Feb. 21, 1933. W. P. HEALY 1,898,626

ELECTRICAL SWITCH

Filed Dec. 26, 1930

Fig. 1.

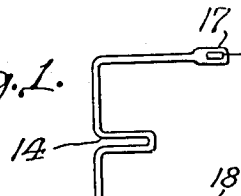
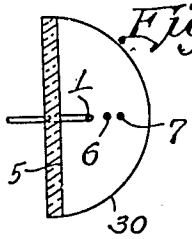


Fig. 2.



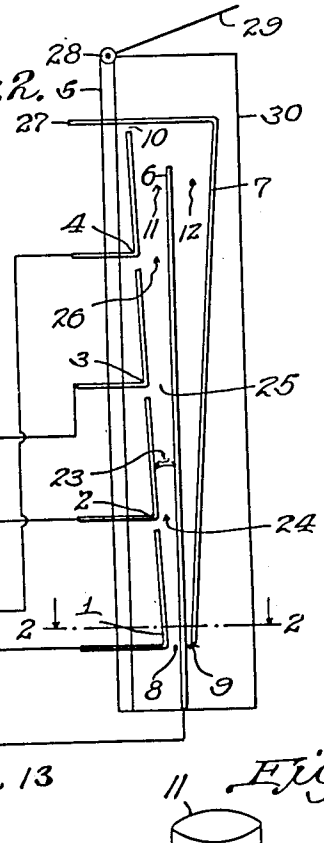


Fig. 5.

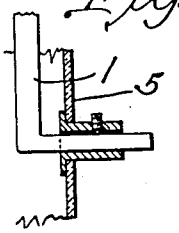


Fig. 3.

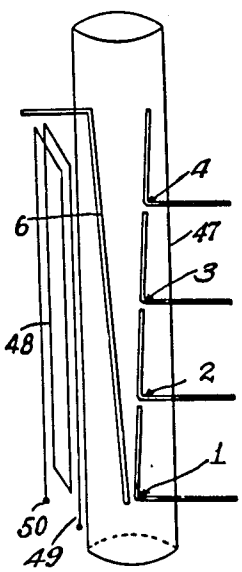
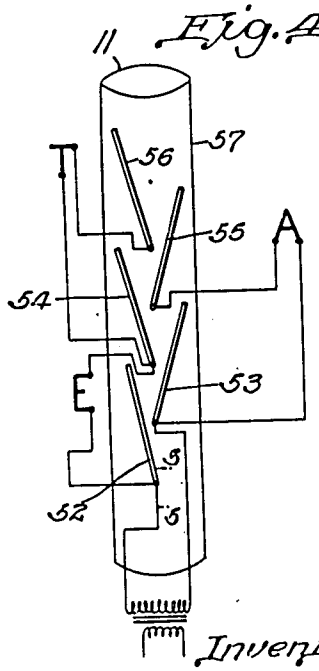


Fig. 4.



Inventor

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UNITED STATES PATENT OFFICE

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ELECTRICAL SWITCH

Application filed December 26, 1930. Serial No. 504,961.

This invention relates to a method and means for automatically switching, and timing the switching of, electrical currents under high potential and more especially to the switching and timing of such high potential circuits as are commonly used in the lighting of gas filled tubes, such as neon lighted signs and the like. Said method and means may be used for switching, and timing the switching of, other electrical apparatus or machinery, such as timing and switching compensation starting controls for electric motors by operating relays, for automatic switching of incandescent, signal and other kinds of electrically controlled lights, for producing spectacular results with electrically lighted signs for displays, for providing time regulated rotating electro-magnetic effects and circuit interrupting effects common in the practice of the electrical arts, and for various other purposes.

It has been customary, prior to my invention, to effect switching, and time regulation of the same, by means of motors, both electrical and mechanical, and other rotating, oscillating and interrupting switching devices. This practice involves the use, in most cases, of bulky and expensive apparatus and the necessity for considerable repair and maintenance.

The general object of this invention is to provide a switching and timing device which will function without, or with a minimum of moving parts, and which also, in one of its phases, provides a spectacular effect advantageous for advertising and display purposes.

Another object is to provide simplified wiring facilities for controlling neon lighted signs and other equipment to which similar circuits are applicable.

A further object is to provide a switching device in which the circuits are closed and opened by the establishment of, and the extinction of, an arc.

An additional object is to provide a device of this character in which the cycle of operations repeats itself automatically and at a rapid rate, which rate, furthermore, may be accelerated or retarded at will.

A further object is to provide a switching device, for the purpose described, which, of itself, constitutes a spectacular attraction, in addition to the attraction afforded by the flashing sign controlled thereby, said device having a transparent container to render the high voltage, moving arcs visible.

Other objects and advantages will be apparent from the following description in conjunction with the drawing, wherein several embodiments of the invention are illustrated somewhat diagrammatically.

In the drawing:

Fig. 1 illustrates one form of switch, connected to three tube sections of a neon sign and a transformer source of current;

Fig. 2 is a section on the line 2—2 of Fig. 1.

Figs. 3 and 4 illustrate modified forms of switches;

Fig. 5 is a fragmnetary view of an electrode and its support.

Referring to Fig. 1, there are shown three individual neon tubes or a sign describing the word eat, arranged vertically in this instance, and also an arc switch. Electrodes 1, 2, 3 and 4 are suitably supported in an insulating mounting, 5, which, for example, may be made of porcelain, as shown in Fig. 5. Said electrodes are connected electrically to one side of the secondary of a transformer, 13, and also to terminal 17, terminals 18 and 19, terminals 20 and 21, and terminal 22 respectively of neon tube letters 14, 15 and 16. Any number of electrodes may be employed, depending on the character of the sign.

Another electrode 6, mounted adjacent to said electrodes 1, 2, 3 and 4, and preferably in a vertical position, is connected to the other side of the secondary of transformer, 13, and, as illustrated, provides arc gaps of various lengths between itself and said electrodes, which later diverge from said electrode 6. The said arc gaps occur in substantially vertical alignment, with the smallest gap, preferably at the bottom and increasing in length to the top, said arc gaps being numbered 8, 24, 25, 26 and 11 and being adjustable in length, as shown in Fig. 5, that is, in their spacing or distance from electrode 6, the adjustment depending upon the resistance of

the various circuits, the apparatus to be connected to them and the effects desired.

The operation of this apparatus as thus far described is as follows: Due to the high potential developed by the secondary of the transformer, which is connected to electrodes 1 and 6, and due to the proper conductivity of arc gap at 8, an arc is formed between electrodes 1 and 6, at the point 8. The arc 23 then rises along the path formed by conductors 1 and 6 until it arrives at conductor 2, arc gap 24, where it leaves conductor 1 and continues along conductors 2 and 6 (see arc 23), repeating this operation with electrodes 3 and 4, and quickly arriving at gap 11, the resistance of which is so great that said arc is extinguished, when it is again re-formed at gap 8 and repeats the described process.

It will be seen that the arc at 8 closes the circuit to the secondary winding of the transformer without including any of the neon tubes. The arc at 24 closes the circuit from the secondary of the transformer to the neon tube 14, i. e., letter E, and back to the other side of said secondary winding of the transformer, the voltage being sufficient to break down the air gap and also to cause said tube to glow. The arc at 25 establishes the circuit from the secondary of said transformer to the terminal 20 of neon tube 15, i. e., letter A, from the terminal 19 to terminal 18 of letter E, and from the other terminal, 17, thereof, back to the transformer, thus connecting the two letters, E and A, in series and lighting both of them. The arc at 26 in like manner establishes the circuit from the transformer to the terminal 22 of neon tube 16, i. e., letter T, and from the terminal 21 thereof to terminal 20 of letter A, and from terminal 19 to terminal 18 of letter E, and from terminal 17 thereof back to the transformer, thus connecting all three letters in series and causing all three of them to be illuminated, after which they are all extinguished simultaneously. When the arc reestablishes itself across the gap 8, as it does immediately, there is a brief interval of time while it is running upwardly to the end of the electrode 1, during which none of the letters is illuminated. This particular arrangement of letters and circuits is selected merely to illustrate one of many possible commercial uses of the arc switch.

Electrode 7, fastened in said insulating support 5, is an additional or optional feature, providing further facility of operation, as follows: After the arc has arrived at gap 11, the ionized gas enveloping the closest points of electrodes 4 and 7 reduces the resistance of gap 10, so that its resistance, plus the resistance of gap 9, with which it is in series, is less than the resistance of gap 8 and consequently, arcs are formed at gaps 9 and 10. The arc formed at gap 10 remains at the point indicated, but the arc formed at gap 9, due to thermal action, rises along diverging conductors 6 and 7 to a point somewhere near gap 12, where it breaks, and being in series with the arc at point 10, both arcs are consequently broken. An arc is again formed at point 8, which is at that moment the lowest point of resistance in any of the gaps considered and the entire operation is again repeated. The advantage of electrode 7, in this particular illustration, is that it permits the word "Eat" to remain entirely lighted, after it has been spelled out letter by letter with electrodes 2, 3 and 4, until the arc formed at gap 9 breaks at the gap indicated near point 12. Terminal 27 of electrode 7 may be used for other combinations of circuit effects possible through the use of other circuits and apparatus and combinations of various arc switches.

The electrodes are surrounded by a container, 30, which may be secured to the insulating support, 5, and is made preferably of transparent material, whereby the rapidly ascending succession of arcs may be viewed, for their spectacular value. While the arc switch may be located at a distance from the sign, it is preferably closely associated therewith and, if mounted in such position as to be visible to observers of the sign, may be used to augment the spectacular effect of the latter.

Said container 30 is open at its upper and lower ends, as shown in Fig. 1, to permit an ascending column of air to flow therethrough. A damper, 29, is shown hinged at 28 to the top of said container, or otherwise adjustably secured thereto, whereby the speed of ascent of the arc, and hence of the cycle of operations, may be regulated—for example, by opening the damper more than in its position, shown in Fig. 1, the arcs ascend at a more rapid rate, causing the sign to flash more rapidly, and, by moving the damper in the reverse direction, the sequence of operations is retarded. The damper may be located at the lower end, instead of at the upper end, or a damper may be provided at each end.

One important advantage of my electrode arrangement is that the device operates at regular timed intervals. For example, where the shorter electrodes are all the same length, as in Fig. 1, and cooperate with a common electrode, the arc runs rapidly up the path provided, becomes extinguished and is reestablished immediately at the bottom, the circuits controlled by said shorter electrodes being closed for equal time intervals. If instead of providing four electrodes of the same length, it is desirable to provide five or six or any larger number of electrodes together with the common electrode, said additional electrodes of the same length as the others are merely added to the combination and the various circuits controlled by all of said electrodes remain closed for equal intervals of time. Conversely, the removal of any

uppermost electrode to provide for one less circuit, will not disturb the uniform time intervals referred to, although the cycle as a whole will require less time, assuming other conditions remain the same, such for example as the adjustment of the damper.

Fig. 3 illustrates a magnetically operated moving arc switch. The electrodes 1, 2, 3 and 4 may be similar to those described in connection with Fig. 1, and are arranged adjacent to the substantially vertical electrode 6, as previously described. The electrodes are surrounded by a container, 47, in this case of cylindrical form, and a coil of wire, 48, is located adjacent said cylinder, the ends of said coil being connected to terminals 49 and 50, of the same source of alternating current as that by which the device is operated, whereby a magnetic field may be created, tending to move the arc formed between the electrodes from the point where the arc gap is the smallest to a point where it approaches a maximum. After the arc breaks, it again reforms between the electrodes 1 and 6, as will be apparent.

Electrodes 1, 2, 3 and 4 may be connected to a neon sign and to a source of electrical energy, as illustrated in Fig. 1, or any other suitable apparatus may be operated by this magnetic moving arc switch. The rapidity of the switching action may be regulated by adjusting the current supplied to the coil, the arc movement being faster as the magnetic field becomes stronger, and vice versa, or, by holding the magnetic field constant, the speed of movement of the arc may be varied by varying the current flowing through said arc.

In the modification shown in Fig. 4, a plurality of electrodes, 52, 53, 54, 55 and 56, are arranged, one over the other, in staggered and overlapping relation but out of contact with each other, each electrode being inclined away from the electrode immediate opposite. The arc gap between the middle of electrode 52 and the lower end of electrode 53 is the shortest, the remaining arc gaps becoming progressingly longer. When the arc is first established at the lowermost gap, it closes the circuit from the transformer to the two lower electrodes without energizing any of the neon tubes or other current responsive devices connected thereto, but when the arc moves upwardly and establishes a circuit across electrodes 53, 54, transformer current flows through the letter E. The next higher arc gap controls the circuit to letter A on one side of the circuit and E on the other side, thereby illuminating both letters, and the uppermost gap in this instance controls the circuit through the letters T and E in series on one side and the letter A on the other side of the circuit, thereby illuminating the entire word, after which the arc extinguishes itself and is reestablished at the bottom gap. As explained in connection with Fig. 1, the arc gaps need not necessarily increase in length from the bottom to the top of the series.

The electrodes, which are shown diagrammaticaly in this figure, may be suitably supported in the wall of the container, 57 as in Fig. 5, the mounting in each case being either at the bottom or the top of the electrode. In fact, in the other forms of invention illustrated in Figs. 1 and 3, also, the electrodes may be supported either at the top or bottom thereof. Furthermore, the short electrodes need not necessarily be mounted in a plane passing through the long electrode but may be inclined with reference to said plane.

In the general application of the container, or enclosure, shown in the several figures of the drawing, the same may be sealed, evacuated and filled with various inert or other gases, particularly in conjunction with the magnetic and electrostatic type of switches. Also, said container may be treated with fluorescent substances to produce a luminous glow, in various colors and degrees, visible to the eye, thereby adding to the display value of the equipment. This latter feature is particularly applicable to the transparent, or partially open, opaque container or enclosure, or such other material used in constructing said container as would pass such rays of the arc as to cause the fluorescent material to glow. Fluorescent treated objects, designs, or the like, may also be placed in or about the container to create many novel effects, all contributing to the spectacular and display value of the equipment.

The proper length of the various arc gaps is dependent on the resistance of the circuits with which the electrodes are connected, said resistance including, in the forms illustrated, the resistance of the neon tubes.

It is an inherent function of neon tubes and other gaseous tubes, as is well known, that the resistance of the same is relatively high and requires a high voltage to break down said resistance and establish a circuit. During the alternations of an ordinary commercial alternating circuit, the transformer voltage has to build up sufficiently to break down the resistance of the tube, after which a circuit is established and current flows until the voltage decreases below the point sufficient to maintain said current flow. No current flows, from this point during the reversal of the cycle, until the voltage during the succeeding half cycle builds up to a point sufficient to break down the resistance, after which current flows for a short interval of time and the operation is repeated during each half cycle. During the operation of the arc switching device described herein, the arc path switches from one circuit to another between the half cycle periods when no current is flowing. Said arc first establishes itself across a gap between the first electrode

and the common electrode after which the arc moves to such a position that a path of lesser resistance for the operation of the arc is created between the common electrode and the second circuit electrode. Just as this condition is established, the arc discontinues the circuit between the common electrode and the first electrode directly following the interruption of current flow of the last half cycle of the alternating current supply. During the next half cycle when sufficient potential is established, current flows from the common electrode to the second circuit electrode.

The method of switching in this manner, by means of an arc, will be claimed in a separate application.

I claim:

1. An arc switch comprising an insulating support, a series of electrodes passing therethrough at successive points thereon and a common electrode also carried by said support, arranged adjacent said first electrodes and diverging therefrom, said first electrodes being adjustable with respect to said common electrode.

2. An arc switch comprising a substantially vertical electrode having a circuit terminal, a series of shorter electrodes arranged substantially in vertical alignment in spaced end to end relation but divergent with respect to said first electrode, each of said shorter electrodes having an independent circuit terminal whereby an arc established between said first electrode and the nearest point on one of said shorter electrodes will travel upwardly along said first electrode and close the successive independent circuits from the common circuit terminal to the circuit terminals of said shorter electrodes, a casing enclosing said electrodes and means providing a variable opening in said casing to regulate the rate of travel of said arc.

3. An elongated arc switch comprising an insulating support, a series of electrodes passing therethrough at successive points thereon and each having a portion arranged nearly parallel to said support, a common electrode also carried by said support and arranged adjacent said first electrodes and extending along the same at gradually increasing distances from one end to the other, a casing secured to said insulating support and enclosing said electrodes but open at its ends, and a hinged closure at one end for varying the effective size of the opening.

4. The combination with an arc switch having a long electrode, a series of shorter electrodes diverging from said long electrode and arranged throughout the length of said long electrode at increasingly greater distances therefrom, of a series of current responsive devices, circuits therefrom to a source of current and to said shorter electrodes, and a circuit from said long electrode to said current source to permit an arc to be established between said long electrode and said shorter electrodes seriatim to close and open certain of said circuits.

5. The combination with an arc switch, having a long, substantially vertical electrode, a series of shorter electrodes diverging from said long electrode and arranged throughout the length of said long electrode at varying distances therefrom, of a plurality of gaseous discharge tubes such as neon tubes connected in series with each other, a source of high potential including a transformer the end tube of the series being connected to one terminal of the secondary of said transformer, the other end tube of the series being connected to the end electrode of said series of shorter electrodes, the electrode at the other end of said shorter electrode series being connected also to said terminal of said transformer secondary, and a circuit from said long electrode to another terminal of said transformer secondary to permit an arc to be established between said long electrode and said short electrodes, one after the other, to close and open certain of said circuits.

6. The combination with an arc switch, having a long, substantially vertical electrode, a series of shorter electrodes diverging from said long electrode and arranged throughout the length of said long electrode at increasingly greater distances therefrom, of a plurality of gaseous discharge tubes such as neon tubes connected in series with each other, the end tube of the series being connected to one secondary terminal of a transformer, the other end tube of the series being connected to the end electrode of said series of shorter electrodes, connections from points intermediate said tubes to other of said shorter electrodes, a circuit from said long electrode to another secondary terminal of said transformer to permit an arc to be established between said long electrode and said shorter electrodes seriatim to connect said tubes in circuit one after the other, a casing for said electrodes to exclude disturbing air currents, and means permitting a regulated flow of air therethrough to control the rate of travel of said arc.

7. An arc switch comprising a plurality of electrodes mounted one over the other in staggered and overlapping relation, but out of contact with each other, and each inclined away from the adjacent electrodes, supply circuit terminals for the two lower electrodes and terminals for the remaining electrodes permitting connections therefrom to an adjacent electrode through a current responsive device.

8. In an arc switch, a series of substantially aligned electrodes, a common electrode arranged adjacent said series of electrodes and extending along the same at varying distances

from one end to the other, and another electrode adjacent said common electrode and also diverging therefrom with the one end within arcing distance of said common electrode and the other end within arcing distance of the end electrode of said series of electrodes.

9. A flashing device comprising a plurality of illuminating units, a source of high tension current for said units, a circuit connecting each unit to said source, a pair of electrodes in series in each circuit, and having an ascending gap between them which widens as it ascends, said pairs of electrodes being arranged end to end but slightly spaced apart with the lower ends of each pair above the lowermost pair disposed within the field of the spark jumping the gap between the upper ends of the next lower pair, the gap between the lower ends of the lowermost pair of electrodes being the smallest of all, whereby a spark will jump the gap at the lower ends of the lowermost pair of electrodes and close the circuit of that pair, and then travel upwardly from pair to pair and closing the circuits in succession.

10. A flashing device, comprising a plurality of illuminating units, a source of high voltage current, an individual circuit connecting each unit to said source, a pair of electrodes in series in each circuit, and an ascending passage in which said pairs of electrodes are arranged end to end with a slight space between adjacent ends of the pairs of electrodes, whereby a spark jumping the gap between the electrodes of the lowermost pair will ascend in said passage from pair to pair and close said circuits in succession.

11. A flashing device, comprising a plurality of illuminating units, a source of high voltage current, an individual circuit connecting each unit to said source, a pair of electrodes in series in each circuit, an ascending passage in which said pairs of electrodes are arranged end to end with a slight space between adjacent ends of the pairs of electrodes, whereby a spark jumping the gap between the electrodes of the lowermost pair will ascend in said passage from pair to pair and close said circuits in succession, and means for regulating the flow of ascending air in said passage to vary the rate of travel of said spark.

12. An arc switch comprising an insulating support, a series of electrodes carried thereby and a common electrode also carried by said support and arranged adjacent said first electrodes and diverging therefrom, said first electrodes being adjustable with respect to said common electrode.

13. The combination with gaseous tubes having an inherently high resistance corresponding to that of an open circuit, of a source of alternating current having a voltage sufficient to break down said resistance and establish a circuit through said tubes during each half cycle of said alternating current and continuing for a plurality of cycles, and means for switching the circuit connections from one of said gaseous tubes to another concurrently with changes from one half cycle to another, said means comprising a common electrode, a support therefor and a plurality of electrodes also mounted on said support adjacent said common electrode and diverging therefrom.

14. The combination with gaseous tubes having an inherently high resistance, of a source of alternating current having a voltage high enough to break down said resistance and establish circuits through said tubes during each half cycle of said alternating current, and non-contacting electrodes in circuit with said tubes and said high voltage source and located to permit an arc to close said circuits, and the arc path to switch the circuit connections from one of said tubes to another during the period between half cycles when no current is flowing.

In testimony whereof I hereunto affix my signature.

WESLEY P. HEALY.