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BLASTING MACHINE

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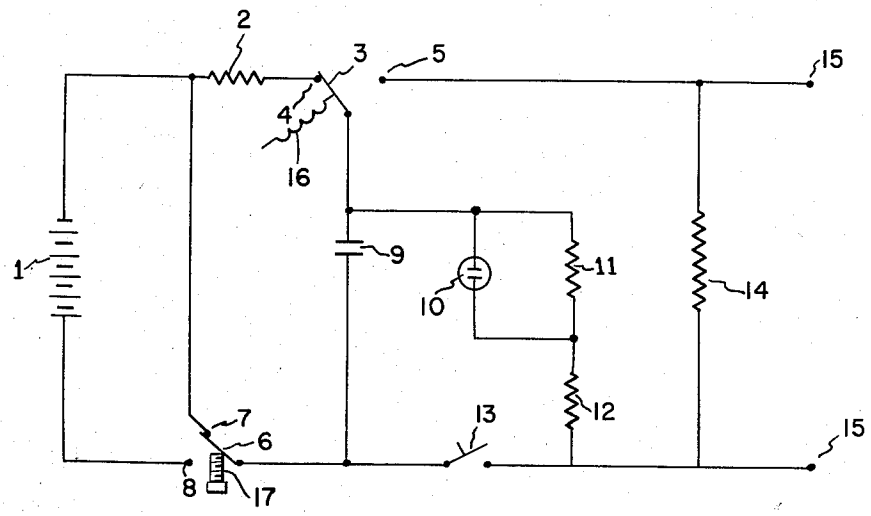

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BLASTING MACHINE

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The present invention relates to an improved blasting machine. More particularly, the present invention relates to a blasting machine of the condenser-discharge type having a high degree of safety and utility. This application is a continuation-in-part of our copending application Serial No. 292,362, filed June 7, 1952, now abandoned.

For many blasting operations in remote or inaccessible areas, the use of a portable source of electrical energy to initiate electric blasting initiators is desirable. Hand-operated generating units have been used for many years, despite the disadvantage that the current produced is directly dependent upon the energy provided by the operator. When the operator is either careless or otherwise fails to exert the force required to produce the necessary current, misfires result. Machines having a condenser arrangement to insure ample current have reduced this problem to some extent, but the machines of this type are heavy and bulky, and are subject to mechanical breakdown under the rugged conditions of normal field use.

Many attempts have been made to provide portable self-energizing blasting machines for field use, and a number are known which are suitable for initiating a small number of detonators. Where the machines are scaled up to provide the current requirements of a large number of detonators, the increased bulk and weight made the machines unacceptable. Also, the machines introduced an injury hazard because of the considerably greater electrical voltage usually present.

An object of the present invention is to provided a portable, self-energizing blasting machine wherein the foregoing disadvantages are obviated. A further object is to provide a blasting machine wherein the components have an unusually long useful life. Further objects will become apparent as this invention is more fully described.

We have found that a blasting machine capable of delivering the high energy required to initiate a large number of detonators simultaneously can be provided when we use an electrolytic condenser (prepared by connecting a plurality of units in parallel) to collect and store high electrical energy from a relatively low-voltage battery, and to release it upon proper actuation into a discharge circuit at such rate as to provide the current required to initiate the detonators. By the use of an electrolytic condenser having a high capacitance, and a battery having a relatively low voltage, we can provide sufficient energy for our purposes without requiring either a bulky or heavy assembly. We have further found that the life of the electrolytic condenser can be made satisfactory even under the usual conditions of rough handling in the field and prolonged storage without use when we arrange the circuits so that the condenser is maintained in a fully-charged condition except when in the process of delivering current to the firing circuit or when the blasting machine is dissembled. By providing a ready switch which is connected in both the firing circuit and an indicator circuit, and a firing switch, both of which must be

actuated by the operator together to deliver a firing current, the machine of the present invention is made safe and practically fool-proof.

In order to more fully describe our invention, reference is now made to the accompanying drawing which schematically illustrates the electrical circuits found in the blasting machine of an embodiment of our invention. In the drawing, **1** represents a battery, **2** is a resistance, **3** is the blade of a two-way, spring-return firing switch, **16** being the spring, **4** and **5** are contact points of the firing switch, **6** is the blade of an interlock switch, **7** and **8** are contact points of the interlock switch, **17** is a bolt from the housing of the blasting machine, **9** is a condenser prepared by assembling a plurality of electrolytic units connected in parallel, **10** is an indicator lamp, **11**, **12**, and **14** are resistances, **13** is a ready switch and **15** is a pair of terminals for connecting detonators to the firing circuit.

As shown in the drawing, the following circuits are present:

(*a*) The battery circuit which includes battery **1** and resistance **2**;

(*b*) The condenser circuit which includes condenser **9**;

(*c*) The firing circuit which includes firing terminals **15**;

(*d*) The bleed-off circuit which includes resistance **14**;

(*e*) The indicator circuit which includes neon lamp **10** and resistances **11** and **12**; and

(*f*) The safety circuit.

The safety circuit and the interlock switch have no operating function and are present only to prevent the possibility of injury when the interior of the machine is removed for repair or servicing. The blasting machine embodying the circuits and components of this invention will normally be housed in a strong protective case, and the interlock switch will be so mounted that when the assembly is properly fastened in the case, the blade **6** will be in contact with point **8** and when the assembly is removed from the case, the blade **6** will be in contact with point **7**. The switch may be of a spring-return push-button type positioned so that when the assembly is fastened to the bottom of the case, blade **6** moves into contact with point **8**, or the switch may be mounted so that an assembly retaining screw or bolt **17** moves blade **6** from point **7** to point **8**. This represents a preferred embodiment which is not essential to the performance of the blasting machine of this invention. Throughout the remainder of the discussion, the assumption will be made that the assembly is properly completed so that blade **6** is in contact with point **8**.

The operation of the blasting machine of this invention is as follows: Blade **3** of the firing switch is normally held in contact with point **4**, thus connecting the battery circuit in series with the condenser circuit and maintaining condenser **9** in a fully charged condition. When the operator has connected the lead wires from the detonator he wishes to initiate to terminals **15**, he actuates ready switch **13**. This connects the indicator circuit in series with condenser **9**, thus permitting the operator to ascertain that the condenser is fully charged. The resistances **11** and **12** and the neon lamp **10** limit the current flow through the indicator circuit to a negligible quantity so that the potential of the condenser is not affected. The ready switch also connects one side of the firing circuit in series with the condenser **9**, a portion of the indicator circuit and the firing circuit being common to both, and the switch being connected in series in this portion. To discharge the condenser **9** through the firing circuit, the operator now actuates the firing switch, moving blade **3** into contact with point **5** while maintaining the ready switch in the actuated position. The high energy stored in the condenser is immediately discharged into the firing circuit, providing suffi-

cient current to initiate the blasting initiators. If the connection between the firing circuit and the detonators is broken or interrupted before the condenser has been completely discharged, the remainder of the charge will bleed-off through the bleed-off circuit containing resistance **14**, thus eliminating any residual current hazard.

It is apparent that the current available at the firing circuit will depend on both the voltage of the battery and the capacitance of the condenser. In view of the requirements of safety, the voltage in the firing circuit should not exceed 600 volts. To obtain sufficient duration of current from the condenser, the capacitance should be at least 50 microfarads. We have found that excellent results can be obtained with battery packs delivering from 100 to 600 volts and an electrolytic condenser having a capacitance between 50 and 1500 microfarads.

For example, a condenser blasting machine capable of initiating at least 50 blasting caps connected in series was constructed embodying the circuit shown in the drawing.

The battery **1** was prepared by connecting six 90 volt batteries in series to provide for the delivery of about 525 volts. Four 300 microfarad electrolytic units were connected in parallel to provide a 1200 microfarad condenser **9**. A 1000 ohm resistor **2**, a 33,000 ohm resistor **11**, a 150,000 ohm resistor **12**, and a 5000 ohm resistor **14** were connected as shown in the drawing. The circuit including neon lamp **10** and resistors **11** and **12** was so designed that the lighting of the neon lamp indicated a charge of at least 400 volts in the condenser **9**. The above described units and necessary switches and wiring were mounted on a labeled face plate and the assembly was fastened into an aluminum box. The dimensions were as follows: height, 12¼ inches; width, 9½ inches; depth, 11 inches; weight, 27 pounds.

The blasting machine was found to be capable of firing 1200 standard electric blasting caps connected in parallel-series (24 series of 50 caps each in parallel), an unusually high number to be fired by any portable blasting machine.

On testing over a ten-month period, during which the machine was discharged approximately 275 times and operated under several different climatic conditions (0° F. to 100° F.), the battery drain was less than 0.1 milliampere and the voltage on the last day of the test was 470, representing a decrease of only 10.5% over the entire period. This is essentially equal to the normal decrease in voltage found under ordinary storage conditions for these batteries. The condenser voltage was 525 on the first day and 470 at the end of the period, showing that no condenser deterioration had occurred.

In a similarly constructed blasting machine in which the condenser was not maintained in a fully charged condition but was charged only before each discharge, battery life was as short as three months in some cases. Shortened battery life was caused by the chemical activity which (1) occurs within an electrolytic condenser when it remains in an uncharged condition for an extended length of time and (2) places an excessive drain (leakage current) on the battery when an attempt is made to recharge an electrolytic condenser in such condition. The foregoing clearly illustrates the advantage gained by maintaining the condenser fully charged at all times.

The blasting machine of this invention is very safe to use because it is improbable that the condenser would be accidently discharged through the firing circuit. The firing circuit is connected to the condenser only when both the firing switch and the ready switch are actuated. The switches are of the automatic return type so that the operator must continue to hold both switches to make the connection. In the embodiment shown, the ready switch is a single pole switch connected in series in a portion of the circuit common to both the indicator and the firing circuit. Obviously, an equivalent arrangement using a double contact switch to simultaneously close two circuits could be used if it is desired to eliminate a common portion. Many other variations will occur to those skilled in the art which are not departures from the spirit of this invention. Therefore, we intend to be limited only by the following claims.

We claim:

1. An improved blasting machine comprising in combination a circuit containing at least one high-capacity electrolytic condenser, a circuit containing a battery, a firing circuit containing a pair of terminals for connecting detonators, a two-way, spring-return firing switch which in the normally-released position connects said battery circuit in series with said condenser circuit and which in the opposite position connects said firing circuit in series with said condenser circuit, a bleed-off circuit containing a resistor across said firing circuit, an indicator-circuit containing a charge-indicating unit connected to said condenser in parallel to said firing circuit, a portion of said indicator circuit being common to said firing circuit, and a normally-open ready switch connected in series in said portion common to both said indicator circuit and said firing circuit.

2. A blasting machine as claimed in claim 1, wherein the condenser comprises a plurality of electrolytic units connected in parallel and having a total capacitance in excess of 50 microfarads.

3. A blasting machine as claimed in claim 1, wherein a safety-interlock switch actuated by disassembly of the machine connects said condenser to a discharge circuit and disconnects said battery circuit from said condenser circuit.

4. A blasting machine as claimed in claim 1, wherein the voltage of the battery is between 100 and 600 volts.

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