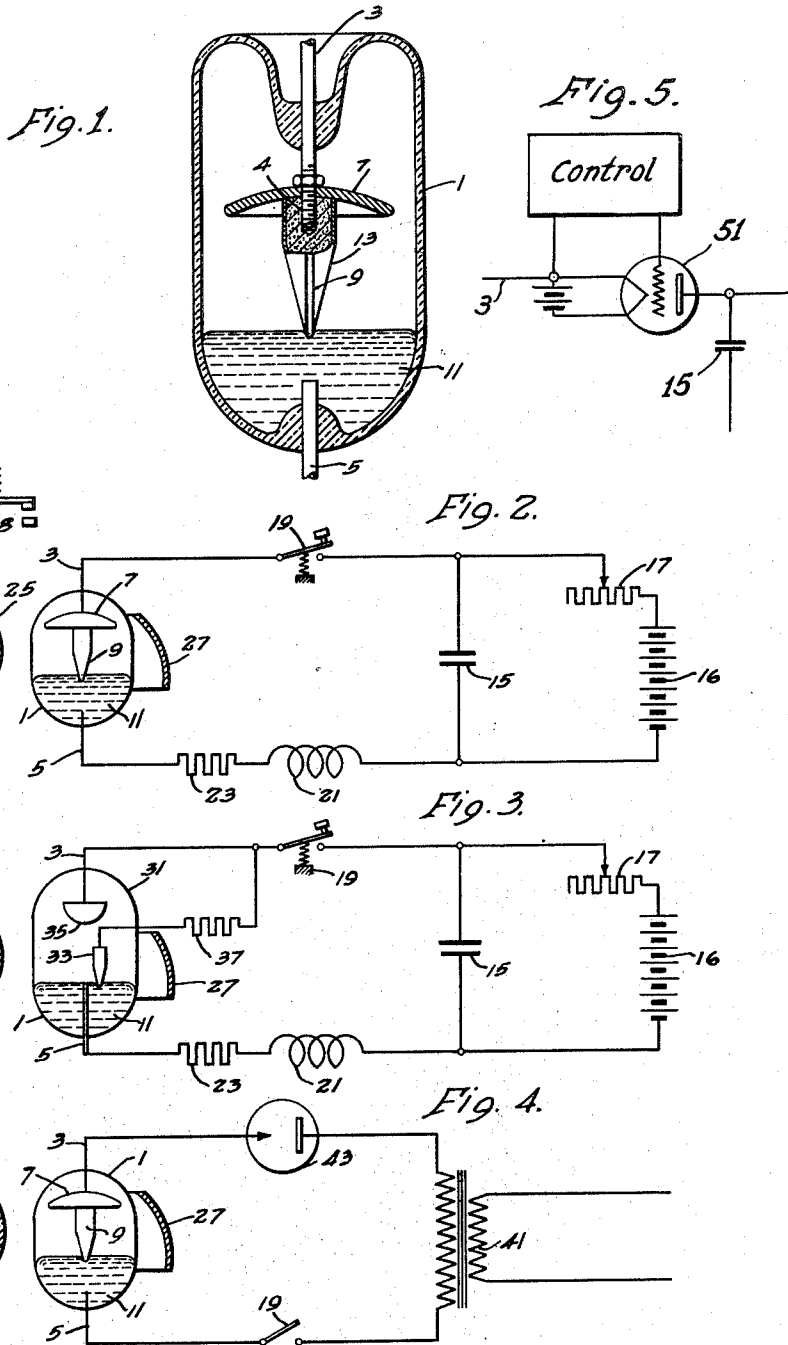


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W. E. BERKEY
ELECTRIC DISCHARGE APPARATUS

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WITNESSES:

Michael Stark
Wm. C. Groome

INVENTOR

William E. Berkey.

BY

F. M. Syle.
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRIC DISCHARGE APPARATUS

William E. Berkey, East Pittsburgh, Pa., assignor
to Westinghouse Electric & Manufacturing
Company, East Pittsburgh, Pa., a corpora-
tion of Pennsylvania

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My invention relates to electric discharge apparatus and it has particular relation to discharge apparatus for signalling purposes.

Various systems have heretofore been used for producing and transmitting light signals. In one of the most widely used signalling systems a hand-controlled shutter or a rotating disc is moved in the path of a beam of light. The efficiency of such an arrangement is low since it requires that the light be operated at full brilliancy all of the time.

Other prior art systems of which I am aware have similar efficiency limitations or are complicated in structure and difficult to operate.

It is accordingly an object of my invention to provide signalling apparatus of simple and inexpensive structure that shall operate efficiently.

Another object of my invention is to provide a source for signalling purposes that shall be capable of emitting radiations of high intensity and a circuit to control the source.

An incidental object of my invention is to provide a simple and inexpensive discharge device particularly adapted to signalling purposes.

An ancillary object of my invention is to provide a source which may be used for photography of fast moving objects or for conversion of light impulses into electric impulses in conjunction with a photo-cell.

In accordance with my invention I provide an electric discharge device for signalling purposes which comprises an evacuated envelope having disposed therein at least one electrode composed of mercury or other metal capable of emitting electrons when excited. A collecting electrode cooperates with the emitting electrode and a starting electrode composed of boron carbide, silicon carbide or other resistant material is supported from the collecting electrode and is in contact with the emitting electrode. When a current is transmitted through the starting electrode and the emitting electrode, a discharge is initiated and a comparatively heavy current is transmitted between the emitting electrode and the collecting electrode.

Since the starting electrode is composed of material having a high resistivity as compared to the effective resistance of the arc path, the arc will bridge the starting electrode and the flow of starting current through the starting electrode will be substantially decreased.

The novel features that I believe to be characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and

its method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a sectional view showing a discharge device constructed according to my invention;

Fig. 2 is a diagrammatic view showing an embodiment of my invention;

Fig. 3 is a diagrammatic view showing a modification of my invention; and

Fig. 4 is a diagrammatic view showing another modification of my invention.

Fig. 5 is a partial diagrammatic view illustrating the use of a grid-controlled tube.

The apparatus shown in Fig. 1 comprises an evacuated envelope 1 provided with a plurality of lead-in wires 3 and 5. The envelope 1 may be constructed of glass or quartz or other transparent material, or it may be constructed of metal having a transparent opening or window. One of the lead-in wires 3 is threaded at the end 4 that projects into the envelope 1.

A disc 7 having the form of a spherical sector and provided with an opening at its center is slipped over the threaded end 4 of the wire 3. The disc 7 operates as an anode. One end of the starting electrode 9 is placed in direct contact with anode 7 by fastening it over the threaded end of the lead-in wire 3. The other end of the starting electrode 9 is in contact with a pool of mercury 11 which functions as a cathode.

The starting electrode 9 is ordinarily a bar of boron carbide, although other resistant material such as silicon carbide may be used. The pool of mercury which comprises the cathode 11 may be replaced by a solid metal such as tin. Mercury, however, has an advantage as cathode material in that the metal vaporized by the discharge will run back down the walls of the envelope 1. The lower end of the starting electrode 9 is coated with some insulating material 13 such as silica paint or glass. When a current of predetermined magnitude flows through the starting electrode 9 to the cathode, an arc is initiated. To confine the arc to a certain spot, a portion of the lower end of the starting electrode 9 is left uncoated.

Hereafter, I shall use the expression "cathode (or electrode) of the mercury type" meaning thereby not only a mercury cathode but also a cathode of metal such as tin may be used. I shall also use the expression "starting electrode" meaning thereby a bar of boron carbide or any material of high resistivity such as silicon carbide

which may be utilized for the purpose of my invention. It is to be further understood that when the expression "high resistivity" is used, it means that the resistance of the material composing the starting electrode 9 is high relative to the effective resistance of the arc path.

In the apparatus shown in Figure 2, a capacitor 15 is provided and it is charged by a battery 16. In series with the battery 16 is a variable resistor 17 which limits the charging current and hence determines the time which it takes the capacitor 15 to charge to full voltage. Thus, for a given battery voltage, the time it takes for the capacitor 15 to reach 63% of the battery voltage is expressed mathematically by the following equation $t=RC$ where R is the current limiting resistance 17 and C is the capacity of the capacitor 15.

The upper plate of the capacitor 15 is connected to one terminal of a switch 19 which is in the usual practice of my invention a telegraph key, although a grid-controlled tube 51 as shown in Fig. 5 may be used. The key 19 when depressed, connects the upper plate of the capacitor 15 to the discharge device 1. The current then flows through lead-in wire 3 to the anode cap 7, passes through the starting electrode 9 which is in contact with the anode 7 to the cathode 11. The current may be of the order of several thousand amperes and persisting for only a few micro-seconds produces a discharge at the junction of the starting electrode 9 and the cathode surface 11.

The capacitor 15 may be an electrolytic condenser with capacity ranging from 1 to 100 microfarads. The inductance 21 and resistance 23 together with the capacitor 15 determine the discharge character. In many cases where a very short time light impulse is desired, the resistance 23 and inductance 21 may be only the circuit lead resistance and distributed inductance inherent in the leads. The current producing the discharge determines the amount of light emitted by the lamp. Thus, for a very intense light, a discharge of several thousand amperes for a few micro-seconds may be used. For a practical case, the arc drop may be 20 volts or less, the starting voltage 50 volts, the capacitor or battery voltage 100 volts or more. When the arc bridges the starting electrode 9, as heretofore described, the surge impedance of the circuit may be .05 ohm or less permitting a flow of several thousand amperes for a few micro-seconds.

The illumination from the arc formed may be confined to one spot by shielding the starting electrode 9 over all but the desired spot. By the aid of a suitable lens 25 and reflector 27, the light from the cathode spot may be reflected, condensed or otherwise directed to form a large or small or concentrated or diverged beam of light. The light may be of a single pulse persisting for only a fraction of a micro-second, or it may be of an oscillatory nature with repeating flashes. By repeating the condenser discharges so as to produce 30 or more light flashes per second, the light signals may be made to appear steady. Any known standard type of receiving apparatus 28, for example a photocell, may be used to pick up the light flashes through an amplifier 29 and then transformed to impulses of an electrical nature.

While I do not wish to confine myself to any specific circuit or apparatus, one must bear in mind that other circuits may be used with an equal degree of satisfaction. Fig. 3 of the draw-

ing shows one modification of my invention using the standard Ignitron tube 31. It is to be noted that the starting electrode 33 is disconnected from the anode 35. A resistor 37 is inserted in series with the starting electrode 33 and limits the discharge current. When the key 19 is closed, current flows from the positive side of the condenser 15 through the igniter electrode 33 to the cathode 11, and to the negative terminal. The sum of the igniter resistance and the resistance 37 must be low enough to permit the flow of sufficient current through the igniter electrode 33 to start the tube. The remainder of the circuit and mode of operation is substantially the same as in the previous described circuit.

The circuit shown in Fig. 4 may be utilized when an alternating source of current is used. Power is supplied from a suitable transformer 41 and a rectifier 43 converts the alternating current into direct current which flows to the lead-in wire 3 thence to the discharge device which is constructed according to my invention. The discharge device 1 also acts as a rectifier and assists in the rectification of the current.

While I have illustrated but one form of device for carrying my invention into effect, and have indicated in a diagrammatic way several circuit connections for utilizing my invention, it will be apparent to those skilled in the art that my invention is by no means limited to the particular device or circuit arrangements shown, but that many modifications in the form of the apparatus used, as well as in the circuit arrangements employed, may be made without departing from the scope of my invention.

I claim as my invention:

1. In combination, an electrical discharge device comprising a cathode composed of metal capable of emitting electrons, a bar of high resistant material, an electrode mounted to cooperate with said cathode, said bar being suspended from said electrode in such manner that it contacts said cathode and a control circuit for said discharge device including a capacitor, means for charging said capacitor, and means for discharging said capacitor through said bar to form an intense arc on the surface of said cathode.

2. In a signalling system for the transmission and reception of light waves, a transmitting arrangement comprising an electric discharge device including an anode, a cathode and a bar of high resistant material having one end supported from and in electrical contact with said anode and the other in contact with said cathode, a power supply for energizing said device including a control circuit and a capacitor capable of producing a discharge through said bar to form a radiant-energy emission spot on the surface of said cathode.

3. In a signalling system for the transmission and reception of light waves, a transmitting arrangement comprising an electric discharge device having a plurality of principal electrodes, one of which is of the mercury type, a starting electrode in electrical contact with, and supported by, one of said principal electrodes and adjacent to said mercury type electrode for initiating a discharge, means for storing electric charges, means for charging said storing means, and means for discharging said storing means after having been charged including said starting electrode and said mercury electrode whereby a pulse of current is transmitted therethrough to form a luminous spot on the surface of said mercury electrode.

4. In combination, an electric discharge device including an anode, a cathode of the mercury type and a bar of high resistant material having one end supported from and in electrical contact with said anode and the other in contact with said cathode, an alternating-current source and means for connecting said source between said anode and cathode, the last said means including current rectifying means.

5. In combination, an electric discharge device of the immersed ignition-electrode type including an anode, a cathode and a starting electrode permanently conductively connected to said anode and immersed in said cathode, a control circuit connected between the starting electrode and the cathode comprising an inductive reactance and a capacitor, and means for charging the said capacitor.

6. In combination, an electric discharge device including an anode, a cathode and a starting electrode in electrical contact with and supported by the anode, a control circuit connected between the anode and the cathode comprising a capacitor and an inductive reactance connected in series, and means for charging the said capacitor.

7. In combination, an electric discharge device including an anode, a cathode of the mercury type and a starting electrode of high resistant material having one end permanently conductively connected to said anode and the other end in contact with said cathode, and a control circuit connected between said starting electrode and said cathode, said control circuit including an inductive impedance and means for impressing an intermittent potential upon said starting electrode.

8. In combination, an electrical discharge device comprising a cathode of the mercury type, an anode, a starting electrode coated on its outer surface with shielding material over all but a minor portion thereof, said starting electrode being electrically connected to and suspended from said anode in such manner that it contacts said cathode, a control circuit connected between the anode and the cathode comprising a capacitor and an inductive reactance connected in series, means for charging said capacitor, and means for discharging said capacitor including another discharge device having a plurality of principal electrodes whereby a discharge is initiated through said starting electrode to form an intense arc on the surface of said mercury cathode.

9. In combination, an electric discharge device of the immersed-ignition-electrode type including an anode, a cathode of the mercury type, and an ignition electrode permanently conductively connected to said anode and associated with said cathode, a capacitor connected to discharge through the ignition electrode and also between the anode and cathode, and means for charging the said capacitor.

10. In combination, an electric discharge device of the immersed-ignition-electrode type including an anode, a cathode of the mercury type and an ignition electrode permanently conductively connected to said anode, a capacitor connected between the anode and the cathode, means for discharging the capacitor through the ignition electrode, the last said means including a circuit closing and opening device interposed in the circuit between the ignition electrode and the capacitor, and means for charging the capacitor.

11. An electric discharge device for transmitting light signals, the said device having a plurality of principal electrodes, one of which is of the mercury type, a starting electrode in permanent electrical contact with said principal electrodes for initiating a discharge, means for storing electric charges, means for charging said storing means, and means for discharging said storing means after having been charged including said starting electrode and said mercury electrode whereby a pulse of current is transmitted therethrough to form a luminous spot on the surface of said mercury electrode.

12. An electrical discharge device for transmitting light signals, the said device having a cathode of the mercury type, an anode, and a starting electrode coated on its outer surface with shielding material over all but a minor portion thereof, said starting electrode in permanent electrical contact with said anode and cathode, and means for supplying a current through said starting electrode to initiate an arc and form an intense spot on the surface of said mercury cathode in the region of said minor portion.

13. In a system for transmitting light impulses of high intensity and predetermined duration, an electric discharge device having anode, cathode and a starting electrode supported by said anode and in electrical contact with both said electrodes, a power supply for energizing said device, circuit elements including means for producing positive pulses of current, and switching means for initiating and controlling flow of said current between electrodes of said device and said supply.

14. In combination, an electrical discharge device having a cathode of the mercury type, an anode and an igniting electrode coated on its outer surface with insulating material over all but a minor portion thereof, said electrode being electrically connected to and suspended from said anode in such manner as to contact said cathode, a circuit for energizing said device including a power supply, means for producing positive pulses of current and circuit elements for controlling the initiation and duration of said current pulses.

WILLIAM E. BERKEY.