Jan. 22, 1957 W. D. MOUNCE 2,779,014

STEPPING SWITCH

Filed March 21, 1950

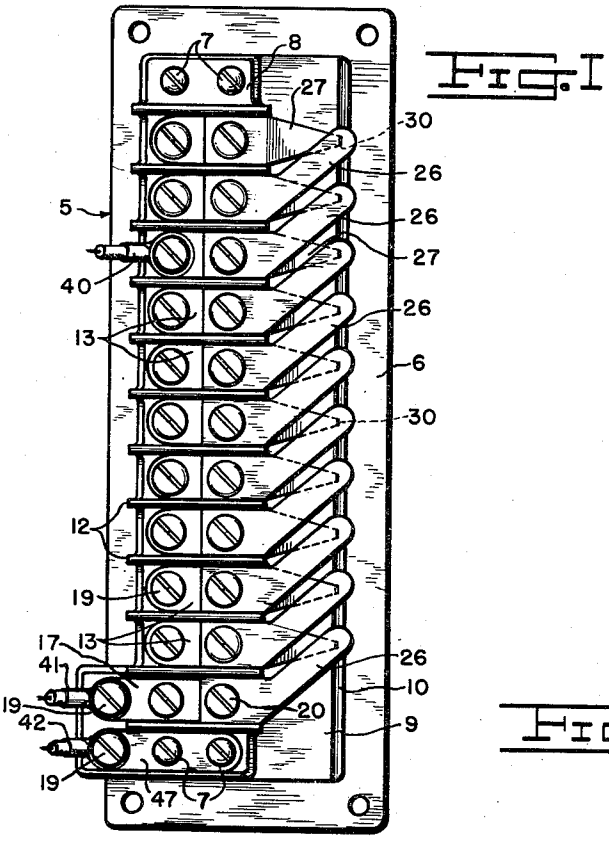


FIG. 1

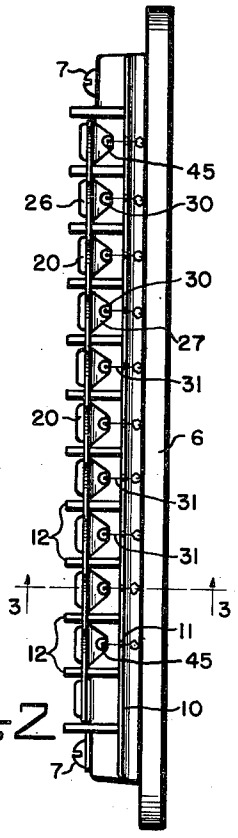


FIG. 2

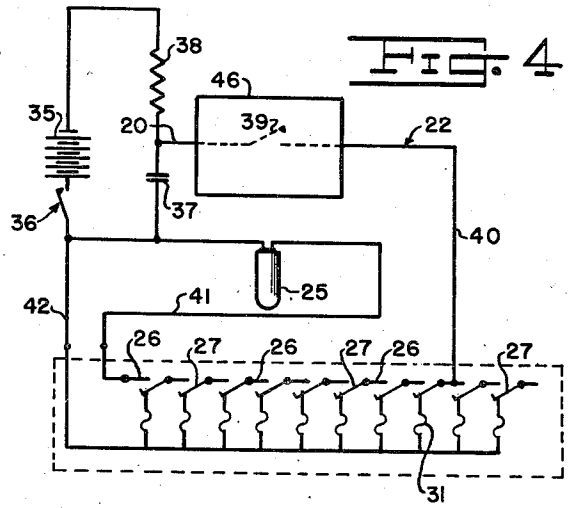


FIG. 4

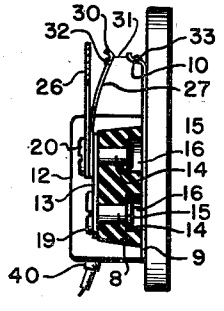


FIG. 3

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United States Patent Office 2,779,014 Patented Jan. 22, 1957

2,779,014

STEPPING SWITCH

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Application March 21, 1950, Serial No. 151,028

4 Claims. (Cl. 340—147)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention relates generally to switch devices and more particularly to a new and improved counter switch of the type adapted to close an electric circuit after a predetermined number of electrical impulses have been received thereby.

Heretofore counter or stepper switches of the conventional electromagnetic types have been extensively employed in various forms of ordnance devices such, for example, as in submarine mines, land mines, and the like, wherein such switches are adapted to close a firing circuit in the mine after allowing the passing thereover of a selected number of ships or other such objects suitable for producing in the mine an electric signal or impulse operative to advance the stepper of the switch one step in the direction of the mine firing position for each such electrical signal produced by the mine.

Ordnance devices of the character indicated are frequently subjected to high degrees of acceleration shock whereupon it is not uncommon for the movable elements of the stepper switches therein to be prematurely advanced in the direction of mine firing positions thereby to entirely alter the responsive characteristics of the mine, or in many instances the switch becomes so damaged as to render the mine thereafter inoperable.

The device of the present invention provides for a low energy counterswitch that is relatively insensitive to shock and particularly adapted for use in mine fuzes, or the like, to establish an electrical connection between the detonator of the mine and a power source, thereby to fire the mine after a predetermined number of electrical signals have been applied to the counter mechanism of the switch.

According to the arrangement of the present invention, a plurality of switches are arranged to be closed in successive order as fusible elements individual thereto are ruptured, each switch being arranged to insert the fusible element of the next succeeding switch into an impulse-receiving, energizing circuit therefor whereby the fusible elements are ruptured in successive order as a series of electrical impulses are passed through the energizing circuit. A detonator, or other electroresponsive device, is connected to the last one of the switches to be operated and to one side of an impulse source connected in the energizing circuit, and a preselected one of the remaining switches is connected to the other side of the impulse source whereby the circuit is completed to the detonator, or like device, when a predetermined number of impulses, equal to the number of switches thus connected in series in the circuit, have been received, and the detonator, or like device is operated by the next succeeding impulse.

It is an object of the present invention to provide a new and improved counterswitch adapted for closing an electric circuit in response to a predetermined number of electrical impulses applied thereto.

A further object is to provide a new and improved counterswitch for a mine firing circuit adapted to establish an electrical connection between the detonator of

the mine and a power source for firing the mine after a predetermined number of firing signals have been applied to the switch.

A still further object is to provide a counterswitch wherein a circuit is completed through the switch after successive rupturing of a selected number of fusible elements for controlling sequential operation of the circuit closing elements of the switch.

A further object is to provide a counterswitch adapted to close a plurality of contact members of the switch in sequential order in response to a preselected number of electrical impulses thereby to ultimately complete a firing circuit to the detonator of the mine.

A still further object is to provide a mine firing counterswitch wherein a plurality of circuits are closed through elements fusible in successive order in response to a preselected number of electrical impulses applied to the switch thereby to effect the ultimate completion of a firing circuit to the detonator of the mine.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same become better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a plan view of the counterswitch of the present invention;

Fig. 2 is a side view of the switch showing the arrangement of the fusible elements thereof;

Fig. 3 is a view in section of the switch as taken along line 3—3 of Fig. 2; and

Fig. 4 is a schematic view of the switch of the present invention as arranged in a mine firing circuit.

Referring now to the drawings and more particularly to Fig. 1 thereof the switch generally designated 5 of the present invention is shown as comprised of a base member 6 formed preferably from insulating material such, for example, as Bakelite and whereupon is secured as by screws 7 a ribbed body or chassis member 8, also preferably formed from Bakelite. Clamped or otherwise suitably secured between these base and body members 6 and 8 respectively is a terminal plate 9 having provided in the forward edge thereof an upwardly extending flange section 10 wherein is formed a plurality of V-shaped notches 11, Fig. 2, the purpose thereof becoming more apparent as the description proceeds. Screws 7, by which the terminal plate 9 is secured to the undersurface of the chassis 8, provides an electrical connection between the plate and a terminal plate 47 clamped as by the screws 7 to the upper surface of the chassis.

Respectively arranged between ribs 12 of the chassis is a plurality of terminal pieces 13, Fig. 3, suitably secured to the chassis as by deep drawn eyelet portions 14 thereof extending downwardly through bores provided therefor in the chassis to be thereafter flared at their lower ends 15 for gripping in a conventional manner an inner flange forming the base of a counterbore 16.

Threaded into the respective eyelets 14 is a pair of clamp screws 19 and 20 of which the former thereof is effective to secure to a selected one of the terminal pieces 13 a connection 40, Fig. 1, forming a part of a mine firing circuit generally designated 22, Fig. 4 and including a detonator unit 25. The clamp screw 20 is so arranged as to secure to the terminal plate 13 a pair of resilient contact elements including a contact plate 26 and spring switch arm 27 both of which include portions extending laterally outward from the supporting edge of the chassis and with an angular portion of the contact plate 26 lying across the spring switch arm of the pair of contact elements adjacent thereto.

The spring switch arms 27 are preferably formed from material more flexible than the contact plates 26 and gradually narrowed at their free ends to terminate ulti-

mately into upwardly extending contact portions 30 initially maintained in open circuit position with respect to the plate members 26 by fusible elements 31 secured as by soldering to the ends of the arms and the flange section 10 of plate 9 at 32 and 33 respectively, Fig. 3. The elements 31, are so arranged as to pass through suitable openings 45 provided therefor in the ends of the arms 27 and lie within the notches 11 formed in the outer edge of the flange section 10 of plate 9.

The rupturing of a connected fusible element 31, responsive to a predetermined voltage applied thereto, frees the arm 27 retained thereby allowing the arm to spring upwardly for contacting the undersurface of the overlying plate member 26 adjacent thereto thereby to close in this manner an electrical connection through the next succeeding element 31 by way of the next spring switch arm in circuit with the said contacted plate. With the rupturing of each element an electric circuit is stepped through the switch, in the manner indicated, to be ultimately completed through the detonator unit 25 for firing the mine after a predetermined number of electrical impulses have been applied to the mechanism of the switch. It will be apparent from the structure of the switch that the electrical connection 40 may be made with any one of the fusible elements 31 selectively whereby the number of electrical impulses required to complete the circuit through the switch may be controlled.

The mine firing circuit 22, Fig. 4, which may be of any type suitable for application with the switch of the present invention, is shown to include a battery 35 initially disconnected from the firing circuit by an arming switch 36 adapted to be closed to arm the mine in any conventional manner as by the removal of an arming pin therefrom in the case of land mines, or the like, or by hydrostatic pressure in the case of underwater ground mines as the mine submerges to a predetermined depth within a body of water. The firing circuit also includes a firing control mechanism 46 which may be of any type suitable to close the switch 39, or to otherwise complete the firing circuit between the conductors 20 and 40. For a more complete disclosure of such a mechanism and firing circuit reference may be had to the copending application of W. D. Mounce et al. for Mine Firing Control System, Serial No. 594,133, filed May 16, 1945.

The closing of the arming switch 36 is effective to connect in the battery circuit a condenser 37 arranged in series with a low value resistor 38 whereupon the condenser is charged gradually to peak potential over a predetermined period of time selectable by the choice of the resistance 38 in the condenser circuit.

The condenser 37 is so arranged with respect to the fusible elements 31 that as the firing switch 39 is closed, a circuit is completed through conductors 40 and 42 to the element 31, whereupon the condenser is discharged through the element to rupture the same thereby allowing the release of the switch arm 27 retained thereby. The freeing of the spring switch arm in this manner allows the arm to engage the undersurface of the next adjacent contact plate 26, as heretofore described, to complete the electrical circuit through the switch to the next succeeding element 31. In this manner, the remaining elements 31 are ruptured in successive order in response to successive electrical impulses received from the condenser 37.

With the rupturing of each element the next succeeding element is prevented from fusing for the reason that the condenser 37 is so selected that when fully charged, it has sufficient potential to rupture only one element and further charging of the condenser to a value sufficient to rupture the next element is prevented until the firing switch 39 has been opened for a predetermined period of time, the selection of the resistor 38 controlling the time required.

The detonator is connected to condenser 37 by way of conductor 42 and the other side thereof is connected by way of conductor 41 to terminal strip 17 which is connected as by a screw 19 to the last one of contact plates 26, conductor 41 being secured to strip 17 also as by a terminal screw 19. Thus, the detonator is connected so as to be fired by the next succeeding impulse from the condenser after a sufficient number of impulses have been received to fuse the intervening elements 31 and connect the last contact plate 26 to conductor 40.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appending claims the invention may be practiced otherwise than as specifically described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalty thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A stepping switch of the character disclosed adapted to close an electric circuit through the switch to an apparatus to be energized after a predetermined number of electrical impulses have been applied to the switch including, in combination, a plurality of pairs of electrically connected contact devices including a fixed contact member and a flexible contact member, said flexible contact member being arranged for contacting the fixed contact member of the adjacent pair of devices, a conducting terminal plate, an elongated insulating block, said flexible contact member being disposed between said block and the fixed contact member, a plurality of fusible elements respectively connected at one of the ends thereof to said flexible contact members and commonly connected at the other of the ends thereof to said terminal plate for initially biasing said flexible contact members out of contact with the respective fixed contact members of each adjacent pair and in a plane transverse to the longitudinal axis of said block, and circuit means for receiving said impulses and connected to a first selected one of said flexible contact members for rupturing the fusible element connected thereto thereby to release the selected flexible contact member for movement into engagement with the fixed contact member of the next succeeding contact device whereby said electric circuit is progressively advanced through the switch in response to each of said electrical impulses.

2. A stepping switch of the character disclosed adapted for use in a mine firing circuit and including, in combination, an elongated insulating support, a plurality of flexible contact members transversely arranged in closely spaced relation along the longitudinal surface of said support and secured thereto, each of said members having one end thereof extending beyond said support and movable in a plane normal thereto, a metallic terminal plate arranged beneath said support and extending throughout the length thereof, a plurality of fusible elements each connected at one end thereof to said plate and at the other end respectively to the movable ends of said flexible contact members to maintain said members initially deflected in a retracted position toward the plate, circuit means for applying electrical impulses in succession to said switch, the first of said impulses being applied to a selected one of said elements to rupture the element thereby to release for movement a selected flexible contact member, a plurality of fixed contact members corresponding in number to said flexible members and respectively arranged across the paths of movement of the flexible members for engagement therewith thereby to connect the next succeeding fusible element for rupture in response to the next succeeding electrical impulse as the flexible members are released in successive order, and electroresponsive means connected to a selected one of said fixed contact members and operable by said impulse

when the flexible member operatively associated therewith is released.

3. A stepping switch of the character disclosed adapted to close a circuit to an electroresponsive device when a predetermined number of electrical impulses have been applied thereto including, in combination, an elongated insulating chassis comprised of a top section and a base section, a plurality of spring contact members secured in closely spaced relation along the upper surface of the top section, each of said spring members having the contact end thereof adapted for flexible movement in a plane normal to the longitudinal axis of said chassis, a metallic terminal plate interposed between said top and base sections and having one edge thereof extending from beneath the top section, a plurality of fusible elements each connected at one end thereof to the said edge of the terminal plate and at the other end respectively to the movable ends of said spring contact members to maintain said contact ends deflected toward the base section of said chassis, means including a source of electrical energy for applying an electrical impulse to a selected one of said fusible elements whereby the selected element is ruptured for releasing the contact member connected thereto for movement in a direction normal to and away from said base section, a plurality of contact plates disposed above said contact members and in electrical contact therewith respectively whereby each of the movable ends of said contact members when released respectively engages the next succeeding contact plate, and means connected to the last contact plate for establishing an electrical connection to said electroresponsive device whereby the circuit to the device is closed by the selected spring member and the intermediate spring members as the last spring member is released.

4. A stepping switch of the character disclosed adapted to close an electric circuit in response to a predetermined number of electrical impulses including, in combination, an elongated insulating block having thereon a plurality of mutually parallel transverse ribs in mutually proximate spaced relation, a plurality of fixed contact elements respectively arranged between said ribs along the surface

of said insulating block, each of said elements having an angular portion extending beyond the edge of said block, a plurality of flexible contact elements interposed between said block and said rigid contact elements and secured in electrical contact respectively with said fixed contact elements to the surface of said block between said ribs, each of said flexible elements having one end adapted for flexible movement into electrical engagement with the angular portion of the next adjacent fixed contact element, a plurality of fusible elements, a terminal plate arranged on the opposite side of said insulating block and having thereon a flange running parallel to the longitudinal axis of said block and disposed substantially beneath the movable ends of said flexible contact elements, a plurality of notches formed in said flange in spaced alignment with the movable ends of said flexible contact elements and wherein are respectively secured one end of each of said fusible elements, fusible means for securing the other ends of said fusible elements respectively to the movable ends of said flexible contact elements thereby to normally bias the flexible elements in the direction of said plate and disengaged from the next adjacent fixed contact elements, means including a terminal connector arranged on a selected flexible contact element for applying an electrical impulse to a selected one of said fusible elements whereby the selected fusible element is ruptured by the first of said impulses to release the flexible contact element connected thereto for engagement with the next succeeding fixed contact element, and means for connecting said circuit to the last one of said fixed contact elements whereby the circuit is closed by the released flexible elements in response to said predetermined number of said electrical impulses.

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