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SWITCH AND METHOD FOR BLASTING

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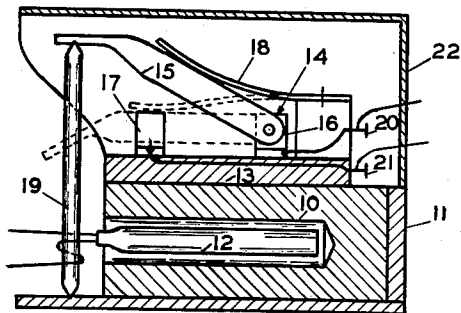


FIG. 1

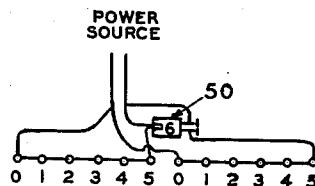


FIG. 3

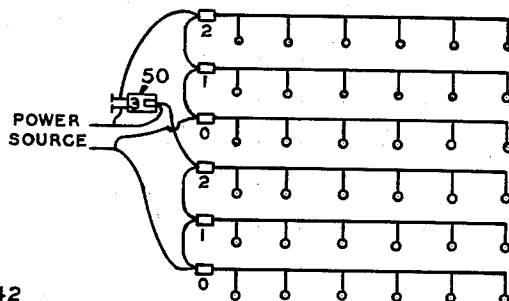


FIG. 4

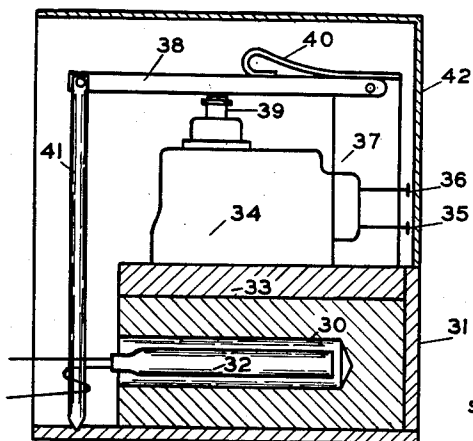


FIG. 2

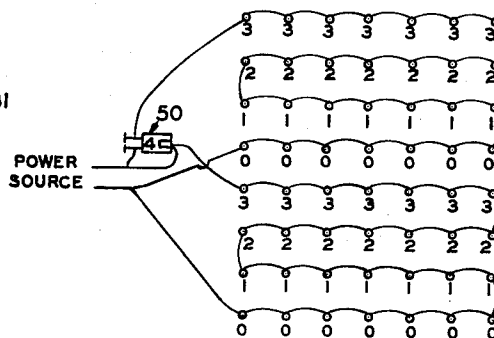


FIG. 5

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SWITCH AND METHOD FOR BLASTING

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This invention relates to the art of blasting and more particularly to improved methods, assemblies, and apparatus for use in delay blasting techniques.

The art has long recognized the benefits obtainable from the use of delay blasting initiators of various types. Until recent years the periods of delay employed between adjacent charges or groups of charges have been in the neighborhood of 0.5 of a second to several seconds. The original and basic object of the use of such delay periods between charges or groups of charges was to make it possible to explode a large quantity of high explosive at spaced intervals in a single shot and escape the undesirable effects normally obtained from exploding the same quantity of explosive instantaneously. In addition, the use of delay initiators enabled those engaged in quarry and cut blasting to break successive portions of the burden at timed intervals in a single shot. Likewise, in tunnel blasting the delay technique enabled the shooter to so time the initiation of the charges in the various boreholes that a cut is first made in the center of the tunnel face and then successive portions of the face are successively cleared by the other charges set off by the initiators having longer periods of delay.

In the more recent years it has been discovered that even better results are obtainable in some instances where the delay between adjacent boreholes or groups of boreholes is considerably reduced. This blasting technique is generally referred to as short period delay shooting. The periods of delay normally employed for optimum results are in the neighborhood of from 10-75 milliseconds. It has been found that this technique results in considerably less earth vibrations and in superior breakage.

As a result of the wide-spread use of both types of delay shooting, the major blasting initiator manufacturers throughout the world have undertaken the manufacture of conventional delay initiators and short period delay initiators having varying periods of delay. Depending upon the type of blasting operations being conducted in the various localities, it is current practice to manufacture and sell delay initiators embodying the number of delay periods which are desired for use in the particular field of operations. In the United States, for example, about 16 periods of conventional delay and 16 periods of short period delay are available. In Sweden, on the other hand, only 6 periods of short period delay are available from domestic producers. It is apparent, therefore, that initiator manufacturers are required to produce caps embodying a large number of delay periods and the operators in the field to stock large numbers of initiators having the varying periods of delay in order to insure the availability of the desired number of delay periods for a particular shot. Where a shot is proposed which will require a greater number of delay periods than are readily available from domestic sources, initiators must, if possible, be obtained from foreign sources with additional inconvenience and at additional expense or else the benefits which, would be derived from this added

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number of periods must be foregone. Obviously, therefore, it would be desirable and advantageous from the standpoints of both the producer and user of delay electric initiators if it were possible to obtain the desired effects without the necessity of more than a relatively few periods of delay in either the conventional or short period delay types.

An object of the present invention, therefore, is a blasting method in which it is possible to readily and economically obtain all of the benefits of a large number of delay periods while employing only a relatively few delay electric initiators.

A further object of the invention is a blasting assembly which will enable the use of any desired number of delay periods in a shot employing any practical number of boreholes while employing only a few delay initiators.

An additional object of this invention is a blasting device which will initiate current flow at the desired time in successive blasting circuits which may individually contain any desired number of periods of delay.

Generally described, the invention resides in employing a timing device comprising a delay electric blasting initiator which will initiate current flow in the circuit in which it is disposed as a result of the firing of the delay electric blasting initiator by a current obtained from another firing circuit. More specifically, the invention relates to a method of blasting which comprises charging a plurality of boreholes with explosive and dividing the boreholes into groups, priming a plurality of the charged boreholes by means comprising electric initiators and connecting the initiators of each group in individual electric circuits, disposing in each such circuit except the first to be fired a device containing electric contacts which enter into conductive relationship through release of an explosive force within the device, disposing in each such circuit except the last to be actuated, an additional delay electric initiator which is not associated with an explosive charge, placing each such additional initiator in operative position in each said device, and applying a firing current to each individual circuit to fire all of the initiators in a predetermined order.

The invention further comprises an explosive device for initiating current flow in successive blasting circuits which in combination comprises a body member, an initiator well formed in the body member, a delay electric initiator disposed in the initiator well, a pair of electric contacts associated with the body member, a movable member associated with the body member, resilient means associated with the movable member which through movement of the said movable member brings the contacts into conductive relationship with each other, and a displaceable rigid propping member disposed across the mouth of the initiator well and in contact with the movable member, said movable member being incapable of movement while the propping member is in place and being movable by the resilient member when the movable member is displaced by firing of the initiator.

The invention further comprises a blasting assembly which comprises in combination at least two groups of charged boreholes, a plurality of the charged boreholes in each group being primed by means comprising electric initiators, the initiators in each group being disposed in an electric circuit connected to a power source, and a timing device in accordance with the invention being employed between at least two such circuits.

Having generally described the invention, the apparatus, blasting assemblies, and methods in accordance with the invention are more specifically described, for purposes of illustration, with reference to the accompanying drawing. In the drawing, Figs. 1 and 2 show two embodiments of an explosive actuated timing apparatus which may be employed in the blasting assemblies and method of the inven-

tion. In Figs. 3, 4 and 5 are shown schematic diagrams of blasting assemblies which may be employed in accordance with the invention.

In Fig. 1, an initiator well 10 is disposed in a body member 11. A delay electric initiator 12 is disposed in the well 10 and is connected in a blasting circuit (not shown). A layer of dielectric material 13 is secured to the top of the body member 11. A double pole, single throw blade switch 14 is secured to the body of dielectric material 13. The switch 14 comprises a conductive blade 15 pivotably secured to an electrode 16. The remaining electrode 17 is contacted by the blade 15 when the switch is in the normally closed position. The blade 15 is normally maintained in the closed position by the action of the spring 18. As shown, however, the blade 15 is maintained in the open position by a rigid propping member 19 which passes across the mouth of the initiator well 10. Electrical connections 20 and 21 are in communication with the electrodes 16 and 17 of the switch 14, and are connected into a second blasting circuit (not shown). Explosion of the delay initiator 12 disposed in the well 10 displaces the prop 19 allowing the spring 18 to force the blade 15 into conductive relationship with electrode 17 to close the circuit. A cover member 22 is disposed about the switch mechanism and suitably secured to the body member 11.

In Fig. 2 is shown a similar switch mechanism. As in Fig. 1, an initiator well 30 is disposed in a body member 31 and contains a delay electric initiator 32. A layer of dielectric material 33 is disposed on the body member 31. A normally open, single pole microswitch 34 is secured to the body of dielectric material 33. Electrical connections 35 and 36 lead to the terminals of the microswitch (not shown), and are connected in a second blasting circuit. A spring mount 37 is secured to the body member 31. Pivotably mounted on the spring mount is a member 38 which rests upon the button 39 of the microswitch 34. The member 38 is forced in the direction of the button of the microswitch by the action of the spring 40 but is prevented from depressing the switch button by a rigid propping member 41 which passes across the mouth of the initiator well 30. The member 41 is pivotably attached to the end of the member 38. As in Fig. 1, the explosion of the delay initiator in the well 30 outwardly displaces the propping member 41, and allows the member 38 to depress the button of the microswitch 34 and close the second circuit. A cover member 42 is secured to the body member 31.

In Fig. 3 is shown a blasting diagram wherein a row of twelve charged boreholes is disposed along a quarry face. As shown, the first hole is primed with an instantaneous or 0 delay cap, the second, third, fourth, fifth and sixth holes with delay initiators having delay periods of 1, 2, 3, 4, and 5, respectively. The seventh hole is charged with a 0 delay or instantaneous cap and the eighth, ninth, tenth, eleventh, and twelfth holes are primed respectively with delay initiators having delay periods of 1, 2, 3, 4, and 5, respectively. The initiators in holes one through six and a separate period 6 delay initiator are connected in a circuit which is connected, in turn, to a power source. A switch 50 such as that shown in either Fig. 1 or Fig. 2 and the initiators in the remaining holes are connected in a second circuit which is also connected to the power source. When a firing current is applied, hole number one shoots instantaneously followed successively by holes two, three, four, five, and six after the predetermined periods of delay. The period 6 initiator in the switch 50 then fires, the propping member of the switch is displaced and the second circuit is closed. Hole seven then fires instantaneously followed by holes eight through twelve, after the corresponding periods of delay. It will be seen, therefore, that in the assembly shown in Fig. 3 a row of twelve holes is shot at desired delay periods while employing initiators having only six periods of delay. The desired number of additional circuits and additional groups

of initiators may, of course, be employed to extend the row of boreholes to any desired length.

In Fig. 4 is shown a blasting diagram and assembly wherein a block of thirty-six holes disposed in six rows are shot. Each of the thirty-six holes in each row is primed with a branch line of Primacord which is joined to a trunk line of Primacord. The trunk line of the first row is primed with an instantaneous initiator, the trunk line of the second row is primed with a period 1 delay initiator and the trunk line of the third row is primed by a period 2 delay initiator. This hook-up is repeated in rows four, five and six. The initiators of the first three rows are disposed in a separate circuit with a period 3 delay initiator while the initiators in rows four, five and six are joined in a circuit with a timing device 50 in accordance with the invention. Both circuits are connected to a power source. When a firing current is applied, the holes of row one are shot substantially instantaneously. The holes in row two fire after a delay of the first period while the holes in row three fire after a delay of the second period. The period 3 initiator in the switch then fires and the second circuit is closed as described in conjunction with Fig. 3, whereupon the holes in the fourth row instantaneously shoot followed by rows five and six after the predetermined periods of delay. As in the shot shown in Fig. 3, the number of rows and the number of holes in each row may be increased as desired by employing an additional number of initiators having the desired periods of delay and/or by employing additional switches and additional circuits.

In Fig. 5 is shown a blasting diagram and assembly for shooting a rock cut such as would be made in highway construction. In the shot depicted, eight rows of charged boreholes are successively disposed inwardly from the face of the cut. The holes in the first, second, third and fourth rows are primed by delay initiators having 0, 1, 2 and 3 delay periods, respectively. All of the initiators in the first four rows are connected in series in a single circuit with a period 4 delay initiator which is disposed in a timing device 50 such as that shown in Figs. 1 or 2. The holes in the fifth, sixth, seventh and eighth rows are also charged respectively with 0, 1, 2 and 3 period delays and are connected in series in a single circuit which contains the timing device 50. Both circuits are connected to a power source. When the firing current is applied, rows one, two, three and four are fired in order after the predetermined period of delay. The period 4 delay initiator in the switch will then fire to close the second circuit and rows five, six, seven and eight will fire in order. Again, the number of holes and the number of rows may be increased as desired by employing initiators having additional periods of delay and/or by employing additional timing devices.

It will be seen, therefore, that the invention has achieved its objects in presenting a method of blasting, blasting assemblies and explosively actuated timing devices which make it possible to obtain all the benefits of delay blasting while employing only a relatively few periods of delay.

The explosively actuated timing devices disclosed can be constructed of any desired materials. If it is desired to reemploy the devices, the body members may be constructed of a material such as steel which will withstand the force generated by the exploding initiator. As illustrated in Fig. 1, the propping member may be expendable or, as shown in Fig. 2, may be constructed of sturdy material and pivotably attached to either the body member or the movable member which acts to close the circuit. If desired, all or part of the elements of the device, except those necessary to the electric circuit, may be constructed from frangible plastic or other expendable materials. Equivalent mechanical means of making electrical contact other than those specifically disclosed in Figs. 1 and 2 will be apparent to the art. The microswitch employed with very satisfactory results is manufactured by the Micro Switch Division of Minne-

apolis-Honeywell Regulator Company under the designation B2V-2RQ.

As indicated, the blasting assemblies, the positioning of boreholes, and the particular periods of delay employed in these holes can be altered to fit the needs of the particular operation. For example, it is not necessary that the first hole in each circuit be primed by means of an instantaneous initiator and, in like manner, it is not necessary that the delay initiator employed in the timing device be characterized by the longest period of delay of any initiator disposed in that particular circuit. For example, if in the assembly and blasting diagram shown in Fig. 1 short period delay initiators are employed which are characterized by a difference in firing time of 25 milliseconds, the identical result, in so far as timing between holes is concerned, can be obtained by employing a period 5 delay in the timing device and by employing a period 1 delay in the seventh hole. Furthermore all instantaneous caps may be employed to prime the holes and the desired delay between groups obtained by employing the corresponding delay initiator in the timing switches.

Any suitable power source may be employed in practicing the invention. The particular source of power will be dictated by presently known considerations since the disposition of the mechanical switch in a blasting circuit does not materially change power requirements. It is of course necessary that the firing current be applied for a period of time long enough to insure proper ignition in all of the initiators of the individual circuits employed.

The delay initiators employed in accordance with the invention may be either the conventional or the short period type. Various timing sequences may be employed other than those specifically shown in the drawing in accordance with the needs of the particular operation.

Since it is apparent that many modifications may be made without departing from the scope of the invention disclosed, it is intended that the invention shall be limited only by the scope of the appended claims.

What I claim and desire to protect by Letters Patent is:

1. An explosive device for initiating current flow in successive blasting circuits which in combination comprises a body member, an initiator well formed in the body member, a delay electric initiator disposed in the well, a pair of electrical contacts associated with the body member, a movable member associated with the body member, resilient means associated with the movable member which through movement of the said movable member brings the contacts into conductive relationship with each other, and a displaceable, rigid propping member disposed across the mouth of the initiator well and in contact with the movable member, said movable member being incapable of movement while the propping member is in place, and being movable by the resilient member when the movable member is displaced by firing of the initiator.

2. An explosive device for initiating current flow in successive blasting circuits which in combination comprises a body member, an initiator well formed in the body member, a delay electric initiator disposed in the well, a pair of electrical contacts associated with the body member, a conductive member in conductive relationship with the first contact, resilient means associated with the conductive member which tends to force the conductive member into conductive relationship with the second contact, and a displaceable propping member disposed across the mouth of the initiator well and in contact with the conductive member, said conductive member being incapable of movement while the propping member is in place, and being movable by the resilient member when the movable member is displaced by firing of the initiator.

3. A blasting assembly comprising in combination at least two groups of charged boreholes, a plurality of the charged holes in each group being primed by means comprising electric initiators, the initiators in each group being disposed in an electrical circuit connected to a power source, a timing device employed between at least two such circuits which has in combination a body member, an initiator well formed in the body member, a delay electric initiator disposed in the well, said initiator being disposed in one of the said circuits, a pair of electrical contacts associated with the body member, and disposed in another of the said circuits, a movable member associated with the body member, resilient means associated with the movable member which through movement of the said movable member brings the contacts into conductive relationship with each other, and a displaceable, rigid propping member disposed across the mouth of the initiator well and in contact with the movable member, said movable member being incapable of movement while the propping member is in place, and being movable by the resilient member when the movable member is displaced by firing of the initiator.

4. An assembly according to claim 3 in which the initiators in each group are characterized by varying periods of delay.

5. A blasting assembly comprising in combination at least two groups of charged boreholes, a plurality of the charged holes in each group being primed by means comprising electric initiators, the initiators in each group being disposed in an electrical circuit connected to a power source, a timing device employed between at least two such circuits which has in combination a body member, an initiator well formed in the body member, a delay electric initiator disposed in the well, said initiator being disposed in one of the said circuits, a pair of electrical contacts associated with the body member, and disposed in another of the said circuits, a conductive member in conductive relationship with the first contact, resilient means associated with the conductive member which tends to force the conductive member into conductive relationship with the second contact, and a displaceable propping member disposed across the mouth of the initiator well and in contact with the conductive member, said conductive member being incapable of movement while the propping member is in place, and being movable by the resilient member when the movable member is displaced by firing of the initiator.

6. An assembly in accordance with claim 3 in which all of the holes in each group are primed with electric initiators characterized by varying firing times and all initiators in each group are disposed in an individual electric circuit.

7. An assembly in accordance with claim 3 in which only part of the holes are primed by means comprising electric initiators characterized by varying periods of delay and the remaining holes in each group are primed by detonating fuse leading from the holes in which electric initiators are employed.

8. An assembly in accordance with claim 3 in which at least part of the holes are primed by detonating fuse which, in turn, is primed by electric initiators having varying delay characteristics.

9. A method of blasting which comprises charging a plurality of bore holes with explosive and dividing the holes into groups, priming a plurality of the charged boreholes in each group by means comprising electric initiators and connecting the initiators of each group in individual electric circuits, disposing in each such circuit except the first to be fired a device containing electric contacts which enter into conductive relationship through release of an explosive force within the device, disposing in each such circuit except the last to be actuated, a delay electric initiator which is not associated with an explosive charge, placing each such delay initiator in operative position in each said device, and applying

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ing a firing current to each individual circuit to fire all of the initiators in a predetermined order.

10. A method in accordance with claim 9 in which all the initiators associated with the explosive charges are instantaneous initiators.

11. A method in accordance with claim 9 in which the initiators in each group are characterized by varying periods of delay.

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