Oct. 25, 1955 J. NESSEL 2,721,959

APPARATUS FOR PRODUCING FLASH ILLUMINATION

Filed March 16, 1953

Fig. 1.

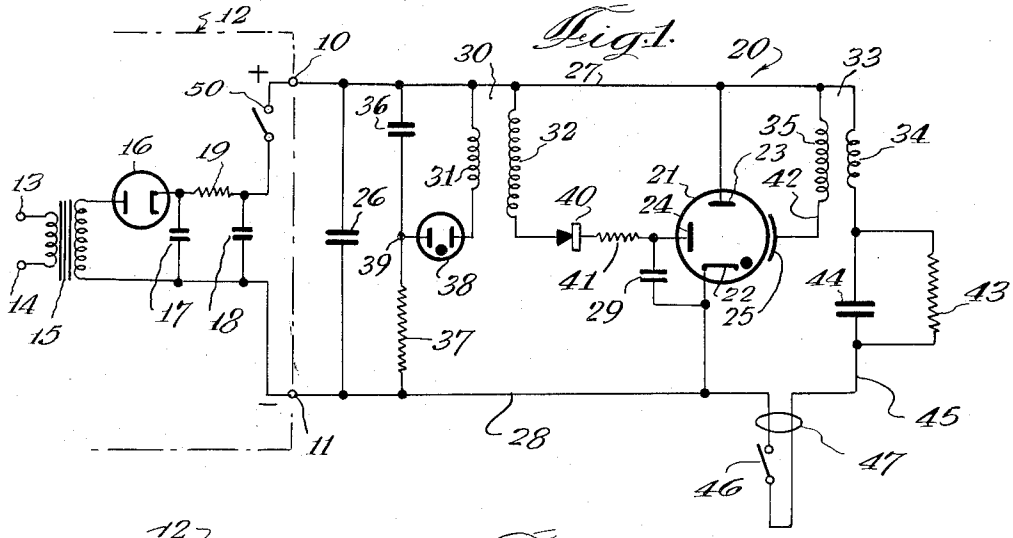


Fig. 2.

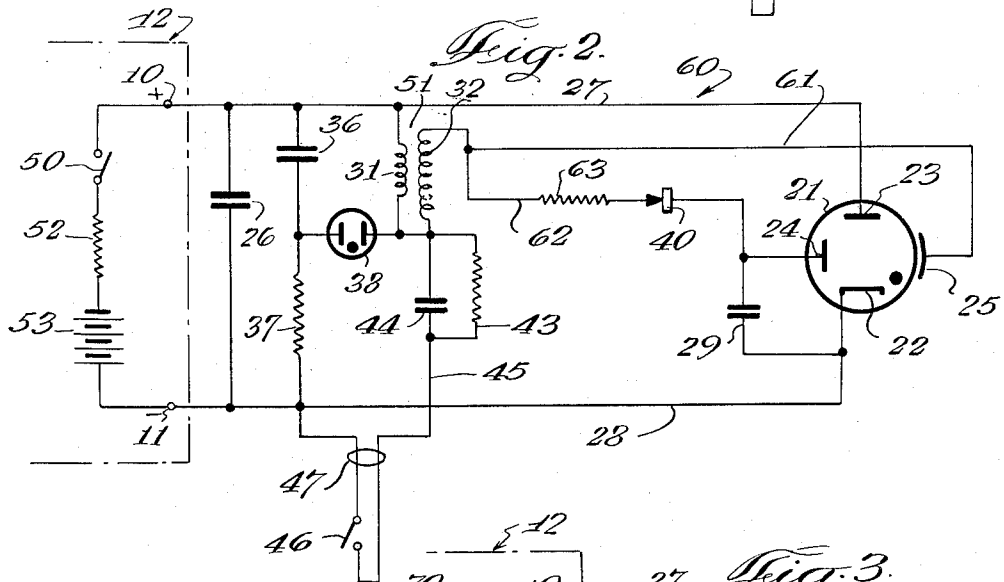
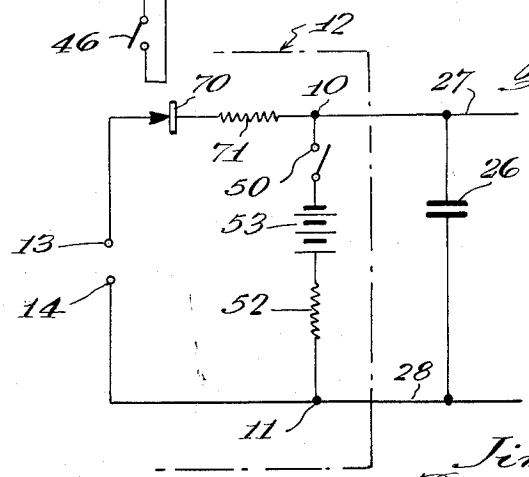


Fig. 3.



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APPARATUS FOR PRODUCING FLASH ILLUMINATION

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16 Claims. (Cl. 315—234)

This invention relates generally to apparatus for obtaining a flash of high intensity for purposes of illumination and more specifically is directed to apparatus utilizing the sudden discharge of a gaseous discharge tube for photographic purposes.

This application is a continuation-in-part of my co-pending application entitled "Device for Producing Electric Flash Light," Serial No. 319,498, filed November 8, 1952.

The use of the so-called photo-flash devices by photographers has been limited to a great extent heretofore for a variety of reasons, including their high cost, large size and heavy weight, all of these disadvantages occasioned by reason of inefficient circuits heretofore used.

In my co-pending application I described apparatus which utilized a gaseous discharge tube having a cathode and an anode and intermediate third electrode. I have found that the discharge of such a gas discharge device may consist of two parts with proper circuit constants. The first part of the discharge is a high voltage, low energy phenomenon, while the second part is a relatively lower voltage phenomenon absorbing a considerably greater amount of energy than utilized in the first phase of discharge. In the apparatus of my co-pending application I provided two separately energized condensers, one being a relatively low voltage condenser charged by means of a source of D. C. such as for example, a battery of relatively low voltage but high current capacity. This condenser was connected across the gaseous discharge device between the cathode and anode. The second condenser was a considerably smaller condenser but capable of assuming a high charge so that it could be charged by means of a low energy high voltage battery.

Utilizing well known means for igniting the gaseous discharge tube, that is initiating the ionization within the tube, the first phase of discharge was provided by the high voltage condenser which was connected between the third electrode and the cathode. The second phase of discharge was provided by the lower voltage condenser.

By means of this construction I was enabled to utilize cheap and relatively small batteries of the dry type. In addition to this advantage which decreased the weight and size of the apparatus, inasmuch as the tube was subjected to high voltage and low energy for a small portion of the discharge I was enabled to utilize a considerably smaller and hence more economical tube.

The present invention utilizes the same principles, that is, the initial high voltage low energy pulse followed by a high energy low voltage pulse. In the present invention I utilize a resonant circuit and a transformer to achieve a charge upon the condenser supplying the first portion or phase of the discharge.

In addition to the above, the prsent invention utilizes novel igniting means and the principal objects of this invention are, in addition to improving the apparatus of

my co-pending application, to provide the novel aspects of ignition.

A further object of the invention is to eliminate the necessity for one of the sources of D. C. required of the apparatus of my co-pending application.

A further object of the invention is to provide a device in which a transformer is utilized to supply not only the ignition impulse for the gas discharge tube but also to supply a transient voltage for charging the high voltage capacitor, which in turn provides the initial phase of discharge of the gaseous discharge device.

Many other objects of the invention will become apparent as the description thereof proceeds and it will also be apparent to those skilled in the art that considerable variation is possible within the scope of the invention. In order to comply with the patent statutes, I have illustrated practical embodiments of my invention from an inspection of which it is believed that the invention should be well understood as to all of its ramifications, and in connection with such illustrations there is also included a detailed description thereof together with an exposition of that which I consider to be the theory upon which the apparatus is based.

Fig. 1 is a circuit diagram of apparatus utilizing my invention in which separate transformers provide respectively the igniting pulse and high voltage pulse for the first phase of discharge of the gaseous discharge tube.

Fig. 2 is a circuit diagram similar to that of Fig. 1 but in which the transformers have been combined thereby eliminating one.

Fig. 3 is a circuit diagram of a modified form of D. C. voltage source for charging the condensers of the device, which is capable of self-rejuvenation through connection with an A. C. line.

The apparatus of the invention is intended to be carried in a relatively small container by the photographer and may be built into and become a part of a reflector either attached to the camera or separate from the camera. Through the use of my invention and in view of the extremely economical arrangement, the parts are very small and occupy little space such that the container may be carried in the photographer's pocket. In use, first a switch of relatively simple design is thrown to charge the condenser and energize the resonant circuit. This switch may be carried upon the apparatus itself. Through a cable, the device is connected to the camera shutter switch and when the camera shutter is operated the closing of this switch will produce the flash desired to illuminate the object so that the now uncovered film of the camera will be exposed. This latter switch is built into most cameras.

Referring now to the specific details of the device it will become apparent from Fig. 1 that that portion of the apparatus illustrated which appears to the left of terminals 10 and 11 comprises a source of D. C. voltage. It may be either a dry cell battery, illustrated for example in Fig. 2, or as here shown, it may comprise a rectifier 12 intended to be connected across the usual A. C. line by means of the terminals 13 and 14. While a half-wave rectifier is illustrated same may comprise a conventional full wave power pack. The actual construction of my device is such that either a battery unit or a power pack may be plugged into the container for the device.

The particular half wave rectifier 12 includes the transformer 15, a diode 16, filter condensers 17 and 18 and a resistor choke 19. As indicated the terminal 10 will be the positive end of the source of direct current. The reference character 20 is used to designate the apparatus generally, and I have illustrated a gaseous discharge tube 21 having a cathode 22, anode 23 and a third electrode 24. There is a fourth electrode 25 which may be external of the envelope of the tube 21 and is usually in the form

of an elongate member of foil. The electrode 25 serves as the igniting electrode for the device. The two principal condensers of the apparatus are the condenser 26 which is connected between the conductors 27 and 28, and the condenser 29 which is connected from the electrode 24 to the cathode 22.

The condenser 26 corresponds to the low voltage high energy condenser of the apparatus described in my copending application while the condenser 29 corresponds to the low energy high voltage condenser of such apparatus. It will be seen that there is provided a transformer 30 having a primary 31 of substantially less turns than the secondary 32. This transformer provides the pulse which is utilized in charging the condenser 29 in a manner shortly to be described. A second transformer is illustrated at 33. In this case the primary is indicated at 34 and the secondary at 35. Any suitable construction of transformers 30 and 33 may be used. For simplicity and economy they may both be air core, although iron or sintered metal cores can be adapted to the circuits. Since transformer 30 operates at lower frequencies, it is preferably iron core. Various other factors, such as weight, and size may affect the choice.

A condenser 36 and a resistor 37 are connected in series and across the conductors 27 and 28. The upper end of the primary 31 is also connected to the conductor 27 and its lower end is connected through a glow discharge tube 38, such as for example, a neon tube, to the juncture 39 between the condenser 36 and the resistor 37. The upper terminal of the secondary 32 is connected to the conductor 27 and its lower end is connected to the electrode 24 through a series rectifier 40, preferably of the selenium oxide type. Small protective resistor 41 may be inserted in the connection if desired, although the same is not essential to the operation of the device.

Calling attention now to the ignition portion of the device, it will be seen that the upper ends of both windings of the transformer 33 are together connected to the conductor 27 with the lower end of the secondary 35 connected by lead 42 to the igniting electrode 25 and the lower end of the primary 34 being connected to a parallel resistor 43 and condenser 44. The condenser and resistor in turn are connected to the lead 45. It will be seen that the camera switch 46 is connected by cable 47 between the lead 45 and the conductor 28.

The elements 31, 36 and 37 are chosen to produce resonance at some convenient audio frequency. Economically the condenser 36 may be approximately .01 microfarad and the resistor 37 may be one megohm. The neon tube 38 may be of a type having an igniting voltage of approximately 80 volts with an operating voltage of about 60 volts. When the switch 50 in the conductor 27 is closed the D. C. source 12 will charge the condenser 26 and will cause the condenser 36 to build up to sufficient voltage to ignite the lamp 38. As quickly as the lamp 38 is ignited it will leak the charge off the condenser thereby extinguishing itself and providing in effect a continual pulsing of the primary 31 of the transformer 30 at an audio rate. This is a relatively low energy resonance and it will produce a high alternating current voltage across the secondary 32, depending upon the transformation ratio, which may be of the order of about 10 to one. I am enabled thereby to produce several hundred volts, say about 500 at the rectifier 40, which, when rectified, produces a D. C. charge on the condenser 29, the voltage of which may be several times higher than the voltage existing across the conductors 27 and 28 and hence across the condenser 26. This voltage which may be of the order of several hundred volts, sufficient to provide the initial phase for discharge of the tube 21 but not without the tube first being ignited in some other manner.

With the apparatus in this condition the same is ready to be utilized by the photographer. The intermittent low energy flashing of the neon tube 38 may be used to indicate this condition or if desired, a small low voltage neon tube may be connected in the circuit to indicate that sufficient charge exists on the condenser to enable the same to be used.

When the photographer opens the shutter he will close the switch 46 thereby charging the condenser 44 and causing a pulse in the primary 34 in the transformer 33. This pulse will be substantially magnified and appear in the secondary, and hence provide a high voltage low energy igniting pulse of extremely short duration at the electrode 25. The initial ionization of the tube 21 commences at this point and the first phase of discharge consists of the discharge of the condenser 29 between the electrodes 24 and 25. The second phase of discharge then consists of the discharge of the condenser 26 across the electrodes 22 and 23.

I am enabled through this apparatus as described hereinabove to obtain the necessary high intensity illumination for exposing photographic film in taking photographs. The values of the various components of the apparatus to provide a practical embodiment may be worked out by those skilled in the art from the information given herein. As an example, the condenser 26 may be such as to provide a voltage of approximately 100 volts from a suitable rectifier 12 or from batteries. The igniting condenser 44 may be approximately .5 microfarad and the resistor 43, .1 megohm. Obviously, the condenser 44 must be substantially smaller than the condenser 26 in order that the same charge with the switch 46 closed. The capacity of condenser 26 must be such as to provide a discharge of about 30 watt-seconds in order to give the desired illumination, about 5000 microfarads.

A modified form of the invention is illustrated in Fig. 2 in which the transformer 33 has been eliminated and its functions taken over by the transformer 51 illustrated in Fig. 2. Across the terminals 10 and 11 of Fig. 2 I have shown connected a switch 50 in series with a resistor 52 and a battery 53. Obviously, this is the equivalent of the D. C. unit 12 of Fig. 1 and hence, same has been delineated by the broken lines 12 as an equivalent. For purposes of clarity the apparatus of Fig. 2 is generally designated by the reference character 60. As in the case of Fig. 1 there is a tube 21 having the cathode 22, anode 23, third electrode 24 and the igniting electrode 25. The high energy low voltage condenser 26 is connected between the conductors 27 and 28, and the condenser 36 and resistor 37 and neon lamp 38 are arranged in similar manner with respect to the primary 31 of the transformer 51 as utilized in the apparatus 20 of Fig. 1. The condenser 29 is again connected between electrodes 24 and 22 and a selenium oxide rectifier 40 is again connected in series with the secondary 32 and the electrode 24.

It will be seen however that the upper end of the secondary 32 is no longer connected to the conductor 27 but instead is connected directly to the igniting electrode 25 through a conductor 61. In the conductor 62 between the upper end of the secondary 32 and the selenium oxide rectifier 40 I provide a resistor 63 of relatively high ohmage, such as for example, 10 megohms, across which it is desired that a voltage appear. The lower ends of the primary and secondary of the transformer 51 are connected together and to the parallel condenser 44 and resistor 43 which in turn are connected to an electrical conductor 45 which forms one part of the cable 47 leading to the camera shutter switch 46.

The operation of this device is quite similar basically to that of Fig. 1. When the switch 50 is closed it charges the condenser 26 and energizes the resonant circuit thereby providing a high voltage across the secondary 32 to charge up the condenser 29. The resistor 63 prevents the rectifier 40 from loading the secondary 32 and preventing the high voltage oscillations from appearing thereat. It can be said that the secondary 32 is "free" to produce these oscillations. Likewise resistor 63 protects the rectifier 40 from current over-

load caused by the high voltage secondary **32**. Simultaneously there appears at the igniting electrode **25** the voltage developed across the secondary **32** which may be of the order of 500 volts, high enough to provide the charge necessary on condenser **29** but insufficient to ignite the lamp **21** through ionization. When the switch **46** in the camera shutter is closed the condenser **44** will charge providing a pulse which, when superimposed on the high voltage pulse appearing in the secondary **32** will be sufficient to initiate ionization in the tube **21** so that in turn condensers **29** and **26** may provide the complete discharge.

In Fig. 3 I have illustrated a simple D. C. source **12** which completely eliminates the need for transformer **15**, diode **16**, and the filters. In this system, the D. C. source consists merely of a series rectifier **70** and a resistor **71** connected in lead **27**. The battery **53**, resistor **52** and switch **50** are permanently connected between leads **27** and **28** exactly as illustrated in Fig. 2. Here, however, when it is desired to connect the device to the A. C. line at terminals **13** and **14**, there is no need to remove the battery. Condenser **26** may be charged up to the peak voltage of the line, which in the case of a 110 volt A. C. line may be as high as 150 volts. The battery **53** can remain in the circuit or not, as desired, depending upon switch **50**. If in the circuit, the line voltage provides at least a partial charging up of the battery, thereby giving it longer life. In this case it may be necessary to keep high potential from the line out of the camera switch **46** through the use of some protective means such as for example a low voltage relay.

It is believed that the invention, its construction, and the manner in which same operates have been explained with sufficient clarity such as to enable a full and thorough appreciation and understanding thereof. It is desired to emphasize, however, that the theories set forth herein are not presented for limiting the invention, but merely to aid in clarifying the discussion of the same. I wish to be limited only by the structural recitations in the appended claims, considered in their broadest range of equivalents as circumscribed by the prior art.

What I desire to secure by Letters Patent of the United States is:

1. An electric flash producing system which comprises, a source of D. C. voltage of a predetermined potential, a gaseous discharge tube having a cathode, a first anode and a second anode, the cathode and first anode connected across the source, a first condenser connected in parallel with the source, a second condenser connected between the cathode and the second anode, means for charging the second condenser with a voltage substantially higher than the potential of the source from the source, and means for igniting the tube including a circuit supplying a high potential pulse providing initial ionization and including a remote circuit-closing switch.

2. A system as described in claim 1 in which the means for charging the second condenser includes a make-break device energized by the source, an inductive reactor in connection with the make-break device amplifying the signal produced by the make-break device, the second condenser being connected to receive a D. C. component of said signal.

3. A system as described in claim 1 in which there is a resonant network connected across the source and oscillated thereby and having a step-up transformer connected therewith, the transformer output being connected with the second condenser and there being a rectifier in said connection.

4. A system as described in claim 2 in which there is a rectifier connected between the inductive reactor and the second condenser.

5. In an electric flash device which includes, a source of D. C. voltage having a condenser connected thereacross, a first gaseous discharge tube having a cathode and an anode and being connected across the source, a third electrode, a second condenser connected between the third electrode and the cathode, the herein invention which comprises, means for charging the second condenser from the source to a potential substantially higher than the source and including a capacitive-inductive network connected across the source and having a relatively low frequency resonance, a second gaseous discharge tube connected in said network and having characteristics providing continuously alternating ignition and extinguishment at the potential to which same is subjected in said network, a transformer having primary and a secondary windings, the primary being connected in said network as a part thereof, and the secondary being connected to energize said second condenser and having a rectifier in circuit therewith.

6. A structure as defined in claim 5 in which the network includes a third condenser and a resistor connected in series across the source, the primary being connected in series with the second gaseous discharge tube and between one side of the source and the juncture between the third condenser and the said resistor.

7. A structure as defined in claim 6 in which the first gaseous discharge tube has a fourth electrode, there is a pulse transformer having a primary and secondary energizing the fourth electrode, a fourth condenser in series with the primary of the pulse transformer, and a switch, the said primary, fourth condenser and switch being connected in series and across the source whereby when the switch is closed the said first condenser will charge the said fourth condenser producing a pulse in the pulse transformer.

8. A structure as defined in claim 2 in which the gaseous discharge tube has a fourth electrode and the said electrode is connected to receive an A. C. component of said signal.

9. A structure as defined in claim 3 in which the gaseous discharge tube has a fourth electrode and the transformer output is also connected to the fourth electrode, and in which there is a pulse condenser and a switch connected between one side of the transformer output and a pole of said first condenser whereby the closing of the switch and resultant charging of the pulse condenser will superimpose a pulse on the condenser output sufficient to cause igniting of said gaseous discharge device by said fourth electrode.

10. A structure as defined in claim 4 in which the gaseous discharge tube has a fourth electrode and the said electrode is connected to receive an A. C. component of said signal.

11. A structure as defined in claim 5 in which the first gaseous discharge tube has a fourth igniting electrode, and the secondary being connected to the said fourth electrode and excluding the rectifier in the said connection.

12. A structure as defined in claim 11 in which there is a pulsing condenser and a switch connected between one end of said secondary and a terminal of said first condenser.

13. A structure as defined in claim 12 in which the second end of the secondary condenser is connected in series with said rectifier to said second condenser and there is a relatively large voltage dropping resistor also in series with said rectifier whereby the voltage drop across the said large resistor is made available for charging said second condenser.

14. An electric flash system which includes a first gaseous discharge device having anode, cathode, an initial discharge electrode and an igniting electrode, a source of D. C. connected across the tube between cathode and anode and having a value for supplying energy for the second phase of discharge, a first condenser connected across the source, a second condenser connected between the initial discharge electrode and the cathode, a transformer having primary and secondary windings, a res-

onant circuit including a third condenser, a resistor and a second gaseous discharge device connected across the source and energizing the primary winding, a switch having one side connected to one side of the source, a fourth condenser adapted to be charged and connected from the second side of said switch to a terminal of the said secondary, the said last terminal being connected to a terminal of the primary and one pole of said second gaseous discharge device, the second terminal of the primary being connected to the second side of the source, the second terminal of the secondary being connected to the igniting electrode and also having a connection with the initial

discharge electrode, said last mentioned connection including a rectifier and a voltage dropping resistor.

15. A structure as described in claim 9, in which there is a resistor in parallel with the pulse condenser.

16. A structure as described in claim 14 in which there is a resistor in parallel with the fourth condenser.

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