Sept. 20, 1960 J. E. CHAUVINEAU 2,953,721

ELECTRONIC FLASH LIGHTING SYSTEM

Filed Oct. 25, 1957 2 Sheets-Sheet 1

Fig. 1.

PRIOR ART

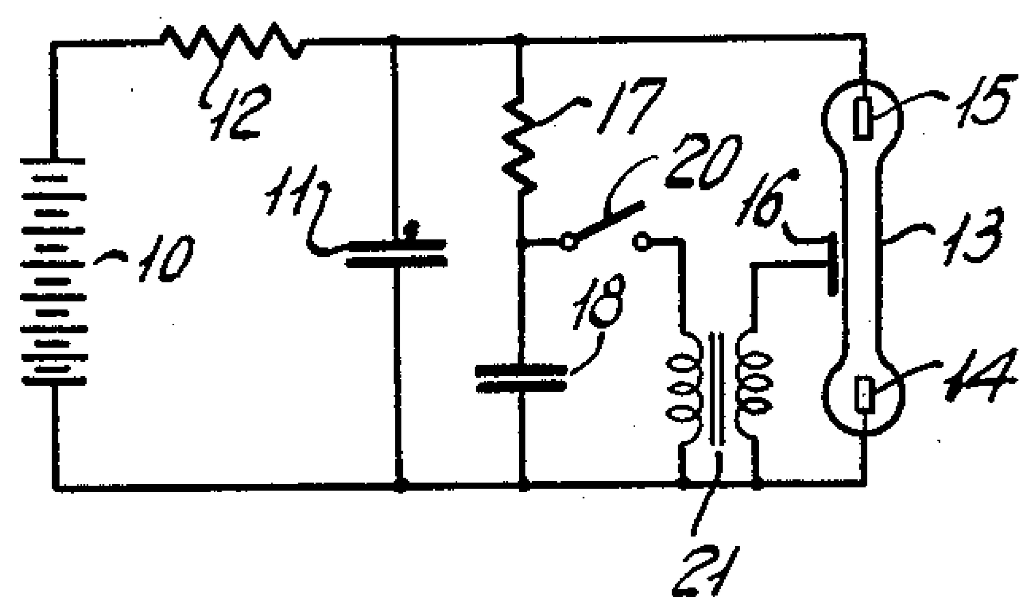


Fig. 2.

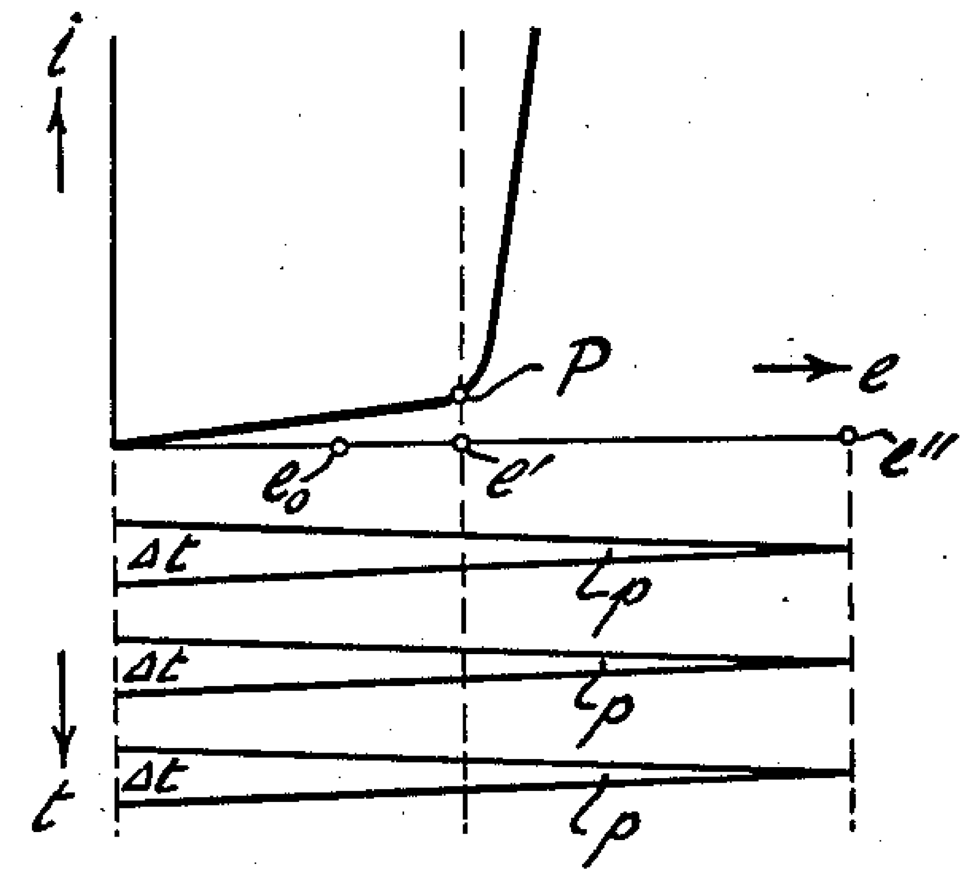


Fig. 3.

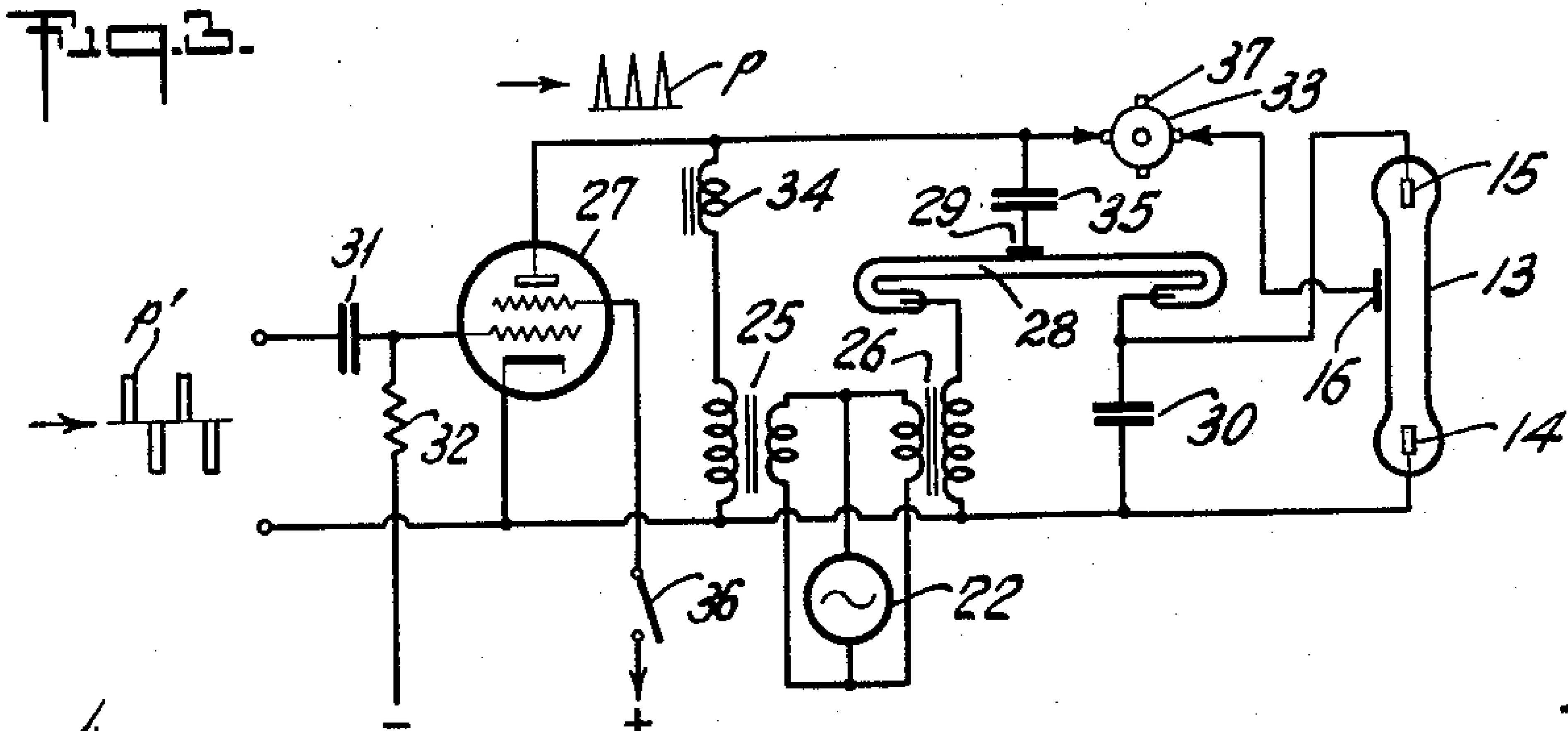


Fig. 4.

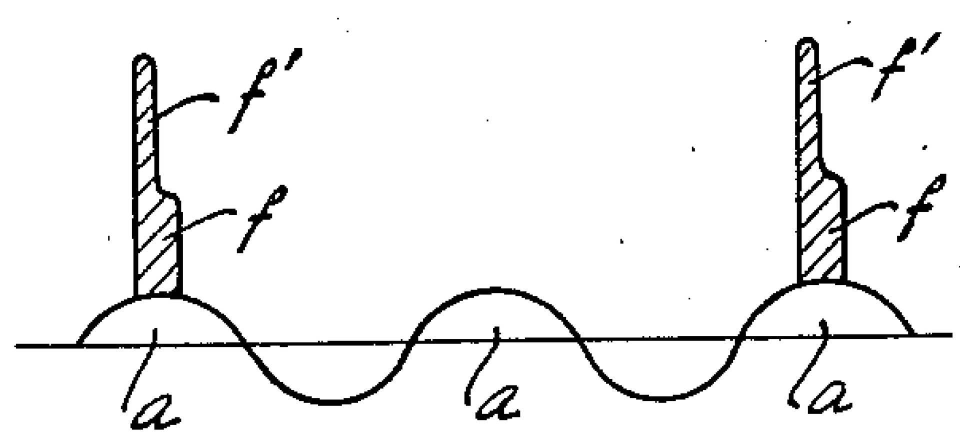


Fig. 5.

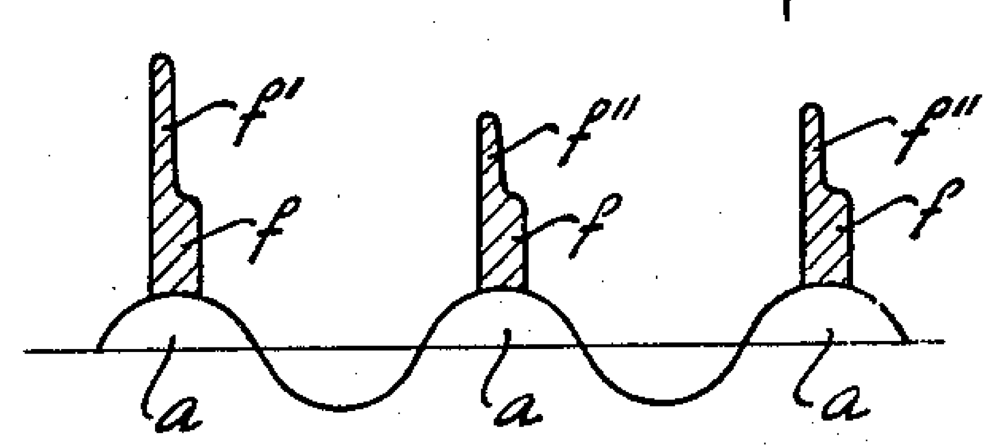
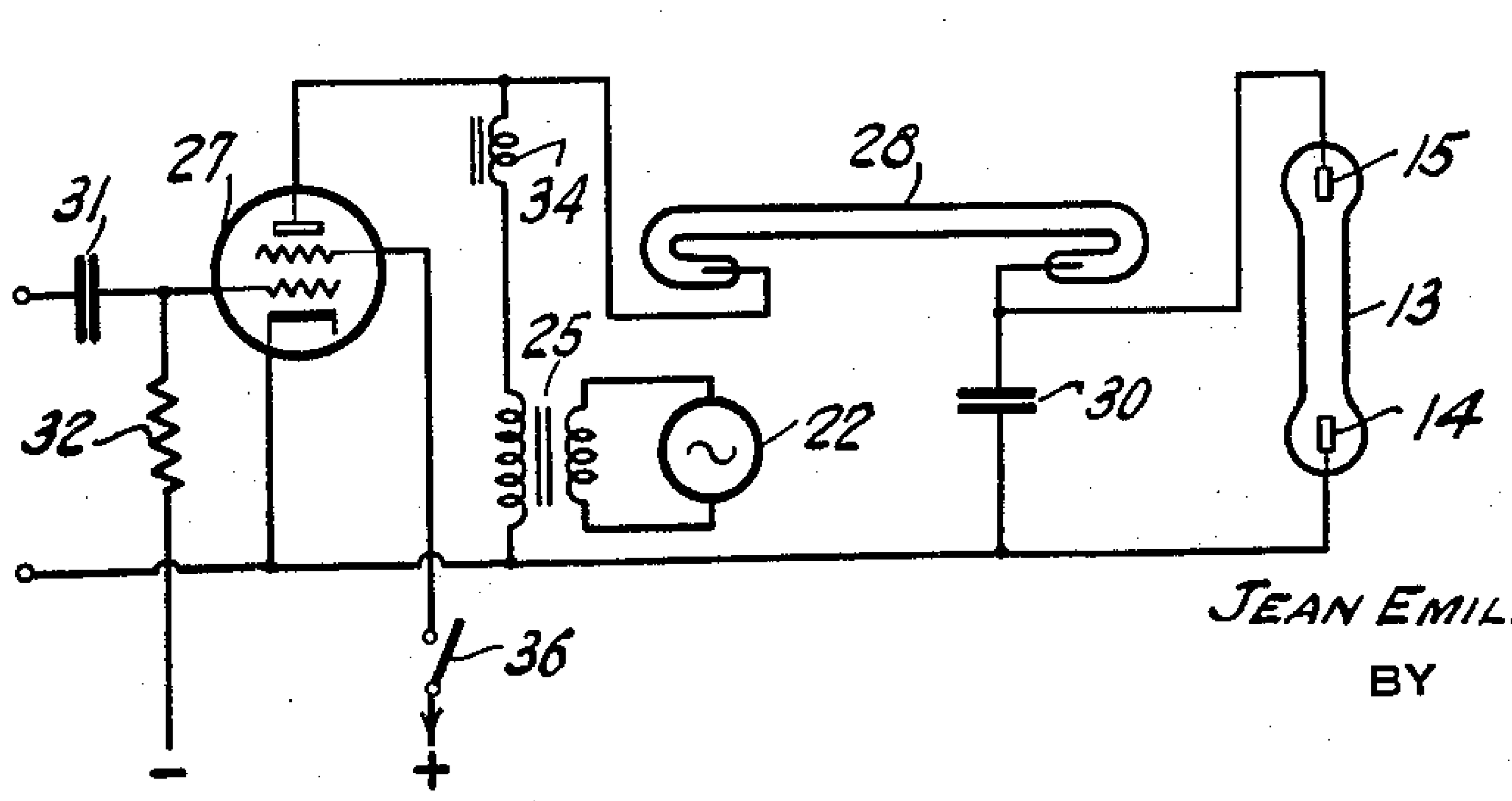


Fig. 6.



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ELECTRONIC FLASH LIGHTING SYSTEM

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Fig. 7.

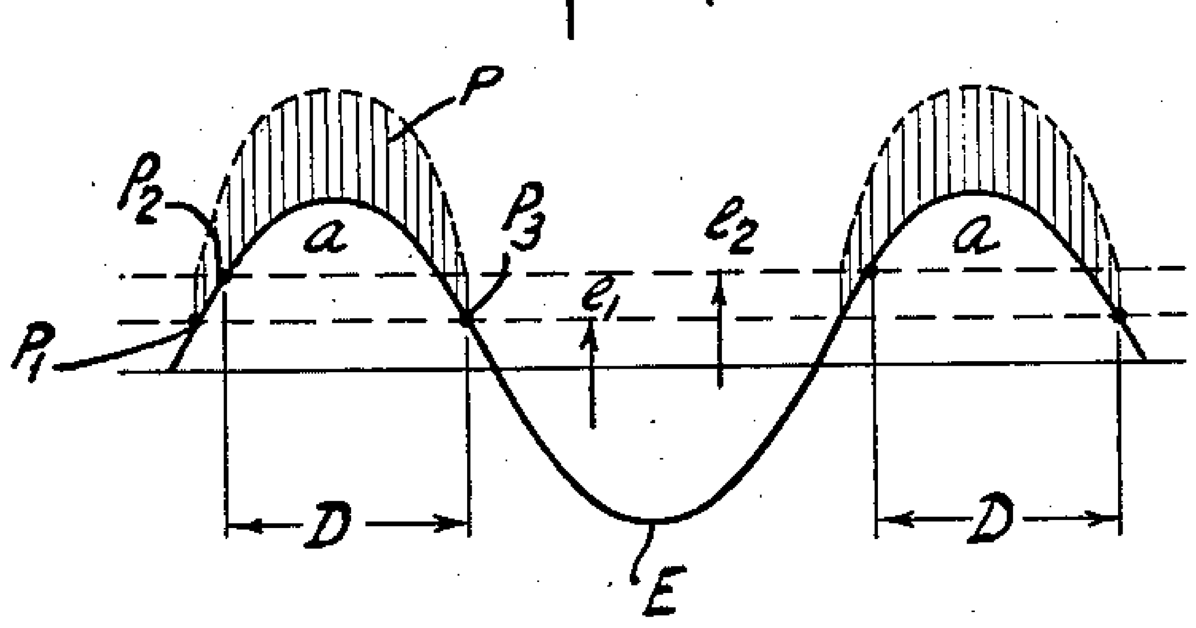


Fig. 8.

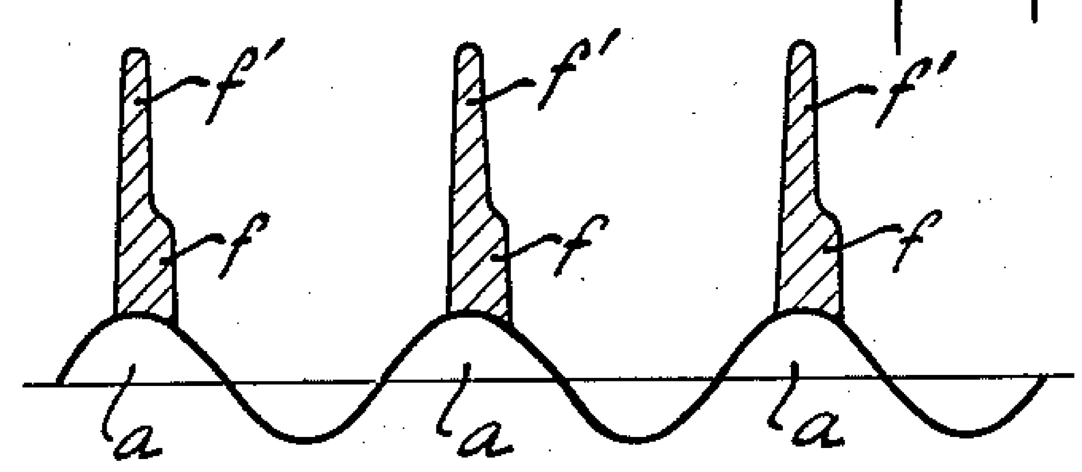


Fig. 12.

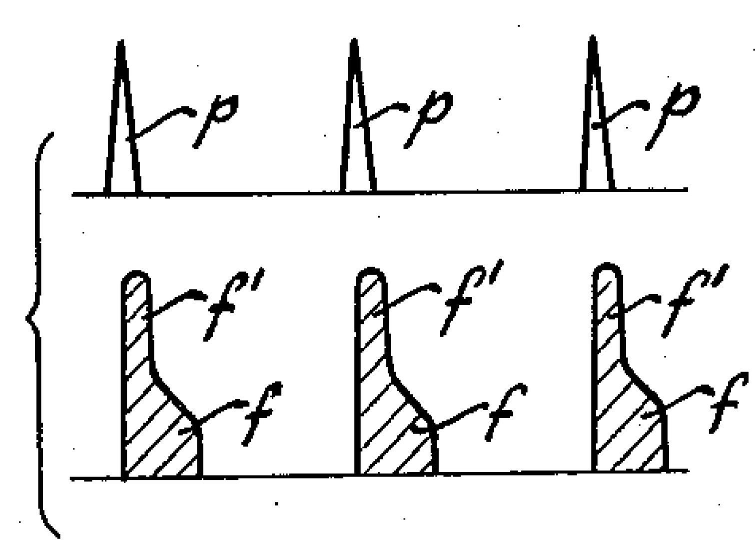


Fig. 9.

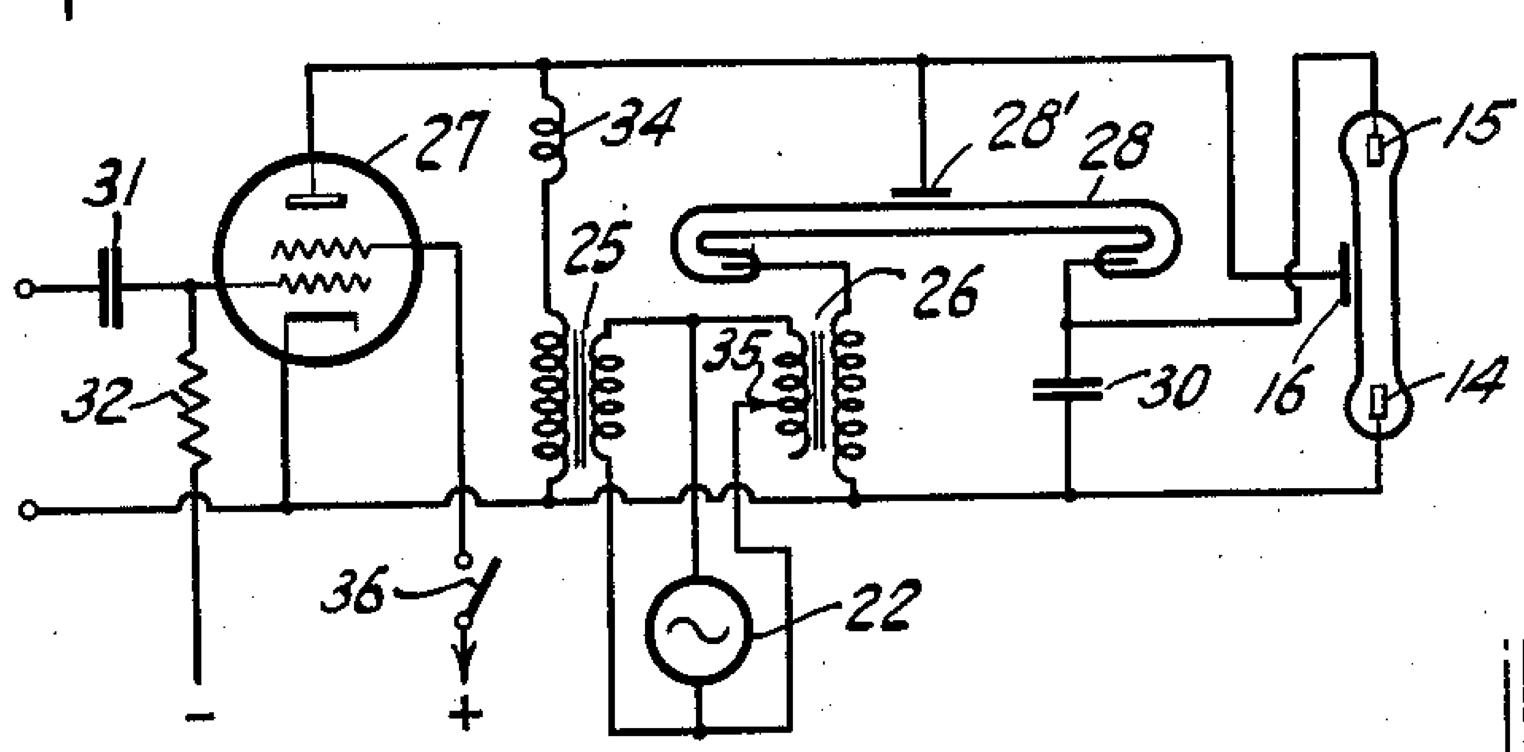
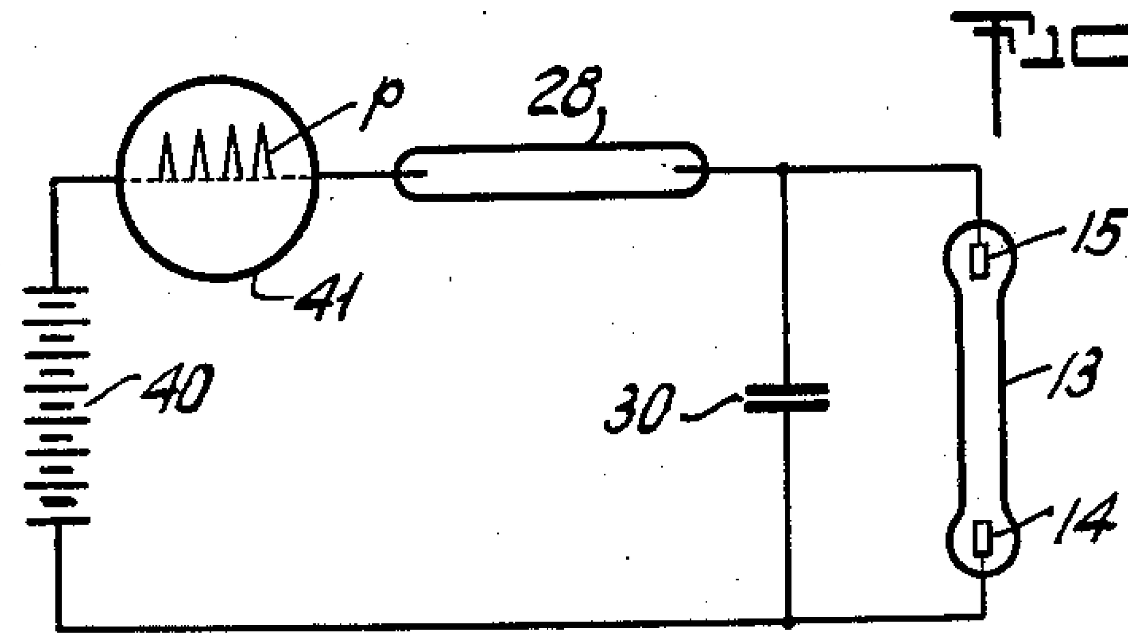


Fig. 10.



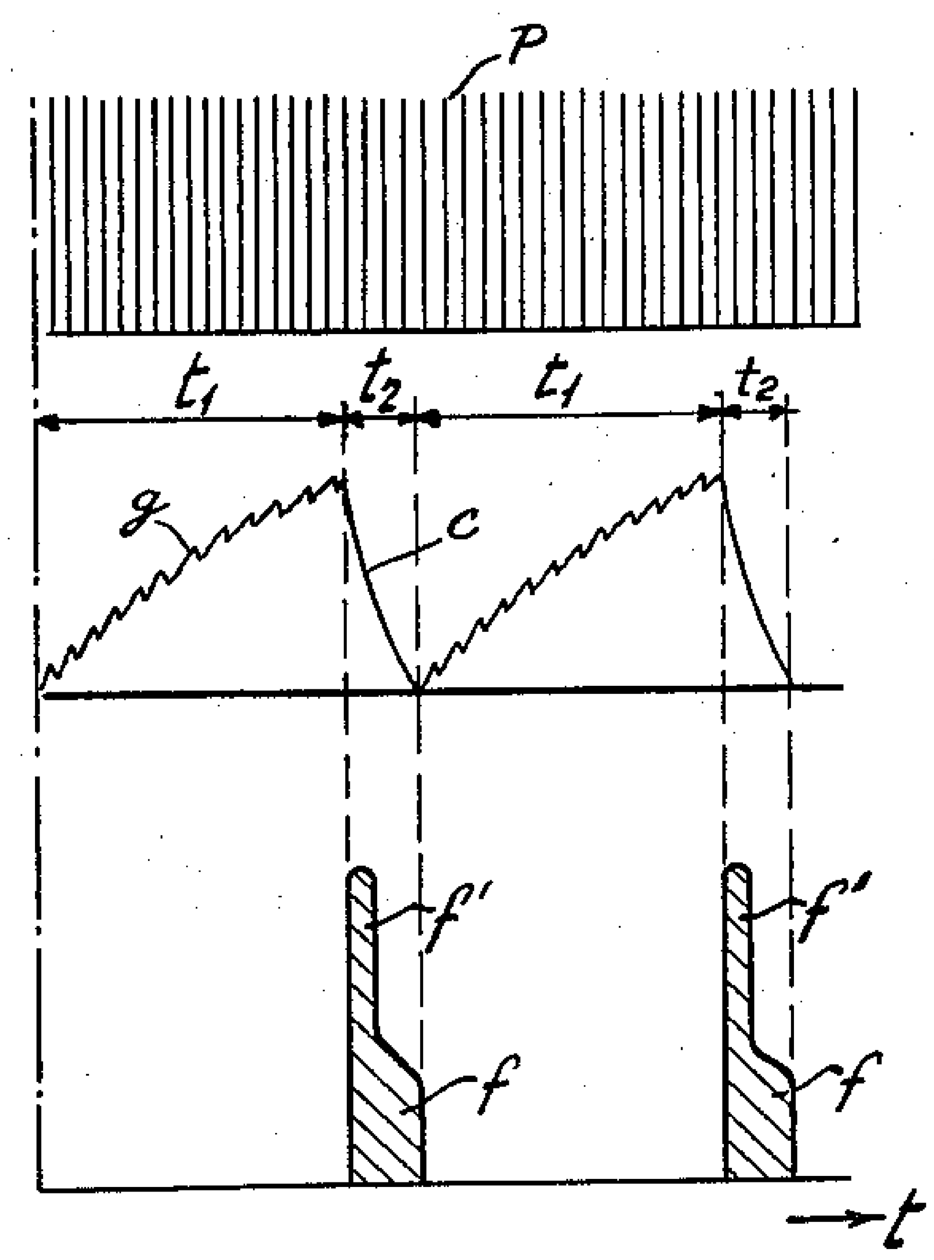
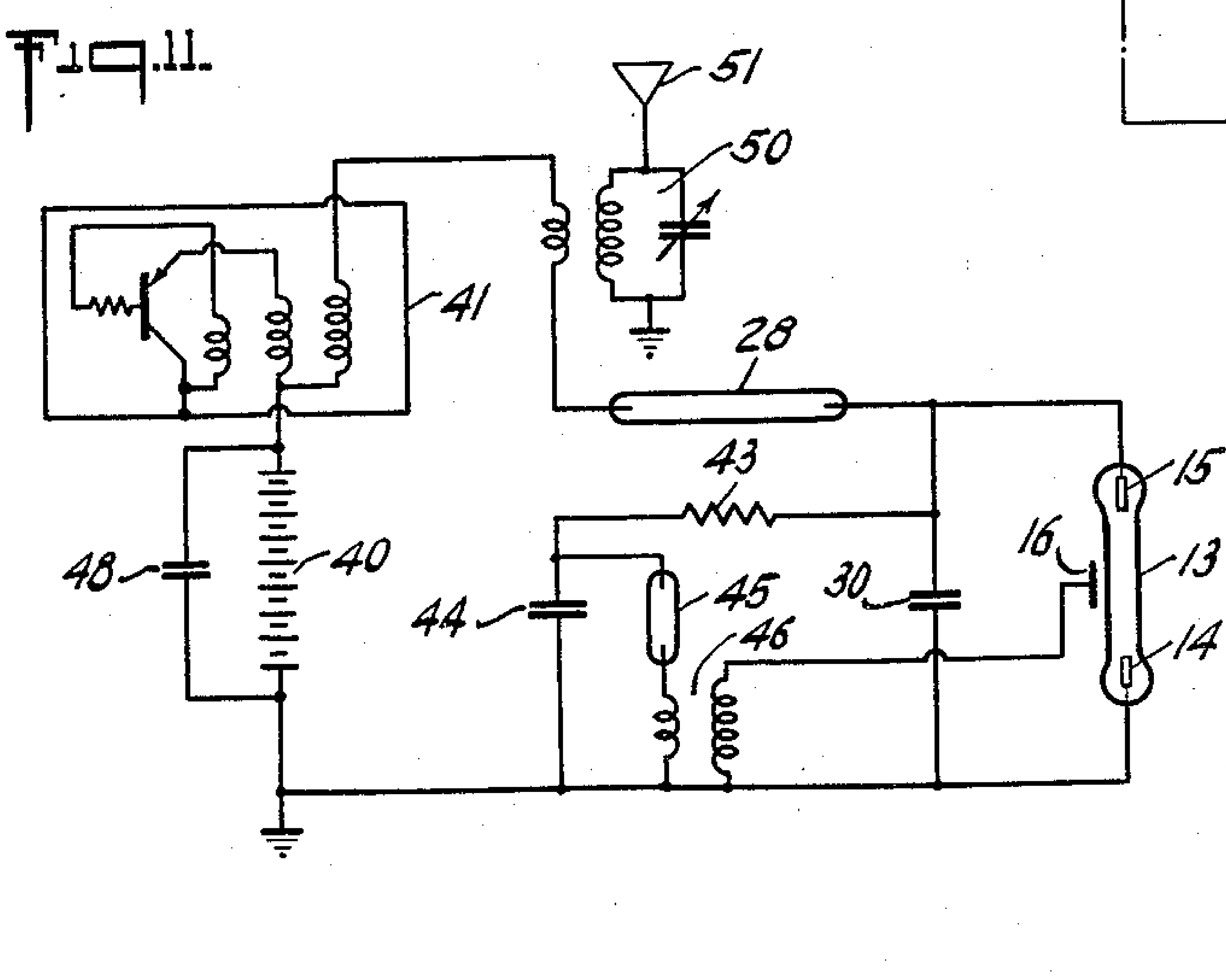


Fig. 13.

Fig. 11.



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United States Patent Office

2,953,721

Patented Sept. 20, 1960

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2,953,721

ELECTRONIC FLASH LIGHTING SYSTEM

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Filed Oct. 25, 1957, Ser. No. 692,351

6 Claims. (Cl. 315—241)

The present invention relates to electronic flash lighting systems and a method of operating the same, more particularly, to flash lighting systems for use in high speed flash photography, motion picture photography, light signaling, stroboscopes, marine or land beacons and other uses and applications, where a high intensity and easily controllable light source is required.

Conventional high intensity electronic flash lights essentially comprise a gaseous discharge tube consisting of a glass envelope filled with a suitable rarefied gas or mixture of gases, such as argon, neon, crypton, xenon, etc. at a suitable pressure, and a pair of main discharge electrodes providing an ionic or gaseous discharge path within said tube. One of said electrodes constituting the cathode or electron emissive element consists of or is coated with a suitable electronically active material to emit electrons under the effect of the negative voltage gradient, upon application of a suitable direct current operating voltage to the tube, while the other electrode constitutes the anode or electron collecting element well known to and understood by those skilled in the art.

Gas discharge devices including flash tubes normally present a high impedance to the passage of an electric current and, in fact, such tubes may be regarded as a current interrupter or insulator under ordinary conditions. If, however, a potential difference or voltage of a sufficiently high value, that is, exceeding the ionization or breakdown potential of the tube, is applied to the tube, the impedance of the tube changes suddenly to a very low value. This, in turn, may cause a considerable current flow in the form of a high intensity low voltage arc through the tube accompanied by a light flash having an intensity and spectral composition depending upon the nature, pressure and other characteristics of the gas and design features of the tube.

This sudden change of the tube from an insulator to an extremely low impedance is the result of the cumulative ionization of the gas molecules by the free electrons being accelerated in the direction from the cathode towards the anode and producing an ever increasing number of new ionizing electrons upon collision with the gas molecules, provided the applied voltage has a certain minimum, known as the critical or ionization voltage of the tube.

Instead of varying the main operating or discharge voltage, the latter may have a fixed value below the ionizing or breakdown point of the tube, while the ionization and ignition of the tube is effected by means of an ionization or triggering potential applied to a suitable auxiliary or starting electrode. The latter may be applied either to the outside of the tube wall, in the form of a coiled wire, metal coating or the like, or interposed in the discharge path in the form of a starting grid or the like, in a manner well known in the art.

Ordinarily, a tube of the above type would be destroyed by the intense breakdown (short-circuit) current, unless it were protected by a series or limiting impedance, if the operating voltage is applied over an extended period, or unless the amount of the operating or discharge energy is limited, such as when supplied by the charge or energy stored in an electrical capacitor. In the case of a conventional capacitor type flash discharge, the instantaneous current, although of very short duration, reaches a considerable peak value, to result in an intense light flash of short duration.

Capacitor type electronic flash discharge tubes have great advantages and desirable features, foremost among which is the fact that the instantaneous current or light flash can be produced efficiently and reliably if the duration or flash period is relatively short, say about one millisecond or less, as used for high speed flash photography and similar applications. On the other hand, if a relatively stronger light source is required or if the flash duration is to be increased appreciably, such as, for instance, for use in light signaling, beacon lights, etc., the storage capacitors and accessory equipment, such as the rectifier power supply etc., will assume such dimensions and bulk as to render the use of this type of discharge device uneconomical, if not prohibitive, for a great many uses and practical applications.

The reason for these limitations and shortcomings of the conventional capacitor type electronic flash lights is the fact that the total electric energy converted into light energy in the flash discharge must be stored by the capacitor, that is, the capacitor must have a dimension and operating voltage sufficient to handle the total output energy of the flash, whereby to greatly limit the potentialities and flexibility of the conventional capacitor type flash, both with regard to power output as well as duration of the flash.

Accordingly, an important object of the present invention is the provision of an improved flash lighting system for producing light of high intensity and/or duraton, utilizing a flash discharge tube as a light source, which substantially overcomes the above and related drawbacks and difficulties inherent in the conventional capacitor type electronic flash devices heretofore known in the art.

Another object of the invention is the provision of a flash lighting system comprising a capacitor controlled ionic flash tube combined with means for direct energization of the tube from a suitable power source, to both increase or control the total light output and/or to extend the length or duration of the flash produced.

A more specific object of the invention is the provision of a capacitor type ionic flash lighting system including means to increase both the power and/or duration of the light flash beyond the limit determined by the size of or energy of the storage capacitor.

Another object of the invention is the provision of a readily controllable high intensity light source utilizing an ionic flash discharge tube operated intermittently at a sufficiently high repetition frequency, to provide a practically continuous high intensity light output.

Other objects and novel aspects of the invention will become more apparent from the following detailed description of a few practical embodiments thereof taken in reference to the accompanying drawings forming part of this specification and wherein:

Fig. 1 is a basic circuit diagram of a conventional capacitor type flash lighting system, known in the art of flash photography, stroboscopes and the like;

Fig. 2 is a graph explanatory of the function and operation of the invention;

Fig. 3 is a circuit diagram of an A.C.-operated flash lighting system embodying the principles of the invention;

Figs. 4 and 5 are further graphs explanatory of the function of Fig. 3;

Fig. 6 is a circuit diagram showing a modification of a flash lighting system according to the invention, designed for producing a practically uniform high intensity light output during prolonged and readily controllable time periods;

Figs. 7 and 8 are graphs explanatory of the function and operation of Fig. 6;

Fig. 9 is a circuit diagram showing yet another modification of an A.C.-operated flash lighting system according to Fig. 3;

Fig. 10 is a basic diagram of a D.C.-operated flash lighting system embodying the principles of the invention;

Fig. 11 is a more detailed circuit diagram of a system according to Fig. 10 especially, though not limitatively, suitable as a lightweight emergency light beacon combined with a distress signal radio transmitter; and

Figs. 12 and 13 are graphs explanatory of the function and operation of Figs. 10 and 11.

Like reference characters identify like parts throughout the different views of the drawings.

With the foregoing objects in view, the invention involves generally the provision of a suitable power or operating voltage source, such as a battery, D.C. generator or alternating current generator or network connected to a storage capacitor of relatively low capacitance, compared with the storage capacitor of a conventional capacitor type flash lighting system, said capacitor being, in turn, shunted by a rarefied gas flash discharge tube of the type described above.

In place of the usual current limiting impedance, there is connected in series with the operating source and flash discharge tube, according to one embodiment of the invention, an auxiliary gas discharge or switching tube acting as a periodic interrupter and being controlled by a source of highly peaked ionizing voltage pulses, which latter may be further applied to or serve to periodically ionize the flash discharge tube. As a result, the impedance of said switching tube varies alternately between relatively low and high values at the rhythm of and in synchronism with the ionizing voltage pulses, in such a manner as to cause the latter to be applied intermittently to said flash tube during the low impedance periods of said switching tube, on the one hand, and to provide high impedance periods, to result in ready extinction of the tube during the spacing intervals between the ionizing pulses.

The capacitor acting as a stabilizing means is charged intermittently by the operating source until assuming a charging voltage to enable the ionizing voltage pulses to initiate the breakdown of the flash discharge tube. Since the latter is connected during the discharge periods to the operating source without a high series impedance, due to the action of the switching tube, the major portion of the power for the light flash will be directly supplied from said source, while an excessive discharge current is prevented as a result of the intermittent operation or periodic extinction of the discharge, in a manner further understood from the following.

The storage capacitor in a system according to the invention supplies only a relatively small fraction of the total power or energy converted into light by the gas discharge, and among other functions, serves to control the initiation of the discharge flashes and to stabilize the operation of the system, in such a manner as to enable a reliable and effective control of both the intensity and duration of the flash discharge. As a result, the system becomes suited for an increasing number of practical applications, such as for optical signaling, light beacons and the like.

Referring more particularly to Fig. 1, there is shown a basic diagram of a conventional capacitor type flash discharge system as used in high speed flash photography and for similar applications, comprising a direct current high voltage power source **10**, such as a battery or rectifier power supply, connected to a storage capacitor **11** through a series of limiting impedance, such as a high ohmic resistor **12**. As a result, the capacitor **11** will be charged gradually according to an exponential charging curve to the full operating voltage of the source **10** which has a value below the ionizing or breakdown potential of the flash tube **13** connected across said capacitor, the total charge E of the capacitor being determined by the equation $E=\frac{1}{2}CV^2$, wherein C represents the electric capacitance and V represents the voltage of the source **10**.

In order to start or initiate the flash discharge there is further provided a starting or trigger circuit connected across the capacitor **11** and comprising a resistance **17** and relatively small capacitor **18** in series. As a result, a charge will be stored in the capacitor **18**, which upon momentarily closing of the switch **20** discharges suddenly through the primary of a trigger transformer **21**, whereby to cause a high voltage surge to be induced in the transformer secondary and to be applied to the starting electrode **16** of the tube **13** having a cathode **14** and anode **15**. As a result, the gas within the tube becomes ionized to an extent to reduce the impedance of the tube to an extremely low value and to cause the storage capacitor **11** to be discharged through the tube in the form of a short and high peaked luminous flash. At the same time, the limiting resistance **12** prevents a direct short-circuit current from the source or battery **10** through the tube **13**, thus preventing destruction of the tube and other parts of the circuit. Only after the capacitor **11** has again been charged by the source **10** will the system be ready for producing a new discharge flash upon closing the switch **20**, in a manner well known to and understood by those skilled in the art.

While capacitor discharge systems of this type have been found to have many uses where a relatively short flash of limited power is required, such as in high speed photography, stroboscopic applications, etc., the device becomes more and more bulky and inconvenient to handle, as well as expensive, in light signaling, flashing light beacons and similar applications. The main reason for the disadvantages and shortcomings of the conventional capacitor type flash system, according to Fig. 1, lies in their basic operation and requirement that the total electrical energy converted into light must be stored in the capacitor **11**, thus necessitating the use of bulky capacitor units and/or high operating voltages as the demand for greater power or light output and flash duration increases.

Referring to Fig. 3, there is shown a circuit diagram of an A.C.-operated flash lighting system according to the invention producing light flashes of increased intensity and/or duration and utilizing in part the energy stored in a capacitor and in part energy directly supplied from an operating or power source **22**. The latter, which may be a 60 cycle power line or network, feeds a pair of transformers **25** and **26** which serve to supply operating voltage to both the ionizing pulse generator **27** and the flash tube **13**, respectively, the latter being shunted by stabilizing a capacitor **30**. Connected between the transformer **22** and a capacitor **30** is an electronic switch in the form of a gas discharge tube **28** having a pair of main electrodes and an auxiliary or starting electrode **29**.

The ionizing pulse voltage generator may be of any suitable type, and, in the example shown, comprises a screen grid vacuum tube **27** having its anode energized by the source **22** through the supply transformer **25**. The grid of tube **27** is excited or controlled, by way of a grid coupling capacitor **31** and grid leak resistance **32**, by a square wave voltage or series of rectangular voltage pulses p' obtained, for instance, from a conventional square voltage generator (not shown), such as a multivibrator, blocking oscillator, etc. As a result, current pulses will be set up in the output of the tube during the positive alternations of the anode voltage in rapid sequence, resulting in a storage of magnetic energy in peaking inductance **34** inserted in the anode circuit and the generation of inductive voltage peaks p, Fig. 2, at the instants of cessation of each anode current pulse or collapse of the magnetic field of the coil 34. The ionizing voltage pulses which, by proper design of the peaking coil 34 to have a natural frequency equal to the pulse repetition frequency, have a peak amplitude many times the amplitude of the plate voltage and serve to control the ionization of both the flash tube 13 and the switch tube 28.

In the example shown, the ionizing voltage pulses p, instead of being directly applied to the flash tube 13, are impressed upon the separate starting electrode 16 by way of a current interrupter, such as a rotating cam 33 having contacts 37 and being driven by a synchronous motor (not shown) energized by the source or network 22. Similarly, the switch tube 28 has a starting or ionizing electrode 29 excited by the pulses p through a preferably adjustable coupling capacitor 35. Both the flash tube 13 as well as the switch tube 28 may, however, be directly excited by the ionizing pulses, as shown in subsequent figures. Fig. 2 shows the usual operating characteristic of a gaseous discharge tube representing current i as a function of applied voltage e. The critical or breakdown voltage is shown at e' coinciding with the bent or point P of the curve, while e_0 represents the source voltage and e'' the voltage of the pulses p.

The operation of the system according to Fig. 3 will now be described with further reference to Figs. 4 and 5.

Assuming the cam 33 to be designed and/or operated so as to apply a series or train of ionizing pulses p to the starting electrode 16 of the flash tube 13 during a single alternation or half-cycle a of the power supply, such as, for example, during the first, third, fifth, etc. alternation, as shown in Fig. 4, the capacitor 30 will be charged during the intervening alternations through the tube 28 having its impedance reduced to zero by the ionizing pulses p which are simultaneously applied to the control electrode 29 in synchronism with the control of the flash tube 13. The design of the circuit and the amplitude of the operating voltage are such that the capacitor 30 will be charged to a voltage sufficiently below the ionizing voltage of the flash tube 13 to prevent a direct discharge in the absence of an ionizing or triggering pulse p.

On the other hand, during the closing of the contacts 37 of the cam 33, the flash tube 13 becomes ionized by the pulses p simultaneously with the tube 28, whereby to cause the capacitor 30 to be discharged and to produce a series of high intensity luminous flashes through the tube 13. Since the tube 28, being in series with the tube 13 and power source, offers a relatively low impedance during the periods Δt of the ionizing pulses p, Fig. 2, a supplementary relatively heavy current is caused to flow directly from the source 22 and transformer 26 through the flash tube 13, resulting in an increase of both the light output as well as an increase of the flash duration, as shown in Fig. 4. In the latter, f' represents the peak or discharge component resulting from the capacitor charge $CV^2/2$ and f indicates the energy component directly supplied by the power source and being equal to V^2/Z, where Z is the impedance of the circuit.

There is thus provided by the invention a luminous flash discharge system enabling the production of single flashes of increased intensity and duration simply and efficiently by means of a relatively small discharge capacitor, being practically of the order of about 100 to 150 mfd. and serving mainly as a means to control and stabilize the operation of the system.

As is well known, the relatively short life of the conventional capacitor type flash tubes is due primarily to the molecular disintegration of the electrode material by the intense instantaneous discharge peaks caused by the sudden release of the energy stored in the relatively large capacitors required by the conventional systems. This defect is greatly minimized or eliminated by the invention which utilizes only a relatively small storage capacitor as a stabilizing means with the main discharge energy being supplied directly by the power source.

Instead of the flash discharges being separated by a single alternation a of the operating voltage, as shown in the drawing, Fig. 5, the capacitor 30, by suitable design of the cam 33, may be charged by a greater number of intervening alternations, to suit existing conditions and requirements.

The system according to Fig. 3 may also be operated to produce a discharge of the tube 13 during each positive alternation a of the operating source, to provide effective continuous light output composed of a series of discrete short periods or light flashes, that is, 60 flashes in case of a standard 60-cycle network or operating source. In this case, the cam 33 may be dispensed with or designed to close the contacts 37 during each positive alternation a of the supply current, to produce a series of discharges of the tube 13 during a desired time period, by closing a control switch 36 of the ionizing pulse generator.

The direct discharge component has the further effect of preventing the capacitor from discharging completely, in such a manner that during the next following positive alternation a, the capacitor will again be charged during a fraction, say one-third of the next alternation, to a value sufficient to result in additional flash discharges during the subsequent alternations having a reduced initial discharge peak f'', Fig. 5, and providing a practically continuous light output suitable for many practical uses, such as light signaling, beacon lights, etc. According to a practical example, the full charging voltage V may be about 1500 to 2000 volts and the reduced charging voltage V' may be about 500 volts, while the ionizing peaks p may be from 4000 to 5000 volts at a repetition frequency of 5000 per second and higher. In place of controlling the total flash duration by starting and stopping the cam 33, the same effect may be obtained by controlling the peaked voltage wave generator by operation of the switch 36, or in any other suitable manner.

In other words, since, in the example of Fig. 3, the maximum flashing rate of the tube 13 of 60 flashes per second is a substantial submultiple of the repetition frequency of the ionizing or switching pulses p, the tube 13 is directly intermittently connected to the source 22 during the conducting periods Δt, Fig. 2, of the switching tube 28, whereby to result in an incremental direct energy supply to the flash tube 13 from the source 22, in addition to the energy stored by the capacitor 30. At the same time, the intermittent operation of the switching tube 28, acting as a protective impedance for the flash tube 13, prevents a dangerous build-up of the direct source current to a value liable to damage the tube or other circuit elements.

Referring to Fig. 6, there is shown a modified system according to the invention for producing a series of discharges of equal intensity and length during each alternation a of the operating current. The circuit shown differs from the circuit of Fig. 3 by the provision of a single transformer 25 supplying operating voltage to both the ionizing pulse generator 27 and to the flash tube 13. Furthermore, both the tube 28 and flash tube 13 are shown to be controlled directly by the ionizing pulses, that is, without the aid of any special starting electrodes. For this purpose, the tube 13 may be of a relatively short length to cause a discharge at about one-third of the full operating voltage. In a system of this type, upon closing of the switch 36, the supply voltage and ionizing pulses are continuously and simultaneously applied to both the switch tube 28 and flash discharge tube 13 in series, in such a manner that, provided a proper design of the circuit constants and parameters, equally high intensity discharge flashes will be produced during each positive alternation a, as shown and further understood by reference to Figs. 7 and 8 of the drawing. At the same time, the size of the capacitor 30 is further reduced. For practical purposes, the capacitor may be designed to supply only about 2% of the total power dissipated in the flash, the remaining 98% being supplied by the power source 22 through transformer 25. As a result, a capacitor with a capacitance as low as 8 mfd. has been found suitable for the purpose of the invention.

The operation of the circuit according to Fig. 6 is as follows. The peak voltage generator 27, having its anode energized by the alternating voltage supplied by the transformer 25, begins to function only with a minimum voltage e_1 during the positive alternations *a*, as shown at P_1, Fig. 7, at which point the tube 28 is ionized by the applied high voltage pulse *p*, thereby charging the capacitor 30. Assuming an operating voltage of 1500 volts supplied by the transformer 25 and a critical or breakdown voltage e_2 of the flash tube 13 of about one-third this value, that is, 500 volts, the tube 13 will be ionized upon reaching point P_2 of the alternation, thus initiating a high intensity ionic discharge *f'*, Fig. 8, which is instantly reinforced by a substantial current or energy component *f* directly from the source 22 through the transformer 26, the tube 28 offering a relatively low impedance during the duration of the pulses *p*. At the same time, the duration of the flash is extended to about one-third of the alternation, that is $\frac{1}{360}$ sec. in the case of a 60-cycle power supply.

The flash is extinguished when the tube 27 ceases to supply ionizing pulses *p* at the point P_3 of the alternation, thus increasing the impedance of the tube 28 until the next operating cycle or alternation *a*. As a result, substantially all the power dissipated in the flash and converted into light energy is supplied by the source 22, the capacitor 30 merely serving to determine the initiation of the flashes during each alternation and to thereby stabilize the action repeated during each successive alternation. This, in turn, results in a practically continuous light output which may be controlled both in intensity and/or duration to suit any existing conditions and requirements.

In the simplified circuit as shown, the ionizing pulses *p*, shown in the form of straight lines in Fig. 1, are directly superimposed upon the operating voltage pulses or alternations *a*, it being understood that the discharge control may be effected by means of an additional starting electrode, in the manner shown in Fig. 9. The latter further differs from Fig. 6 by the provision of a separate power supply for the flash tube and ionizing pulse generator in the form of two transformers 25 and 26, respectively. The invention also provides a simple means for and method of controlling the total flash output and or duration of the individual flashes by varying the amount of the supplementary energy in any suitable manner, such as by controlling the voltage of the power source by means of a step transformer, as shown at 35 in Fig. 9, or by any other suitable means.

Fig. 10 shows a simple D.C.-operated flash lighting system according to the invention comprising a battery 40 or the like, the switching tube 28 and ionizing pulse generator 41, all connected in series with the stabilizing capacitor 30 which is shunted across the flash tube 13. In operation, tube 28 is first ionized by a pulse *p*, Fig. 12, to charge the capacitor 30. After the latter has been charged to a sufficient voltage, the flash tube 13 becomes in turn ionized, producing an instantaneous light flash *f'* by the capacitor discharge followed by a supplementary component *f* directly supplied by the source 40. All this happens within the duration of a single pulse *p*, thus resulting in a continuous series of high-intensity light flashes at the ionizing pulse recurrence frequency.

Fig. 11 shows a modification of a D.C.-flash lighting system including means to produce a series of trains of light flashes of greater duration for use as a beacon light or the like. For this purpose there is shunted across the capacitor 30 a self-running relaxation oscillator producing a periodic ionizing potential at a sub-multiple of the recurrence frequency of the pulses *p*, and being applied to the starting electrode 16 of the flash tube 13. The ionizing oscillator shown comprises a resistor 43 in series with a capacitor 44, the latter being shunted by a neon or equivalent gaseous discharge tube 45.

In operation, the capacitor 44 is charged according to curve *g*, Fig. 13, during successive ionizing pulse periods *p* and within a time period t_1 until reaching the breakdown potential of the tube 45 at which time the charge collapses causing a high voltage potential surge to be applied to the electrode 16 by way of a step-up transformer 46. As a result, the capacitor 30 having been charged simultaneously by the source 40 discharges through the tube 13 during the time t_2 as shown at *c*, causing thereby an instantaneous light flash *f'* followed by a supplementary discharge *f* directly from the source 40. By the proper choice of the frequency of the relaxation oscillator determined by the resistor 43 and capacitor 44, intermittent high-intensity light flashes may be produced of any desired length and spacing intervals.

Again, since the frequency of the ionizing oscillators 43, 44, 45 determining the flashing rate of the tube 13 is a substantial submultiple of the peaked pulse wave generator 41, the tube 13 will be intermittently directly connected to the source 40 through the switching tube 28 during a flash discharge period, to result in an incremental direct energy supply to the tube 13.

In Fig. 11, the ionizing pulse voltage generator 41 is shown in the form of a transistor blocking oscillator to reduce weight and bulk of the apparatus when used as an emergency beacon or the like. In order to further improve the operation and to reduce the drain on the battery 40, the latter is advantageously shunted by a further stabilizing capacitor 48 of suitable size.

If the device is used as an emergency light beacon, it may be simply combined with a distress radio signal transmitter by causing the voltage pulses *p* to shock excite a resonant transmitting circuit 50 connected to an antenna 51, to produce a series of damped radio wave trains as indicated at *r* in Fig. 13. In this manner, the location of an accident can be ascertained first by the bearing of the long-range radio signal and thereafter by a close-range light beacon.

In the foregoing the invention has been described with reference to a few specific and illustrative devices. It will be evident, however, that changes and variations, as well as the substitution of equivalent parts and circuits for those shown, may be made without departing from the broader spirit and scope of the invention as set forth in the appended claims. The specification and drawings are accordingly to be regarded in an illustrative rather than in a limiting sense.

This application is a continuation-in-part of my application Serial No. 495,636, filed on March 21, 1955 entitled Electronic Luminous Device, now abandoned.

I claim:

1. A capacitor flash light system comprising a gaseous flash discharge tube, a capacitor connected in parallel to said tube, a voltage-sensitive impedance device, a source of energy connected to said capacitor in series with said device, means to effect an alternate charging of said capacitor by said source through said device and a discharge thereof through said tube in a series of luminous flash discharges having a predetermined repetition frequency, and further means producing a series of peaked high-voltage pulses having a repetition frequency equal to a substantial multiple of said first repetition frequency and controlling said device, to cause alternate conducting and non-conducting periods thereof resulting in an intermittent incremental energy supply directly from said source to said tube during a flash discharge period.

2. A capacitor flash light system comprising a gaseous flash discharge tube, a capacitor connected in parallel to said tube, a gaseous switching tube, a source of energy connected to said capacitor in series with said switching

tube, means to effect an alternate charging of said capacitor by said source through said switching tube and a discharge thereof through said flash tube in a series of luminous flash discharges having a predetermined repetition frequency, and further means producing a series of peaked high-voltage pulses having a repetition frequency equal to a substantial multiple of said first repetition frequency, to periodically ionize said switching tube and to cause alternate conducting and non-conducting periods thereof resulting in an intermittent incremental energy supply directly from said source to said flash tube during a flash discharge period.

3. In a capacitor flashing light source as claimed in claim 2, said last means being connected in series with said source and said switching tube.

4. In a capacitor flashing light source as claimed in claim 2, an ionizing electrode for said switching tube, said last means being connected to said electrode.

5. In a capacitor flash light system as claimed in claim 2, said first means consisting in said source being an alternating current source designed to effect a charge of said capacitor during a predetermined, including unity, number of positive half-cycles of said source, and said last means producing a series of peaked high-voltage pulse trains during and in synchronism with said positive half-cycles of said source.

6. In a capacitor flashing light source as claimed in claim 2, said source being a direct current source and said first means including a relaxation oscillator having a frequency equal to a submultiple of said last-mentioned frequency, and means to periodically ionize said flash tube by said oscillator.

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