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BLASTING MACHINE

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This invention relates to blasting machines of the portable condenser-discharge type, and more particularly to an improved electric circuit and a switch actuating device therefor.

The utilization in recent years of a portable self-energizing blasting machine for use to initiate electric blasting initiators has become widespread. It has been found that by the provision of a condenser circuit having a high capacitance with a relatively low voltage battery, sufficient energy can be stored and available over prolonged periods of time to initiate large numbers of detonators, without the requirement of heavy and bulky equipment.

One disadvantage of this portable-type equipment is the possibility and danger of a condenser discharge to the firing circuit incapable of firing all the detonators. The result of such misfiring or no firing are missed holes which are highly dangerous. To obviate this advantage, there is provided an improved circuit having a novel switch actuating device therein. The circuit utilizes only two switches, both of normally open, spring returned-type. One switch when actuated closes a circuit through a visual indicating means, such as a voltmeter, for indicating to the operator the condition of the battery. The second or firing switch when actuated directs the condenser-stored energy through a firing circuit to initiate the blasting initiators.

The switch actuating device of this invention is so arranged in combination with the two switches that it can operate both in sequence. However, the switch actuating device is constructed so that the second switch, or firing switch, cannot be actuated until the first switch has been both actuated and de-actuated. Thus, the operator is forced to check the condition of the battery before he attempts to fire the detonators. Consequently, should the battery condition be indicative of insufficient firing energy, the operator will not attempt to actuate the firing switch. A possible misfiring will thereby be averted.

It is therefore an object of this invention to provide an improved blasting machine.

Another object of this invention is to provide an improved circuit for a blasting machine.

A further object of this invention is to provide a blasting machine with an electric circuit including a switch actuating device which makes it impossible to close a firing circuit without first indicating to the operator the condition of the electric potential for firing.

Yet another object of this invention is to provide a switch actuating device for the circuit of a blasting machine having normally open voltage indicating and firing switches, wherein an actuator is movable to a first position to close the voltage indicator switch, to a second position to close the firing switch concurrently with opening the indicator switch, and to a third position where both switches are released and in their normally open positions.

Another object of this invention is to provide a blasting machine circuit with a switch actuating device capable of attaining the objectives enumerated hereinbefore which is simple, economical and efficient in operation.

These objects, and other features and advantages of this invention will become readily apparent from the following description and the accompanying drawings, wherein:

FIG. 1 is a perspective view of the blasting machine of this invention;

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FIG. 2 is an enlarged fragmentary plan view of the switch actuating device of this invention, with certain parts broken away and others shown in dotted lines for clarity of illustration;

FIG. 3 is a view similar to FIG. 2, and showing the switch actuating device in an alternate position;

FIG. 4 is an enlarged, fragmentary sectional view taken along the line 4—4 in FIG. 1; and

FIG. 5 is a schematic wiring diagram of the blasting machine of this invention.

Referring now to the drawing, the blasting machine of this invention is indicated generally at 10 in FIG. 1, and includes an L-shaped mounting plate 11 having a back wall 15, and a bottom wall 20 formed with an upstanding lip 12 along the front edge thereof. A face plate or panel 13 is secured at its rear edge by bolts 14 to an intumed flange (not shown) provided along the upper edge of the back wall 15.

A pair of 225 volt batteries 16 and 17 are mounted between the back wall 15 and the lip 12. To secure the batteries against movement, a bar 18 is supported across their front exposed faces by a bolt 19 extended between the batteries 16 and 17 and connected at its rear end (not shown) to the back wall 15. A pair of condenser units 21 and 22 are positioned above the batteries 16 and 17 and securely mounted to the back wall 15 by means of brackets 23 (one showing). A 1,000 ohm resistor 24 (see FIG. 5) is also secured to the back wall 15 adjacent the units 21 and 22.

The panel 13 carries a voltmeter 26 (FIG. 1) and the switch actuating device 27 of this invention. A pair of terminals 28 and 29 on the panel 13 are connectible with detonators. Mounted on the panel 13, between the terminals 28 and 29, and the switch actuating device 27 is an upright plastic wall or shield 31 which functions as a guard to prevent the hand or fingers of the operator from accidentally touching the terminals 28 and 29, when manipulating the switch actuating device 27.

As shown in FIG. 5, the batteries 16 and 17 are connected in series with each other and with the resistor 24. One side of the batteries is connected through line 32 with the firing terminal 28, whereas the other side of the batteries is connected through the resistor 24 and a line 33 to one terminal 34 of a two-position firing switch 36. The other terminal 37 of the firing switch 36 is connected through a line 38 with the firing terminal 29.

The terminal 45 of the firing switch 36 is connected through line 39 with a terminal 41, and line 42 to the condenser units 21 and 22 which are arranged in parallel. The units 21 and 22 are each rated at 525 microfarads and when connected in parallel as shown herein (FIG. 5) provide a 1050 microfarad condenser. In series with the condenser units 21 and 22 are an indicator switch 43 and the voltmeter 26, connected through line 44 to the terminal 41. It is to be noted that the line 46 connecting the condenser units 21, 22 to the indicator switch 43 is connected by a terminal 47 to the firing terminal line 32.

The elements described hereinbefore, except for the panel 13, are enclosed in a metal protective can (not shown) to prevent accidental contact with the high voltage. The leads for the batteries 16 and 17 are brought through the can by a safety plug (not shown) which is disconnected when the batteries are being changed. Otherwise the safety plug is connected so that when in use, the circuit is as illustrated in FIG. 5.

In the operation of the blasting machine 10, assume the firing switch 36 to be in its normal or rest position as illustrated in FIG. 5, wherein the batteries 16 and 17 are connected in series with the condenser units 21, 22 to maintain them in a fully charged condition. With the firing terminals 28 and 29 connected to the detonators to be set off, the operator changes the position of the firing

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switch 36 so that line 39 is connected to terminal 37. The energy stored in the condenser units is then discharged across the firing terminals 28 and 29 to initiate the detonators.

However, as mentioned hereinbefore, there must be a sufficient amount of energy stored in the condensers 21 and 22 to initiate the detonation. To visibly indicate the amount of energy to the operator, the indicator switch 43 is closed, whereby the voltmeter 26 is connected in parallel with the condenser units 21, 22. The face of the voltmeter 26 has a red and green battery condition. If the condenser units contain 375 to 450 volts the voltmeter will indicate a green or "go ahead" reading. Below a condenser charge of about 375 volts the voltmeter will indicate a red or "no go" reading.

To obviate an accidental actuation of the firing switch 36 when there is insufficient energy stored in the condenser units 21 and 22, the switch actuating device, hereinafter referred to as the switch actuator 27, is provided. As best shown in FIGS. 2, 3 and 4, the switch actuator 27 includes an elongated, spring biased arm 51 secured at one end to the upper end 52 of a rotatable shaft 53. As best shown in FIG. 4 the shaft end 52 is projected upwardly from the panel 13. Secured to the lower end of the shaft 53, and below the panel 13, is an elongated arm follower 54. A pair of sleeves 56 and 57 mounted above and below the panel 13 provide journal means for the shaft 53 and space the arm 51 and the follower 54, respectively, above and below the panel 13.

To bias the arm 51, shaft 53, and follower 54 in a clockwise direction as viewed in FIGS. 2 and 3, a torsion spring 58 (FIG. 4) is wrapped about the shaft 53 with one end 59 secured to the shaft and the other end 61 pressed against the side 62 of the indicator switch housing 63. The follower 54 is extended on a level with the housing 63 (FIG. 4) and is adapted to engage the side 64 (FIG. 2) of the housing 63 opposite the spring side 62 of the housing.

Thus movement of the arm 51, shaft 53 and follower 54 in a counterclockwise direction from their rest or normal positions in FIG. 2 to their positions in FIG. 3 takes place against the bias of the torsion spring 58. On a release of the arm 51, therefore, the arm 51, shaft 53 and follower 54 are moved in a clockwise direction by the spring 58 to their rest positions shown in FIG. 2 and defined by the engagement of the follower 54 with the housing side 64.

Movably connected at one end to the follower 54 is a link 66 (FIG. 2) having a slot 67 for slidably receiving a pin 68 which is mounted on the follower 54. The other end of the link 66 is connected by a pivot pin 69 to the outer end of a spring-pressed actuator 71 for the firing switch 36. When the actuator or plunger 71 is in its normal, extended position of FIG. 2, the firing switch 36 is in its open position relative to the detonator terminals 28 and 29, as shown for its full line position in FIG. 5. However, when the plunger 71 is depressed in response to movement of the follower 54 as shown in FIG. 3, the firing switch 36 is in its closed position relative to the detonator terminals 28 and 29, as indicated in dotted lines in FIG. 5.

The indicator switch 43 is provided with a normally extended spring-returned actuator or plunger 72 (FIG. 4) which is operated by a push button 73 reciprocally movable through a bore 74 provided therefor in the arm 51. The bore 74 is countersunk at 76 on the under side of the arm 51 to receive a flange 77 formed on the lower end of the button 73. The countersink 76 provides a shoulder 78 for limiting the upward movement of the button 73 in response to the upward spring action of the plunger 72. The plunger 72 is reciprocally movable through an externally threaded sleeve 81 (FIG. 4), which is mounted on the switch housing 63 and secured to the panel 13 by a pair of locking nuts 82 and 83.

In the normal position of the plunger 72 as best shown

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in FIG. 4, the indicator switch 43 (FIG. 5) is open and the plunger 72 extends upwardly into the countersunk hole 76 so as to lock the switch arm 51 against sidewise or horizontal pivotal movement. However, it may readily be seen that upon depressing the button 73 until its head engages the arm 51, the plunger 72 is moved out of engagement with the arm 51. As a result the arm 51 is released for pivotal movement from its position in FIG. 2 to its position in FIG. 3.

Concurrently with releasing the arm 51, depression of the plunger 72 closes the voltmeter circuit whereby the voltmeter 26 will visually indicate to the operator the charged condition of the condenser units 21 and 22. Thus, prior to a manipulation of the switch arm 51 to its position in FIG. 3, wherein the arm follower 54 actuates the firing switch 36, the operator must depress the button 73 and actuate the voltage indicator switch 43.

Assuming that the voltmeter 26 indicates a sufficient condenser charge for firing, the operator, while holding the push button 73 depressed, swings the arm 51 counterclockwise from its FIG. 2 position to its FIG. 3 position to actuate the firing switch 36. This actuation of the firing switch occurs due to the operation of the firing switch plunger 71, by the follower 54, through the link connection 66. Concurrently with the movement of the switch arm 51 to its position in FIG. 3, to close the firing switch 36, the push button 73 and arm 51 are moved out of engagement with the plunger 72 to permit opening of the voltmeter circuit. The voltmeter switch 43 is thus open when the firing switch 36 is connected with the detonator terminals 28 and 29.

After the blast has been fired the push button 73 and arm 51 are released, whereby the parts of the switch actuating device are moved from their positions in FIG. 3 by the action of the torsion spring 58. The batteries 16 and 17 are thus automatically connected in a charging relation with the condensers 21 and 22, through the switch 36, while the indicator switch 43 is maintained open.

To facilitate a return of the plunger 72 to its position below the push button 73, the underside of the arm is formed with a groove 87 that is open to the countersunk portion 76 of the bore 74. The upper end 79 of the spring-pressed plunger 72 thus acts directly as a cam relative to the flange 77 to raise and hold the push button 73 in the upper position therefor shown in FIG. 1.

The blasting machine 10 of this invention is capable of firing at least 50 blasting caps in series and has fired a total of 1200 caps connected in parallel-series groups. Over a six month period under actual working conditions, after 250 firings the initial voltage of 450 volts had dropped but 25 volts to 425. Tests showed that with a 2 ohm resistor across the output or firing terminals 28 and 29, the machine furnished 190 amperes of current for 5 milliseconds.

Although a preferred embodiment of this invention has been disclosed herein, it is to be remembered that various modifications and alternate constructions can be made therein without departing from the scope of the invention as defined in the appended claims.

I claim:

1. A blasting machine having a circuit for firing a series of detonators, the circuit comprising in combination:

- (a) a source of voltage;
- (b) means for storing said voltage;
- (c) means for indicating the amount of voltage stored in said storing means;
- (d) a first switch having a normal open position and movable to a closed position to connect said storing means in series with said indicating means;
- (e) a pair of terminals for connection to said detonators;
- (f) a second switch normally positioned in a first position to connect said voltage source in series with said storing means, and movable to a second position to

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- connect said storing means in series with said terminals; and
- (g) switch actuating means operably connected to said first switch and second switch and movable to a first position to close said first switch, and movable to a second position to actuate said second switch and to simultaneously open said first switch.
2. A blasting machine having a circuit for firing a series of detonators, the circuit comprising in combination:
- (a) a source of voltage;
- (b) means for storing said voltage;
- (c) means for indicating the amount of voltage stored in said storing means;
- (d) a first switch having a spring-return plunger normally extended therefrom to open said first switch and depressible to connect said storing means in series with said indicating means;
- (e) a pair of terminals for connection to said detonators;
- (f) a spring-return second switch having a first position to connect said voltage source in series with said storing means, and movable to a second position to connect said storing means in series with said terminals;
- (g) switch actuating means for said first switch and said second switch including a movable arm for actuating said second switch, said plunger in the extended position therefor being in releasable locked engagement with said arm to hold said arm against movement; and
- (h) a release member on said arm movable to engage and depress said plunger out of locked engagement with said arm.
3. A blasting machine having a circuit for firing a series of detonators, the circuit comprising in combination:
- (a) a source of voltage;
- (b) means for storing voltage from said source;
- (c) means for indicating the amount of voltage stored in said storing means;
- (d) a first switch having a normally extended, spring-return plunger depressible to connect said storing means in series with said indicating means;
- (e) a pair of terminals for connection to said detonators;
- (f) a spring-return second switch having a normally extended plunger, said second switch, when the plunger is extended, acting to connect said voltage source in series with said storing means, and when said plunger is retracted, acting to connect said storing means in series with said terminals;
- (g) a switch actuating means including a swingable arm in releasable locking engagement with said first switch plunger when said first switch plunger is in said extended position therefor;
- (h) a follower member movable in response to said arm and operable upon movement to effect a retraction of said second switch plunger; and
- (i) a push button member movably mounted on said arm and movable in one direction to release said first switch plunger from locked engagement with said arm, concurrently with depressing said first switch plunger.

4. A blasting machine having a circuit for firing a series of detonators, the circuit comprising in combination:

- (a) a battery;
- (b) a condenser of sufficient capacity to store the voltage of said battery;
- (c) a voltmeter for indicating the amount of voltage stored in said condenser;
- (d) an indicating switch having a normally extended spring-return plunger depressible to a retracted position to connect said condenser in series with said voltmeter;
- (e) a pair of terminals for connection to said detonators;
- (f) a spring-return firing switch having a first position wherein said battery is connected in series with said condenser, and movable to a second position wherein said condenser is connected in series with said terminals;
- (g) a switch actuator device including a movable actuating arm in releasable locked engagement with said plunger when said plunger is extended; and
- (h) a push button mounted on said arm and movable relative thereto to depress said plunger out of engagement with said arm, whereby said arm and push button are movable as a unit out of the path of movement of said plunger to engage and move said second switch to the second position therefor.
5. In a blasting machine,
- (a) a first switch unit having operator means for actuating said switch unit from a normal open position to a closed position,
- (b) a second switch unit having a conductor means movable from a first position to a second position,
- (c) control means for said first and second switch units connected to said conductor means for moving said conductor means from said first position to said second position, said control means operatively associated with said operator means of the first switch unit for locking said conductor means of the second switch unit in said first position when said first switch unit is in an open position and unlocking said conductor means when said first switch unit is in a closed position, whereby the first switch unit must be in said closed position before the second switch unit can be moved to said second position.
6. The combination defined in claim 5 including:
- (a) biasing means connected to said control means for resiliently holding said conductor means of the second switch unit in said first position.
7. The combination defined in claim 5 wherein said operator means of the first switch unit comprises a spring-return plunger and said control means includes a movable arm in releasable locking engagement with said plunger.

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