

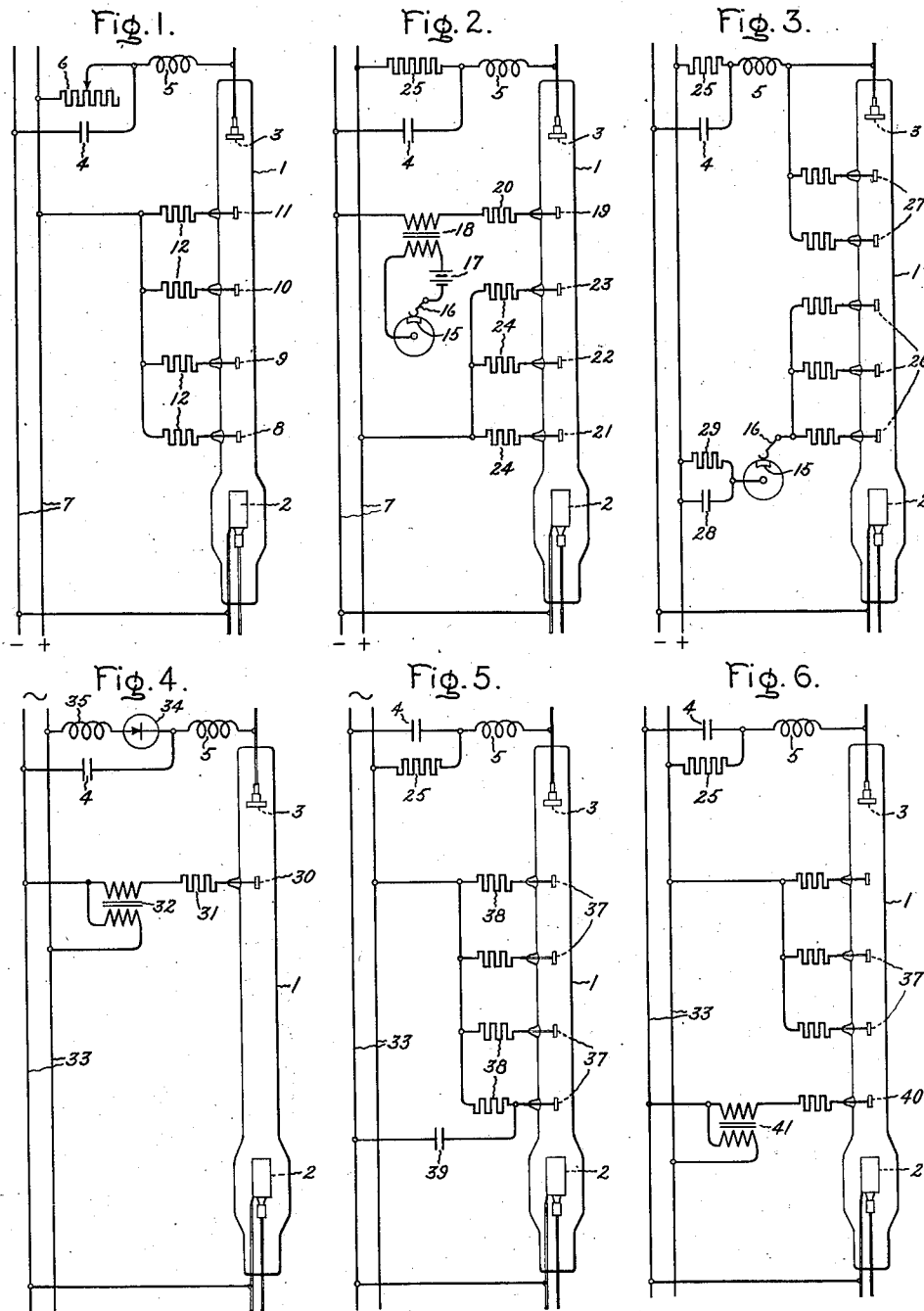
Sept. 17, 1935.

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2,014,957

STROBOSCOPIC APPARATUS

Filed June 10, 1931



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UNITED STATES PATENT OFFICE

2,014,957

STROBOSCOPIC APPARATUS

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Application June 10, 1931, Serial No. 543,481

5 Claims. (Cl. 176-124)

My invention relates to stroboscopic apparatus and particularly to stroboscopic apparatus of that type in which light flashes are produced by the periodic operation of a light source. It is the object of my invention to provide an improved apparatus of the above mentioned type which is operable from a source of low voltage, which shall have high illuminating power during the short intervals of illumination and which is simple, efficient and reliable.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the drawing, Fig. 1 is a diagram illustrating one embodiment of my invention adapted for operation from a direct current source and in which the frequency of the flashes is controlled by the circuit; Figs. 2 and 3 illustrate modified forms in which the frequency of the flashes is controlled by a contact device; Figs. 4, 5 and 6 illustrate modifications which are adapted for operation from a source of alternating current the frequency of the current determining the flash frequency.

In its more essential features the stroboscopic apparatus which I have devised comprises a positive column discharge lamp having main and auxiliary electrodes, a condenser arranged to be charged from a low voltage source and to discharge through the lamp supplying the operating current therefor and various control devices for regulating the instant at which the lamp is operated and the number of operations per second. The positive column discharge lamp 1 comprises a suitable transparent envelope such as glass or quartz of tubular form and containing a gas or vapor, for example, argon, neon, helium, krypton, xenon, mercury, or sodium, or suitable gaseous mixtures. At one end of the envelope is the cathode 2 preferably a hot or thermionic cathode and at the opposite end the main anode 3. For supplying the operating current to the lamp 1, I provide the capacitor 4 which connects through the inductance 5 with the main anode 3 and with the cathode 2 whereby the discharge of the capacitor supplies current to cause a flash operation of the lamp. The capacitor 4 whose value may for example be from 1 mf. to 100 mf. depending upon the amount of light desired from the lamp is charged by being connected through the variable resistor 6 with the source 7 of direct current of low voltage. Throughout the specification and claims in this case it is to be understood

that by low voltage I refer to voltages of the order of 110 or 220 volts.

Because of the length of the lamp 1 a voltage of the order of 2000 volts might be required to start the discharge between the cathode and the main anode. To reduce the voltage required for the starting of the lamp to that which may be obtained from the low voltage source 7, I provide the lamp 1 with one or more auxiliary anodes 8, 9, 10 and 11 and I connect these auxiliary anodes through suitable resistances 12 with the same side of the source 7 as that to which the main anode 3 is connected. Resistances 12, for example, may have a value of 2000 ohms for each of the anodes 8 and 9, 1000 ohms for anode 10, and 500 ohms for anode 11. Because of the high resistances between the auxiliary anodes and the source of current the discharge in the tube between the auxiliary anodes and the cathode is not sufficient to produce a luminous effect. However, the tube is maintained in an ionized condition for a sufficient part of its full length so that as soon as the capacitor 4 reaches a predetermined condition of charge, the voltage applied to the main anode is sufficient to start the tube into luminous operation. Thus, for example, by the use of the auxiliary anodes a voltage of approximately 70 volts only need be applied between the cathode and main anode to produce the full operation of the lamp. The positive column discharge lamp which I have illustrated on the drawing and described above is described and claimed in U. S. Letters Patent No. 1,958,239 to Found and Westendorp dated May 8, 1934.

In the operation of that form of my invention shown by Fig. 1, the capacitor 4 alternately receives a charge from the direct current source 7 through the variable resistor 6 and discharges through the inductance 5 and the lamp 1. The duration of the flash is determined by the inductance and the capacitance of the discharge circuit, the discharge current being approximately a half sine wave. Although on the drawing I have shown the inductance element 5, I have found that in certain cases I may obtain sufficient inductance from the circuit loop by which the capacitor 4 is connected to the main electrodes of the lamp. The frequency of operation of the lamp may be controlled within certain limits by the adjustment of the variable resistor 6. In discharging through the lamp, the capacitor 4 will discharge to a negative potential on account of the constant resistance of the lamp and the inductive reactance of inductance 5 in the discharge circuit whereby it will be seen that a

greater quantity of electricity is drawn from the capacitor, resulting in a somewhat longer period of illumination of the lamp. The illumination periods, however, are very short in comparison with the intervening dark periods.

In the form of my invention shown in Fig. 2 the frequency of operation of the lamp is controlled by means of relatively movable contacts, for example, the rotary contact 15 cooperating with the fixed contact 16. In circuit with these contacts is shown the battery 17 and the primary of the transformer 18 whose secondary connects with the negative side of the source of supply and with auxiliary anode 19 through the resistance 20. The other auxiliary anodes 21, 22 and 23 connect through suitable resistances 24 with the positive side of the source of supply which resistances may have the same values as the corresponding resistances of Fig. 1. The main anode in this case connects with the positive side of the source through the fixed resistor 25. It is to be noted that the energy which the transformer needs to deliver to the auxiliary anode 19 is very small and that the movable contact 15 may be mounted, for example, directly on the shaft of a machine being studied in which case synchronism is automatically secured. By shifting the contact 15 around the shaft in such a case it is very easy to cause the flash to come at any instant of the rotation. As in the form shown by Fig. 1, auxiliary anodes 21, 22 and 23 serve to ionize the tube in the region thereof but due to the resistances 24 in circuit therewith the illumination from the discharge is negligible. As soon as auxiliary anode 19, however, is made operative by the impulse from transformer 18 at the separation of contacts 15 and 16 the ionization is carried on up to the main anode and the lamp becomes luminous.

The modification shown by Fig. 3 is similar in certain respects to that shown by Fig. 2. In this figure the rotatable contact is connected directly with the lower three auxiliary anodes 26 while the upper two auxiliary anodes 27 connect with the main anode 3. To reduce sparking at the contacts I have shown the capacitor 28 and resistor 29 in circuit therewith. It will be noted that in this form of my invention the starting of the lamp is determined by the closing of a circuit rather than the breaking of a current. Hence the instant of starting will always be in the same phase position and not dependent upon the formation of a spark. In this case, as soon as auxiliary anodes 26 are energized by the closing of the circuit at contacts 15 and 16, the ionization is carried up to auxiliary anodes 27.

The modification illustrated by Fig. 4 is for operation from an alternating current source, which for example, may be 110 V. 60 cycles. In this form of my invention, I have shown the lamp 1 having a single auxiliary anode 30 which connects through resistor 31 with the secondary of the transformer 32, the primary of this transformer being connected across the source of alternating current supply 33. I have shown the circuit by which the capacitor 4 is charged from the supply 33 as including the rectifier 34 and the inductance 35. If desired the rectifier 34 and the inductance 35 may be omitted and a resistance substituted therefor; however, in that case an undesirable loss of heat may occur in the resistance. The transformer 32 by which the auxiliary anode is supplied is constructed to step up the voltage of the supply circuit. Close to the peak of the voltage wave applied to the auxiliary

anode a discharge between the cathode and this anode will start and will draw a very small current. This current, however, will cause the main discharge to occur between the cathode and the main anode 3, such a discharge being supplied from the capacitor 4. This operation occurs once every cycle as the lamp conducts only in one direction. If desired, the transformer 32 may be of some well known special design to produce a peaked secondary voltage wave which may be found more satisfactory for determining the exact instant of the starting of the lamp.

In the modified form shown by Fig. 5, I employ no higher voltage than that of the source of alternating current supply 33 which, for example, may be 110 V. In this case all four of the auxiliary electrodes 37 connect through suitable resistances 38 with one side of the supply circuit. In this case, however, the first of the auxiliary anodes 37 is retarded a slight amount by connecting the capacitor 39 between it and the cathode. As a result of this arrangement the starting of the lamp is less dependent upon the wave shape of the voltage source.

In the modification comprising Fig. 6, I have shown an arrangement for accomplishing a similar result. In this case the first auxiliary electrode 40 is energized by being connected to the secondary of transformer 41 which is constructed to give a peaked secondary voltage wave. The transformer 41 thus puts a voltage peak on the auxiliary electrode 40 in a definite part of the cycle and thus starts the operation of the lamp always in the same phase position. If desired, the secondary of the transformer 41 may also be connected to one or more of the other auxiliary anodes 37.

While I have not described the auxiliary anodes of the various modifications as having any particular form or shape, it will be understood that at least the first auxiliary anode, or the one nearest to the cathode, preferably is in the form of a ring arranged at right angles to the axis of the tube, such a construction being shown and described in the aforementioned copending application of Clifton G. Found and myself. It will also be understood that various other means may be employed to cause the discharge to progress up the tube from an auxiliary anode. I may even dispense with any means other than a single auxiliary anode and depend upon a small amount of argon mixed with the gas in the tube.

I have chosen the particular embodiments described above as illustrative of my invention and it will be apparent that various other modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A stroboscopic apparatus comprising a low voltage positive column lamp having a thermionic cathode, a main anode and an auxiliary anode, a capacitor having a discharge circuit connected with said cathode and main anode for supplying the operating current to the lamp, means including a resistor for connecting the capacitor with a source of low voltage alternating current and a transformer excited from said source having its secondary connected with said auxiliary anode.

2. A stroboscopic apparatus comprising a low voltage positive column lamp having a thermionic cathode, a main anode and an auxiliary anode, a capacitor connected to be charged from a source

of low voltage and having connections with the cathode and main anode for supplying the operating current to the lamp and a device operable intermittently to connect the auxiliary anode with said low voltage source.

5 3. A stroboscopic apparatus comprising a low voltage positive column lamp having a thermionic cathode, a main anode and a series of auxiliary anodes arranged therebetween, a source of low
10 voltage, a capacitor connected to be charged from said source of low voltage and having a connection with the cathode and main anode for supplying the operating current to the lamp and a rotatable contact device operable to connect in-
15 termittently said source with said auxiliary anodes.

4. A stroboscopic apparatus comprising a positive column discharge lamp having a main anode and a thermionic cathode arranged at opposite
20 ends thereof, a capacitor connected with said anode and cathode for supplying the operating

current to the lamp, a plurality of starting anodes in said lamp arranged in spaced relation between said cathode and main anode and means for supplying a voltage to said capacitor for charging the same and to said cathode and starting anodes, said voltage being insufficient to initiate
5 a discharge in said lamp between the cathode and main anode.

5. A stroboscopic apparatus comprising a positive column discharge lamp having a main anode and a thermionic cathode arranged at opposite
10 ends thereof and having an intermediate starting anode, a capacitor connected with said main anode and cathode for supplying the operating current to the lamp, a source of voltage insufficient to initiate a discharge between said main
15 anode and cathode, means for supplying said voltage to said capacitor for charging the same and means including a resistor for supplying said voltage to said starting anode and cathode.

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