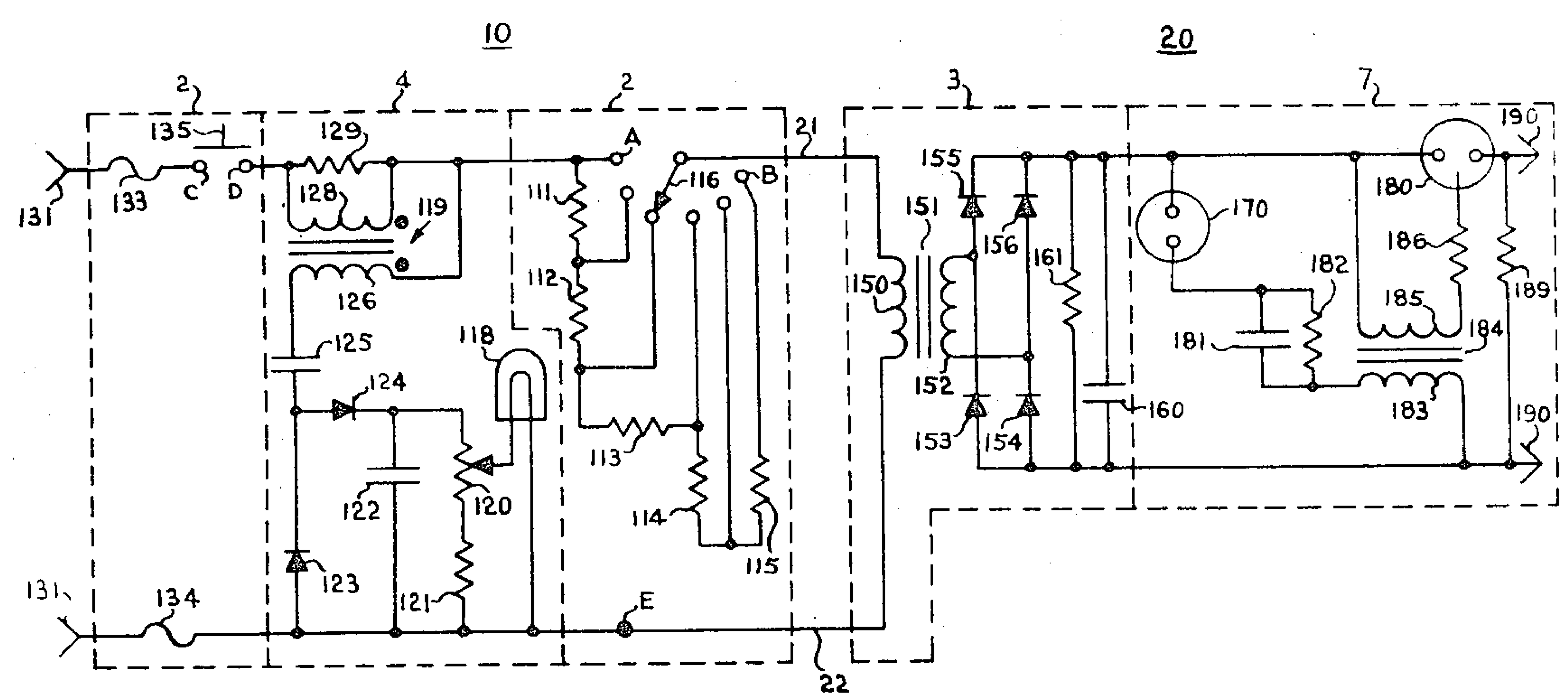
[57] **ABSTRACT**

A remotely controlled blasting machine for detonating explosives. The blasting machine is divided into two modules which are the remote control module and the energy storage module. The energy storage module is located in close proximity to the blasting caps while the remote control module which detonates the blasting caps is located at a safe distance from the explosion to protect the operator. The remote control module includes an indicator light which gives visual indication that the explosives are about to be detonated and a switch for stopping the detonation of the explosives during the presence of the visual indication. The blasting machine may be placed close to the explosive devices to be detonated while the operator controls the blasting machine from a safe distance.

13 Claims, 2 Drawing Figures



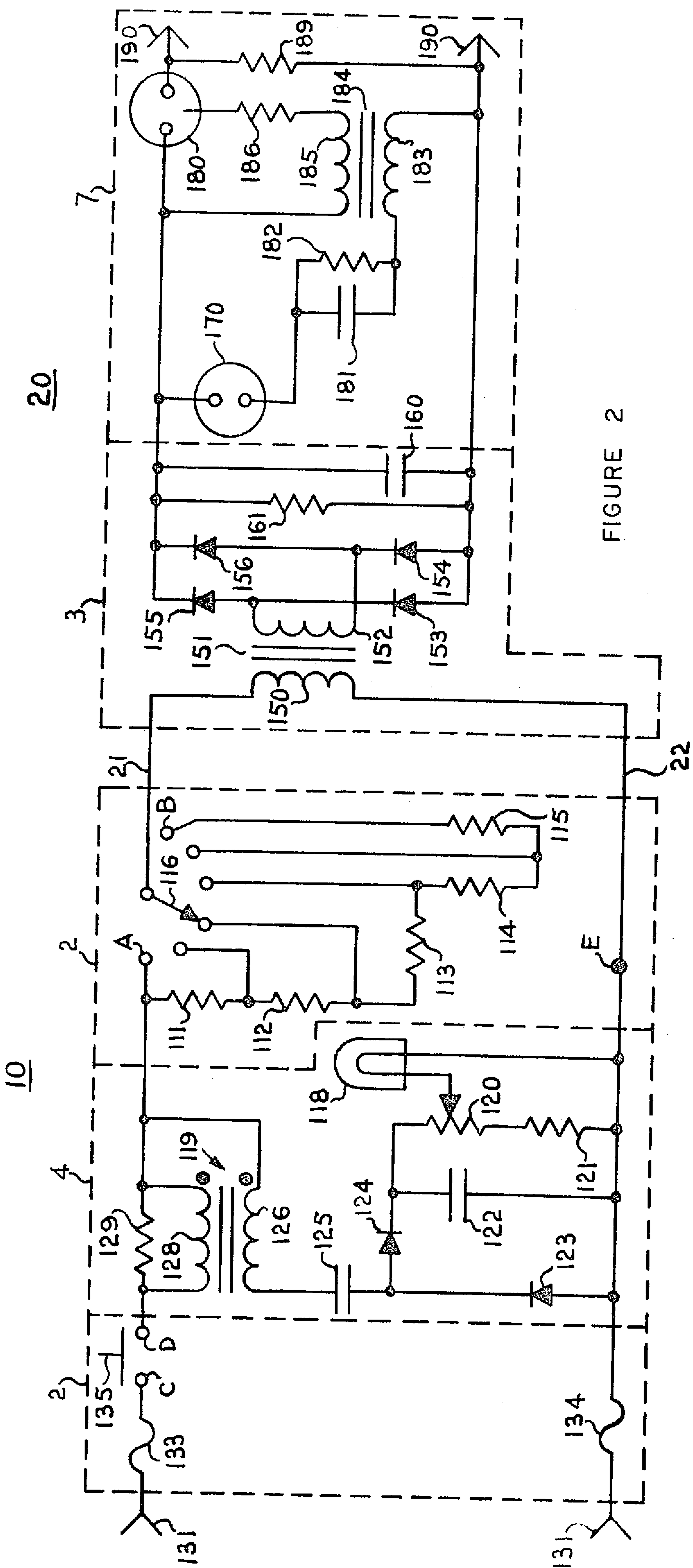


FIGURE 2

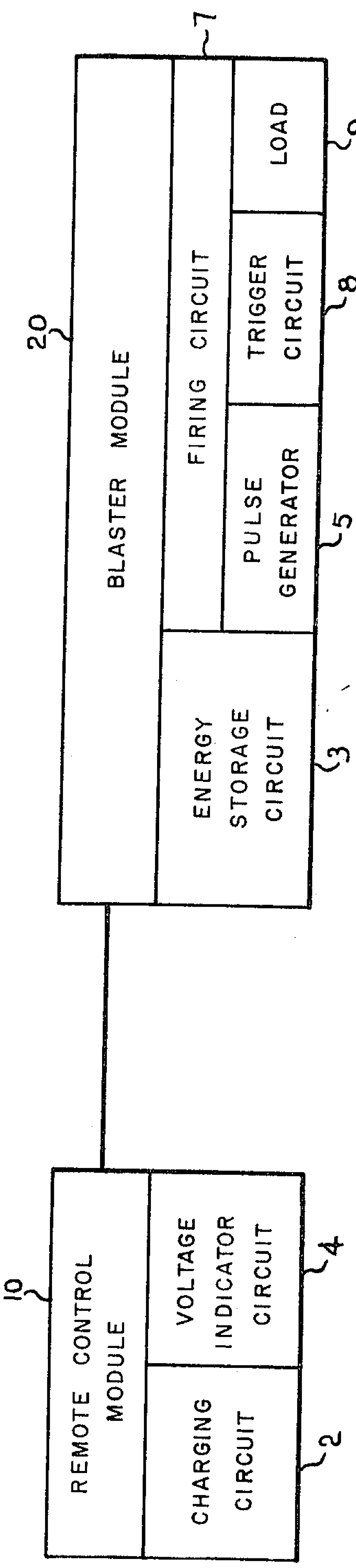


FIGURE 1

REMOTELY CONTROLLED BLASTING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to an improved blasting machine for detonating blasting caps or the like. The invention is more particularly related to an a-c powered blasting machine of capacitor discharge type that may be remotely controlled from a safe distance.

Basically, electrical systems for firing explosive devices include a source of power, a transformer for stepping up input voltage, a storage capacitor which is charged by power from the transformer, and a trigger circuit which allows the energy stored in the capacitor to discharge to fire an explosive device. The energy stored in the capacitor is discharged through the explosive device by means of a triggering circuit which may be operated automatically or manually. Examples of such blasting devices may be found in U.S. Pat. No. 3,417,306 entitled "Regulated Voltage Capacitor Discharge Circuit", to J. L. Knak, issued Dec. 17, 1968; and U.S. Pat. No. 3,275,884 entitled "Electrical Apparatus for Generating Current Pulses", to L. H. Segall et al., issued Sept. 27, 1966.

REFERENCE TO RELATED APPLICATION

Capacitor discharge type blasting machines are disclosed in copending application Ser. No. 214,187, filed Dec. 30, 1971, by Frank J. Digney, Jr. and the present applicant and which matured into U.S. Pat. No. 3,704,393 on Nov. 28, 1972. A blasting machine is disclosed in copending application Ser. No. 201,526, filed Nov. 23, 1971 by James E. McKeown and the present applicant which matured into U.S. Pat. No. 3,752,081 on Aug. 14, 1973.

In certain blasting operations such as those performed in tunnels and shaft mining, it is generally desirable to connect as many as 150 blasting caps together in parallel circuit, principally because such a circuit permits rapid connection of the blasting caps with minimal possibility of error. To assure that all the blasting caps are fired, the blasting machine must always deliver a given minimum energy each time it is fired, otherwise all the blasting caps may not be fired.

Further, in blasting operations of the type requiring 150 blasting caps, safety requires that the operator be positioned a considerable distance from the blasting caps. Presently a blasting machine therefore is located at a considerable distance from the blasting caps. However, it is then necessary to have extremely long leads between the blasting caps and the blasting machine and this introduces a considerable amount of energy loss when the capacitor in the blasting machine is discharged. In some instances up to 90 percent of the energy stored in the blasting machine may be dissipated in the leads going to the blasting caps. Obviously such dissipation distracts from the total number of blasting caps that the machine can fire, and substantially increases the chances of dangerous misfires.

SUMMARY OF THE INVENTION

This invention provides a blasting machine that can be controlled from a distance so that shorter lead lines may be used between the blasting machine and the blasting caps whereby most of the energy stored in the blasting machine is discharged into the blasting caps and not dissipated by long lead wires. This invention further provides a remotely controlled blasting machine that detonates explosives when it reaches a predetermined energy level.

This invention is a blasting machine characterized by a remote control module that is connected to a blaster module by only two wires. The remote control module, although connected only by two wires to the blaster module which is connected to one or more blasting caps, controls the energy transferred to a storage capacitor in the blaster module; gives visual indication when the capacitor is approaching a predetermined level at which the blasting caps will be detonated; and provides a switch for preventing the blasting caps from being detonated at any time prior to the capacitor reaching the predetermined energy level.

In one embodiment of the invention the blasting machine comprises two modules or assemblies. The first assembly includes: a storage capacitor, a transformer and a trigger circuit for automatically discharging the capacitor when it reaches a predetermined voltage level. The second assembly, which is connected by only two wires to the first assembly, includes: an electrical circuit that produces a voltage proportional to the voltage on the storage capacitor located in the first assembly, the electrical circuit including an indicator light that illuminates when the storage capacitor in the second assembly is approaching the voltage at which the trigger circuit discharges the capacitor; and a switch for applying and removing the energy supplied to the second assembly.

Accordingly, it is an object of this invention to provide a safe and efficient remotely controlled blasting machine.

Another object of this invention is to provide a novel blasting machine that allows the operator to place the energy storage portion of the blaster close to the explosives to be detonated, thereby obtaining a maximum transfer of energy from the energy storage device to the device for detonating the explosives while permitting the operator to control the discharge of the energy storage device from a considerable distance.

Another object of this invention is to provide a novel blasting machine that may be remotely controlled from a safe distance by a control module which is connected by only two wires to a blasting module which is connected to an explosive bridge wire device or the like.

It is also an object of this invention to prevent the application of the energy in a capacitor to blasting caps before a predetermined energy level is available in the capacitor and to charge that capacitor from an a-c power supply that may be remotely controlled to stop the application of power to the blasting caps at any time prior to the capacitor's reaching the predetermined energy level at which the capacitor discharges.

It is another object of this invention to combine a circuit in which a capacitor may be rapidly charged to a predetermined voltage over only two lines which provide both power to and control over the discharge of the capacitor.

It is another object of this invention to provide a novel method of triggering the discharge of a storage capacitor in a blasting machine.

Still another object of this invention is to provide a safe and reliable blasting apparatus which does not discharge its energy until a capacitor therein has reached a predetermined energy level.

A still further object of this invention is to provide a novel and remotely controlled electrical system for automatically firing electrically energized squibs and like firing units, such as explosive bridge wire devices.

The above and other objects and features of this invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings and claims which form a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a system block diagram of a blasting machine that utilizes the principles of this invention.

FIG. 2 is a schematic diagram of a preferred embodiment of the circuitry for a blasting machine shown in FIG. 1.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, FIG. 1 illustrates a block diagram of a blasting machine which utilizes the principles of the invention. The basic components of the system include a remote control module **10** and a blaster module **20** which is connected to blasting caps or similar devices. The control module **10** includes a charging circuit **2** and an indicator circuit **4.** The blaster module **20** includes: an energy storage circuit **3**; and a firing circuit **7** which includes a pulse generator **5** that generates pulses when the energy storage circuit reaches a predetermined energy level and a trigger circuit **8** that permits the energy stored to be discharged through the load **9.**

The charging circuit **2** receives standard 115 volt a-c power and transfers it to the energy storage circuit **3** of the blaster module **20.** The charging circuit **2** is preferably manually operable to permit or interrupt the 115 volt a-c power from passing through the control module **10** to the energy storage device **3.**

The voltage indicator circuit **4** gives an audio or visual indication when the energy stored in the energy storage circuit **3** reaches a predetermined level. In a preferred embodiment of the invention the voltage indicator includes an indicator light that gives visual indication when the energy stored in the energy storage **3** reaches a predetermined energy level. A distinct feature of the remote control module **10** is that it is connected to the blaster module **20** by only two electrical wires. Therefore, the function of both supplying power to the blaster module **20** and indicating the energy level in the energy storage circuit **3** is accomplished by the same two electrical wires.

The energy storage circuit **3** is preferably a capacitor in combination with a transformer and rectifying circuit. The purpose of the transformer is to step up the 115 volt input voltage. A discharge resistor may be connected to the capacitor to discharge the energy that remains in the capacitor when the blasting machine is not in use.

The pulse generator circuit **5** is an electrical circuit that automatically generates a plurality of electrical pulses when the energy storage circuit **3** reaches a predetermined energy level. The predetermined energy level may be fixed by design or by a manual control. The pulse generator produces pulses which are applied to the trigger portion **8** of the firing circuit **7** to discharge the energy stored in the energy storage circuit **3** into the load **9.** The trigger circuit **8** may include a gaseous conductor of the **3**-electrode type wherein the trigger electrode upon receiving one or more pulses from the pulse generator **5** allows the remaining two electrodes which are in series with the energy storage circuit **3** to conduct, thereby allowing the energy stored in circuit **3** to discharge into the load **9.** One example of a preferred **3**-electrode gaseous conductor is described in U.S. Pat. Application Docket No. ELC 71/20 filed Sept. 27, 1971 (serial number not received) entitled "Three Electrode Triggered Spark Gap for Use in Blasting Machines," by I. E. Linkroum. The blasting system shown in this figure will automatically discharge the energy stored in the energy storage circuit **3** when the energy reaches a predetermined value unless the charging circuit **2** of the remote control module **10** is open circuited before the energy storage circuit **3** can reach that predetermined energy level.

FIG. **2** is a schematic diagram of a preferred embodiment of a remotely controlled blasting machine that utilizes standard 115 volt a-c power in combination with a transformer **151** and a bridge rectifier to charge the storage capacitor **160** which will be discharged to fire a blasting cap or other explosive bridge wire device or the like. The dotted lines outlining portions of the circuitry indicate the remote control module assembly **10** which includes the charging circuit **2** and voltage indicator circuit **4** and the blaster module **20** which includes the energy storage circuit **3** and a firing circuit **7.**

The charging circuit **2** of the remote control module assembly **10** includes: means for receiving 115 volt a-c power **131, 132**; one or more fuses **133, 134** to protect the circuitry from overload; a charging switch **135** for applying and removing power to the control module **10** and hence to blasting module **20**; a current limiting network of resistors **111, 112, 113, 114, 115**; and a selector switch **116** which may be selectively positioned to a plurality of locations which will increase or decrease the current to the blaster module **20.** The output of the charging circuit **2** consists of only two wires **21, 22** which connect the remote module **10** to the blaster module **20.** These connecting wires **21, 22** vary in length from zero to 5,000 feet; therefore, the resistance or impedance associated with these leads can have a wide range of effects on the circuitry. Therefore, the function of the resistors **111–115** is to compensate for this effect by selecting the position of the switch **116** that matches the length of the wires **21, 22,** thereby keeping the impedance associated with the leads **21, 22** and one of the resistors **111–115** fairly uniform. For example, this circuit is designed for a maximum lead length of 5,000 feet which corresponds to switch position A. Therefore, when shorter leads are used, which means a reduction in resistance, resistance is added to the circuit to keep the total circuit's resistance fairly uniform. The circuit shown shows adjustment for leads with lengths in multiples of 1,000 feet, from 5,000 feet at point A to 0 feet at point B. Finer or coarser steps may be allowed for by increasing or decreasing the number and/or values of the resistors **111–115.** An alternate approach to this would be to have taps on the secondary winding of the transformer **119** to compensate for a particular lead length. In lieu of a tapped transformer, it could also be possible to have a continuously adjustable or tapped voltage divider to adjust the compensation voltage for different lead lengths.

The voltage indicator circuit **4** includes a voltage network that includes resistors **129, 120** and **121**; transformer **119**; capacitors **122, 125**; diodes **123, 124**; and indicator light **118.** The transformer **119** is arranged so that the voltage at the secondary winding 126 is 180 degrees out of phase with the voltage across the control module 10 output leads 21, 22. In parallel with the resistors 120, 121 is a voltage indicator light 118 which illuminates when the voltage impressed thereon reaches a voltage proportional to the voltage across capacitor 160 in the blaster module 20. Resistor 120 is preferably manually variable so that the indicator light 118 may be adjusted to illuminate at a plurality of selected voltage values. The purpose of the indicator light 118 is to provide a warning to the operator of the blasting machine that the voltage on the capacitor 160 is nearing the voltage at which the blasting machine will fire. Therefore, the indicator circuit 4 remotely senses the voltage on the storage capacitor 160 and gives a visual and/or audible warning when the storage capacitor 160 voltage is within approximately 300 volts of the predetermined firing voltage. In operation resistor 129 produces a voltage that is proportional to the current flowing in the lead lines and the primary winding 150 of transformer 151. The voltage across resistor 129 is impressed on the primary winding 128 of compensation transformer 119. The voltage appearing across the secondary winding 126 of the compensation transformer 119 is therefore proportional to the voltage across resistor 129 and is 180° out of phase with the voltage across points A and E. The turns ratio of windings 126 and 128 is chosen so that the voltage of winding 126 is equal to the resistance voltage drop of the lead lines at maximum length plus the resistance voltage drops in the power transformer 151. Since the voltage across the secondary winding 126 is 180° out of phase with the voltage applied to the blaster module 20 through lines 21 and 22, a resultant voltage is obtained across capacitor 122 that is proportional to the capacitor voltage 160 reflected at the primary winding 150 of the transformer 151. Therefore, this circuit arrangement provides a voltage on capacitor 122 that is proportional to the voltage on capacitor 160. Capacitors 125 and 122, with diodes 123 and 124, form a voltage doubler network. Resistors 120 and 121 allow adjustment of voltage indication level as well as allowing for the discharge of capacitor 122 when power is not being delivered to power transformer 151.

The energy storage circuit 3 includes a transformer 151; a bridge rectifying circuit which includes diodes 153, 154, 155, 156; a storage capacitor 160; and a discharge resistor 161. The primary 150 of the transformer 151 receives the energy transmitted from the remote control module 10 through wires 21 and 22. The secondary 152 of the transformer 151 is the input to the bridge rectifiers 153–156 that supplies the capacitor 160 with energy. Resistor 161 is located in parallel with the capacitor 160 to drain off any charge that may remain on the capacitor 160 when the blaster module is not in use. When 115 volts a-c is applied to inputs 131 and 132 of the remote control module and switch 135 connects terminals C and D, the maximum charge that can be obtained on capacitor 160 is about 6,000 volts. However, voltages of this magnitude are not generally required and an additional voltage regulating circuit (not shown) may be added to limit the voltage across the capacitor 160. In this embodiment, when a constant 115 volts a-c is used and the capacitor is a 200 microfarad capacitor, the capacitor 160 can be charged to an energy level of 400 joules within 12 seconds.

The pulse generator 5 of the firing circuit 7 includes a 2-electrode spark discharge device 170, resistor 182, capacitor 181 and one winding 183 of a transformer 184. In operation the 2-electrode spark discharge device 170 will remain in a nonconducting state as long as the voltage on the storage capacitor 160 is less than the breakdown voltage of the spark discharge device 170. When the voltage on the storage capacitor 160 exceeds the voltage breakdown of the discharge device 170, the device conducts, allowing current to pass through capacitor 181 and the primary winding 183 of the transformer 184. As the voltage on the capacitor 181 increases, the voltage across the spark discharge device 170 decreases until the spark device 170 returns to the original nonconducting stage. At this time capacitor 181 then discharges through resistor 182. When the voltage across the spark discharge device 170 again rises to the breakdown potential of the device, conduction begins again and the cycle repeats itself. In this embodiment, when the preferred voltage across the capacitor 160 is reached and pulses are generated by the pulse generator, the pulses are transmitted to the trigger circuit 8 which allows the capacitor 160 to discharge.

The trigger circuit 8 of the firing circuit 7 includes a 3-electrode spark discharge device 180, the secondary winding 185 of the transformer 184 for raising the voltage of the pulses received from the pulse generator 5 and applying them to the trigger electrode of the spark discharge device 180 through resistor 186. For further details concerning a particular type of 3-electrode spark gap discharge device required for this circuit see U.S. Pat. Nos. 3,187,215 entitled "Spark Gap Device" to I. E. Linkroum issued June 1, 1965 and 3,229,146 entitled "Spark Gap Device with a Control Electrode Intermediate the Main Electrodes" to I. E. Linkroum issued Jan. 11, 1966. In operation, when the voltage of capacitor 160 is below the breakdown voltage of gap 170, no pulses are being supplied to the spark discharge gap 180, thereby preventing the firing of any blasting caps (not shown) attached to the output terminals 190. When the voltage of capacitor 160 is at or above the breakdown voltage of gap 170, pulses occur at the primary winding 183 of the step-up transformer 184 where the pulses are stepped up to a higher voltage and applied to the trigger electrode of the spark gap discharge device 180 through resistor 186. This causes ionization within the spark gap discharge device 180 and permits current to flow through the two main electrodes, thereby allowing the energy storage capacitor 160 to discharge through the blasting caps (not shown) connected to the output terminals 190.

OPERATION

Referring now to FIG. 2, the circuit operates as follows: when the remote control module is plugged into a source of alternating current (standard 115 volts a-c applied at inputs 131) and switch 135 is open, resistor 161 removes the energy stored in capacitor 160. When switch 135 is closed, current flows into the remote control module 10 and to the blaster module 20. As the capacitor 160 voltage increases there is a corresponding increase in voltage across capacitor 122 and resistors 120 and 121. As the voltage across capacitor 160 approaches the breakdown potential of spark gap discharge device 170 the voltage across resistors 120 and 121 is selected to be sufficient to cause the indicator light **118** to illuminate. At this point in time the operator knows the capacitor is about to discharge and detonate the explosives. The operator may allow the discharge to occur or may open switch **135** which will stop the transfer of energy from the control module **10** to the capacitor **160** and begin the discharge of the energy stored in the capacitor **160** through resistor **161.** As the energy stored in the capacitor **160** reaches a predetermined level, the pulse generating circuit begins generating trigger pulses. This occurs when the spark gap discharge device **170** reaches its breakdown potential. Meanwhile, the indicator light **118** has been and is still illuminated. When the energy stored in the capacitor reaches the predetermined energy level, trigger pulses are applied to transformer **184** causing spark gap device **180** to conduct, thereby allowing the energy in capacitor **160** to discharge into the blasting caps (not shown) attached to the outputs **190** and detonate explosives.

In one satisfactorily operable system, the blasting machine described in FIG. **2** was powered by standard 115 volt a-c and the circuit elements had the values or were of the types indicated below:

Capacitor **125**—3.0 microfarad, 200 volts a-c
Capacitor **181**—.025–.03 microfarad, 3 KV
Capacitor **160**—400 microfarad, 2.5 KV
Capacitor **122**—3.0 microfarad, 200 volts a-c
Fuses **133, 134**—5 amp
Neon Light **118**—GE-3AJ-A
Resistor **120**—0 to 20K ohms, 2W
Resistor **121**—10K ohms, 1W
Resistors **111, 112, 113, 114, 115**—5 ohms, 25W
Resistor **129**—5 ohms, 25W
Resistor **161**—100K ohms, 25W
Resistor **182**—20 megohms, 1W
Resistor **186**—1K ohms, 5W
Resistor **189**—10K ohms, 10W
Diodes **123, 124**—1N649 (600 V, 400 milliampere)
Diodes **153, 154, 155, 156**—Motorola MR 995A, 4000 V
Discharge Device **170**—2200 volts d-c (breakdown) Bendix Corp., Sidney, N. Y. Part No. 10-374121-14
3-Electrode Spark Discharge Device **180**—3750 volts d-c (breakdown) Bendix Corp., Sidney, N. Y. Part No. L-28615-39
Transformer **151**—Core A28, no air gap Primary 400T No. **21** Secondary 15,000T No. **36**
Transformer **184**—Ferramic Core 3/8" dia. Primary 4T No. 20 Secondary 32T No. 20
Transformer **119**—Core H-6, no air gap Primary 370T No. 23 Secondary 2400T No. 31
Switch **135**—2 contact Bendix Corp., Sidney, N. Y. Part No. 10-348773-1
Switch **116**—Cutler Hammer Part No. 7261K13

While a preferred embodiment of the invention has been disclosed, it will be apparent to those skilled in the art that changes may be made to the invention as set forth in the appended claims, and in some cases certain features of the invention may be used to advantage without coresponding use of other features. For example, different types of semiconductors or solid state control devices may be substituted for the types illustrated. Accordingly, it is intended that the illustrative and descriptive materials herein be used to illustrate the principles of the invention and not to limit the scope thereof.

Having described the invention, what is claimed is:

In the combination of a blasting machine for detonating blasting caps, said blasting machine comprising:
a first assembly which comprises:
means for storing electrical energy;
means for discharging said energy storage means through said blasting caps when said energy storage means reaches a predetermined energy level;
a first transformer means having a primary winding and a secondary winding, said secondary winding being connected in electrical circuit relationship with said energy storage means;
a second assembly physically separate from but electrically connected to said first assembly, said second assembly including:
means for receiving an alternating voltage;
means for applying the alternating voltage received to the primary of said first transformer;
means for indicating when said energy storage means is approaching said predetermined energy level whereby the operator of the blasting machine has an indication that the blasting caps are about to be detonated;
said means for indicating when said energy storage means is approaching said predetermined energy level including:
circuit means for indicating the voltage at the primary winding of said first transformer;
circuit means for producing a second alternating voltage which is equal to but 180° out of phase with said alternating voltage received by said second assembly; and
means for adding the voltage at the primary winding of said first transformer to said second alternating voltage to obtain a resulting voltage which is proportioned to the voltage on the energy storage means reflected to the primary from the secondary of the first transformer.

2. In the combination of a blasting machine for detonating blasting caps, said blasting machine comprising:
a first assembly which comprises:
means for storing electrical energy;
means for discharging said energy storage means through said blasting caps when said energy storage means reaches a predetermined energy level;
a first transformer means having a primary winding and a secondary winding, said secondary winding being connected in electrical circuit relationship with said energy storage means;
a second assembly physically separate from but electrically connected to said first assembly, said second assembly including:
means for receiving an alternating voltage;
means for applying the alternating voltage received to the primary of said first transformer;
means for indicating when said energy storage means is approaching said predetermined energy level whereby the operator of the blasting machine has an indication that the blasting caps are about to be detonated;
said first and second assemblies being electrically connected by only two wires;
said means for indicating when said energy storage means is approaching said predetermined energy level including:
circuit means for indicating the voltage at the primary winding of said first transformer;

circuit means for producing a second alternating voltage which is equal to but 180 degrees out of phase with said alternating voltage received by said second assembly; and

means for adding the voltage at the primary winding of said first transformer to said second alternating voltage to obtain a resulting voltage which is proportioned to the voltage on the energy storage means reflected to the primary from the secondary of the first transformer.

3. The combination as recited in claim 1 wherein said second assembly includes switching means operable to prevent the transfer of energy to said energy storage means from said second assembly whereby an operator may interrupt the transfer of energy to said energy storage means and prevent said blasting caps from being detonated.

4. The combination as recited in claim 2 wherein said second assembly includes switching means operable to prevent the transfer of energy to said energy storage means from said second assembly whereby an operator may interrupt the transfer of energy to said energy storage means and prevent said blasting caps from being detonated.

5. A blasting machine as recited in claim 1 wherein said indicating means is selectively operable to give an indication at an energy level below said predetermined energy level.

6. A blasting machine as recited in claim 2 wherein said indicating means is selectively operable to give an indication at an energy level below said predetermined energy level.

7. A blasting machine as recited in claim 1 wherein said means for indicating when said energy storage means is approaching said predetermined energy level includes:

circuit means for producing a voltage proportional to the energy level of the energy storage means, said circuit means including:

a second transformer having a primary winding and a secondary winding and operable to produce an alternating voltage at the secondary winding thereof that is 180 degrees out of phase with the voltage applied to the primary winding of said first transformer: and

an indicator circuit responsive to the voltages produced at the secondary winding of said second transformer, said circuit having means for adjusting said indicator to provide an indication at a plurality of selected energy levels below said predetermined energy levels at which said energy storage means discharges and detonates said blasting caps.

8. A blasting machine as recited in claim 2 wherein said means for indicating when said energy storage means is approaching said predetermined energy level includes:

circuit means for producing a voltage proportional to the energy level of the energy storage means, said circuit means including:

a second transformer having a primary winding and a secondary winding and operable to produce an alternating voltage at the secondary winding thereof that is 180 degrees out of phase with the voltage applied to the primary winding of said first transformer; and

an indicator circuit responsive to the voltages produced at the secondary winding of said second transformer, said circuit having means for adjusting said indicator to provide an indication at a plurality of selected energy levels below said predetermined energy level at which said energy storage means discharges and detonates said blasting caps.

9. A blasting machine as recited in claim 1 including:

means for compensating for the voltage drop in the wires connecting the first assembly to the second assembly.

10. A blasting machine as recited in claim 2 including:

means for compensating for the voltage drop in the wires connecting the first assembly to the second assembly.

11. A blasting machine which comprises:

a plurality of electro-explosive devices;

a first assembly which comprises:

means for storing electrical energy;

means for discharging said energy storage means through said electro-explosive devices when said energy storage means reaches a predetermined energy level; and

a first transformer means having a primary winding and a secondary winding, said secondary winding being connected in electrical circuit relationship with said energy storage means; and

a second assembly physically separate from but electrically connected to said first assembly by only two wires, said second assembly including:

means for receiving an alternating voltage;

means for applying the alternating voltage received to the primary of said first transformer;

means for indicating when the energy level of the energy storage means of said first assembly is approaching said predetermined energy level; and

switching means operable to stop the transfer of energy to said energy storage means from said second assembly.

12. A blasting machine which comprises:

at least one electro-explosive device;

a first assembly which comprises:

means for storing electrical energy; and

means for discharging said energy storage means through said electro-explosive device when said energy storage means reaches a predetermined energy level; and

a second assembly physically separate from but electrically connected to said first assembly by only two wires, said second assembly including:

means for receiving electrical energy;

means for applying the electrical energy received to said first assembly by said two wires; and

means for indicating when said energy storage means is approaching said predetermined energy level whereby the operator of the blasting machine has an indication that the blasting caps are about to be detonated.

13. The blasting machine as recited in claim 12 wherein said second assembly includes switching means operable to stop the application of energy to said first assembly whereby an operator of said blasting machine having an indication that said blasting caps are about to be detonated may prevent detonation of said blasting caps by operation of said switching means.

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