

March 31, 1931.

J. W. LEGG

1,798,689

METHOD OF AND APPARATUS FOR GENERATING ENERGY BEAMS

Filed April 28, 1927

Fig. 1.

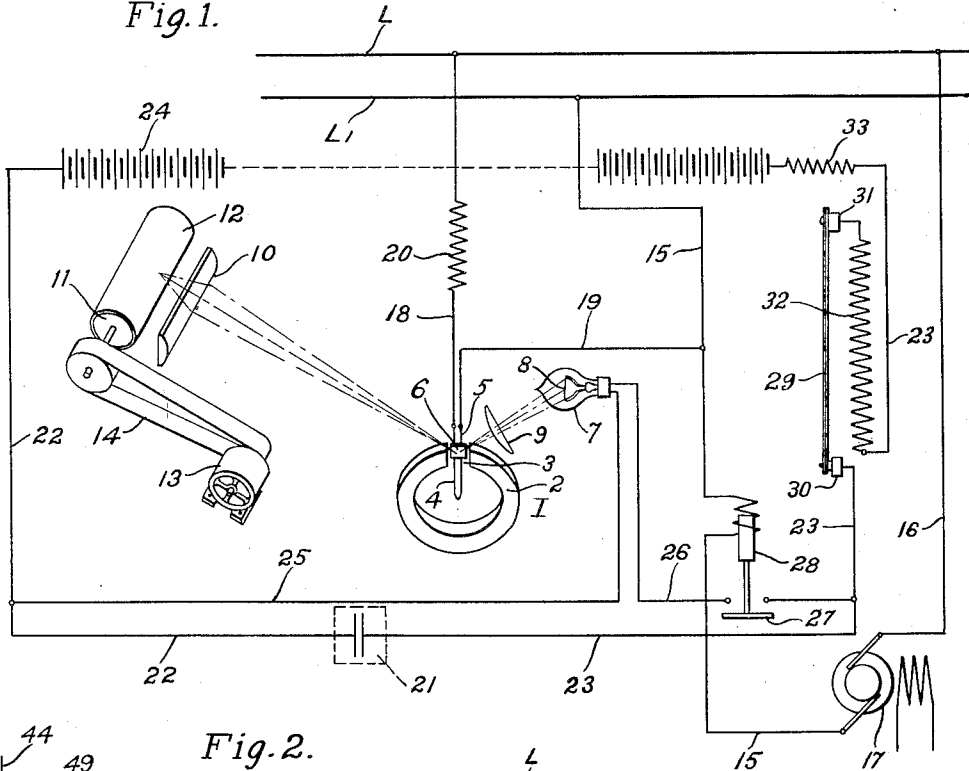
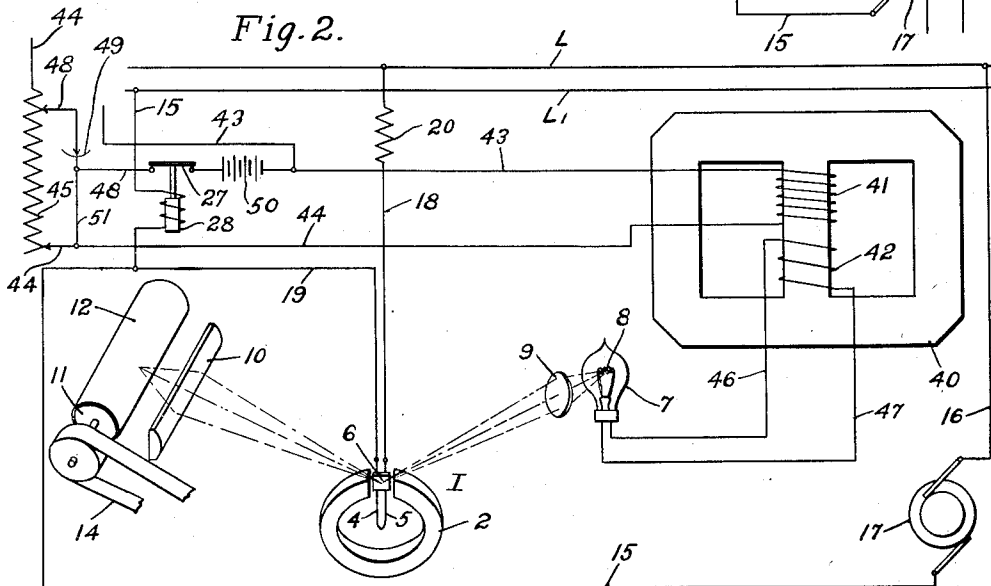


Fig. 2.



WITNESSES:

W. J. Keller.
Lyman D. Oberlin.

INVENTOR

Joseph W. Legg.

BY *Charles H. Legg.*
ATTORNEY

UNITED STATES PATENT OFFICE

JOSEPH W. LEGG, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

METHOD OF AND APPARATUS FOR GENERATING ENERGY BEAMS

Application filed April 28, 1927. Serial No. 187,319.

My invention relates to the art of operating an energy-consuming device and has particular relation to arrangements for supplying energy to energy-beam-generating structures such, for example, as sources of light for oscillograph or recording systems.

In accordance with my invention, an energy-beam-generating structure or source of light, utilizable as aforesaid and, usually, while in its non-operative or cold state, is supplied, preferably momentarily, with an excessive quantity of energy.

Further in accordance with my invention, the aforesaid energy-beam-generating structure or source of light, after initial energization, is maintained at a desired operating condition or degree of luminosity, preferably by a source of energy separate from that producing initial energization and supplying energy at a rate suitable to the requirements of the structure or source of light.

Further in accordance with my invention, operation of an oscillograph or recording system, as aforesaid, is initiated by the occurrence of an event changing a characteristic, as magnitude, of a quantity to which the vibratory or deflecting system of the oscillograph or recorder is responsive, which event may be a manually effected control and, when the quantity is of an electrical nature, the occurrence of an abnormal circuit condition, either chance or otherwise, as a short-circuit excessive flow of current, sub-normal voltage, or the like, such abnormal circuit condition being hereinafter characterized a "transient."

More particularly, in accordance with my invention, in response to occurrence of an event, as described above, operation of a suitable control device, as a quick-acting relay, is effected, whereby an excessive amount of energy is momentarily supplied to the light source of the oscillograph or recording system.

My invention resides in the system, method and apparatus of the character hereinafter described and claimed.

This application is a continuation in part of my pending application Ser. No. 114,187, filed June 7, 1926.

For an understanding of my method and for an illustration of some of the various forms my apparatus may take, reference is to be had to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of an oscillograph system embodying my invention.

Fig. 2 is a diagrammatic view of an oscillograph system of a modified form.

By my invention, the filament of the light source for an oscillograph or recording system is heated to a high temperature, in a very brief period of time, by the discharge of an adequate quantity of stored electrical energy, as from a condenser or inductance, through the said filament which is subsequently maintained at a desired temperature by another energy supply. The time consumed to provide the illumination necessary to the operation of the instrument is so brief as to be almost negligible, and no shutter need be used to make photographs. Thus, the record may start practically instantaneously with the discharge of the stored energy into the light source.

In Fig. 1, is illustrated galvanometer mechanism 1 of any suitable character, for example, such as is disclosed in my prior applications Serial No. 757,586, filed December 23, 1924, or Serial No. 5,166, filed January 27, 1925. When constructed in accordance with either of said last named applications, the galvanometer mechanism comprises a permanent magnet 2 formed of suitable material and having spaced pole faces forming a flux gap 3 in or through which the vibratory system is mounted or extends. As is well understood in the art, a vibratory system of this character may comprise a pair of conductors 4 and 5 of suitable material having great tensile strength and low resistance and having a mirror 6 cemented, or otherwise suitably secured thereto. The conductors 4 and 5 are suitably mounted for oscillatory movement, which arises because the conductors are either joined together at adjacent ends or comprise one integral conductor bent upon itself and because a current is passed along one conductor in one direction and then along the other

in reverse direction, the fields of force thus set up coacting with the magnetic field in the gap 3 to produce the vibratory or oscillatory movement.

5 A suitable source of light 7, energized as hereinafter particularly described, comprises, in the example shown, an evacuated bulb 7 containing a straight filamentary conductor 8 from which a beam of light passes
10 through the lens 9 to the mirror 6 from which said beam is reflected and, after passing through the lens 10, coacts with a viewing or recording structure of any suitable character. As herein illustrated, said structure last
15 named comprises a drum or cylinder 11 having disposed thereon a suitable light-sensitive surface or film 12, the drum 11 being continuously rotated in any suitable manner, as by the motor 13 operating the belt 14 connected
20 to said drum.

As is well understood in the art, the aforesaid mechanism comprising the bulb 7, galvanometer 1 and film 12 should be suitably shielded, whereby only the beam of light passing
25 to the mirror 6, or other desired light beams, reaches the film 12.

As shown in Fig. 1, the mains L and L_1 of a power line or circuit are supplied with energy over the conductors 15 and 16 connected
30 to a suitable source of energy 17, herein illustrated as a direct-current generator.

Connected across the mains L, L_1 , or the conductors 15 and 16, are the conductors 18 and 19 connected, respectively to the aforesaid
35 conductors 4 and 5 of the galvanometer vibratory system. In circuit with one of the conductors 15, 16 is a resistance 20 utilizable for keeping the current in the conductors 4 and 5 substantially in phase with the line
40 voltage.

In case it is found desirable to record the voltage across the line during persistency of a chance transient, the vibratory system of the galvanometer mechanism may be left connected
45 thereto, as indicated, but, since a chance transient of the character specified may not occur for days, weeks or even months, it is not practical to maintain filament 8 in its incandescent state. However, if said filament
50 is left unheated and energy is supplied thereto upon occurrence of the transient, only at normal rate, an appreciable period of time will elapse before the recording operation is initiated. As a result, therefore, the record
55 will not be complete.

In accordance with my invention, the source of light is left in its normally inoperative state but, upon occurrence of the chance transient, an excessive quantity of energy is
60 momentarily supplied thereto. Then, after the source of light has been brought to the proper degree of luminosity, energy is supplied thereto at substantially the normal rate.

65 To this end, any one of a variety of ar-

rangements may be utilized, one of which is illustrated in Fig. 1 as comprising a suitable energy-storing device, as a capacity 21,
70 the terminals of which are connected by the conductors 22 and 23 to the terminals of a suitable energy-supplying device, as the battery 24. Connected, respectively, to the conductors 22 and 23 are the conductors 25 and
75 26 leading to the respective terminals of the filamentary member 8. A set of fixed contacts interposed in either of the conductors 25 and 26 is adapted to be bridged by a conductive member 27 of a quick-acting relay or solenoid 28, the winding of which, in the example shown, is in circuit with the conductor
80 15.

The conductor 23 may comprise a bimetallic element or strip 29, one end of which is movable with respect to a contact 30 and the other end of which is fixed to a contact 31
85 to which is connected one end of a resistance 32 disposed in suitable heat-exchanging relation with respect to the bimetallic element 29. The other end of resistance 32 may be conductively related to a resistor 33 which, in
90 turn, is connected to one terminal of the battery 24.

The condenser 21 may be a standard condenser and of sufficient capacitance to hold a quantity of electrostatic energy when
95 charged to the potential of the battery 4, to heat the filament 8 to at least its normal brilliancy. The battery 24 should be of such voltage as to be capable of supplying sufficient energy to energize the condenser 21 so
100 that it may perform its function of heating the filament 8, and, when the relay 28 is closed, to maintain the filament 8 at a normal or higher degree of luminosity.

The operation is as follows:

105 During persistence of a period when the line circuit is in normal operating condition, the relay 28 remains in the position illustrated, that is, with its conductive member 27 removed from the fixed contacts coacting
110 therewith. At this time, the condenser 21 is charged by, and to the potential of, the battery 24, and, after it is thus charged, flow of current ceases in the conductors 22, 23. Upon occurrence of a chance transient, such
115 as a short-circuit, a surge of current, or the like, in the line L, L_1 , the relay 28 is energized sufficiently to cause its conductive member 27 to move into engagement with the fixed contacts coacting therewith. Ordinarily, the
120 relay 28 comprises a suitable locking arrangement by which it is locked in the position last noted. In so doing, the terminals of condenser 21 are connected directly across the terminals of the filament 8 and all, or
125 nearly all, of the energy stored in the condenser is discharged through the filament 8, heating the same to at least normal normal brilliancy or to such high degree of lumi-
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nosity that, immediately after the closure of relay 28, the mirror 6 receives a beam of light from said filament 8 and reflects the same upon the rotating light-sensitive surface 12.

To thus bring the filament 8 to such high degree of luminosity, the condenser 21 should be of such capacitance that the filament is momentarily supplied with an excessive quantity of energy. Under such conditions of use, damage to the filament does not ordinarily result because the condenser 21 discharges in an exceedingly brief period of time.

When the contact member 27 closed upon its coating contacts, the battery 24, as well as the condenser 21, was connected across the terminals of filament 8. Accordingly, substantially at the time that the energy of condenser 21 becomes exhausted, the slower acting source of energy, namely, the battery 24, takes up the load and maintains filament 8 in its luminous condition, the magnitude of the current thus flowing being dependent upon the resistance of the member 33.

Battery 24 continues to supply energy to filament 8 for a period depending upon the characteristics of bimetallic element 29. Eventually, however, under the influence of the heat radiated from resistance 32, the free end of said element 29 moves from its contact 30, and the supply of energy to filament 8 is discontinued. Bimetallic element 29 may be of such character that it will not automatically return into engagement with contact 30 when it cools, or suitable mechanism, not shown, may be provided to hold the same in its deformed position.

During the period of operation thus instigated, the conductors 4 and 5 are traversed by a current varying in accordance with changes in a characteristic of the quantity being observed. That is, in the example shown, the current passing through the conductors 4 and 5 is proportional to the line voltage and, since the amplitude of vibration of said conductors 4 and 5 and the mirror 6 is proportional to the instantaneous magnitude of said current, a record is formed on the moving film 12 that is indicative of the instantaneous magnitudes of the voltage across the conductors L, L₁.

Thereafter, rotation of motor 13 may be discontinued, and a new film substituted for the exposed film 12. With the motor 13 again in operation, relay 28 may be re-set to move contact member 27 from its coating contacts. Then with the movable end of bimetallic element 29 back in engagement with its contact 30, the condenser 21 will be recharged and the entire apparatus will be in condition for another operation.

The apparatus described above provides for instantaneously or substantially instantaneously lighting the filament 8 and thereby causing a record to be made on the film be-

ginning virtually the instant the transient is of sufficient magnitude to close the relay 28. By way of example merely, it may be stated that, if the filament 8 is supplied with normal current, at least one second will elapse before full brilliancy is attained, and, if the voltage supply is at normal value, somewhat less 0.1 second will be required to attain full brilliancy. However, with the arrangement described above, the filament 8 may be brought to full photographic brilliancy in a period of time of the order of 0.001 second or less.

Ordinarily, it is desirable that energy be supplied to the filament 8 by the battery 24 at a rate somewhat greater than the normal rate at which energy should be supplied thereto, although, for a given period, the quantity supplied is not nearly so great as is supplied by the condenser 21 during an equal period. In so doing, an abundance of light is obtained for photographic purposes.

In Fig. 2, is illustrated a form of my invention wherein a transformer 40 of any suitable type, and preferably relatively large, is utilized, in lieu of the condenser 21 of Fig. 1, as a source of energy for the filament 8. Transformer 40 comprises a primary winding 41 and a secondary winding 42, the former comprising the greater number of turns and being connected by the conductors 43 and 44 to a suitable source of alternating current, not shown. Interposed in the circuit of conductors 43 and 44 is an adjustable resistance 45. Secondary winding 42 is connected by the conductors 46 and 47 to the terminals of the aforesaid filament 8.

Adjustably coating with the resistance 45 is one end of a conductor 48, the other end of which is connected to the conductor 43. The conductor is asymmetrical in character and, hence, comprises a rectifying device 49 of any suitable type. Conductor 48 also includes a suitable source of direct current 50, as a low-voltage storage battery, and the fixed contacts with which coats the conductive member 27 of the relay 28. Connected to the conductor 48 between the rectifying device 49 and member 27 is one end of a conductor 51, the other end of which is connected to the conductor 44, as shown.

The operation of the form of my invention illustrated in Fig. 2 is as follows:

With the relay 28 positioned as shown, that is, when member 27 is closed upon its coating contacts, a pulsating-uni-directional current flows from the source of alternating current through the conductor 44, a portion of resistance 45, conductor 48, including the rectifying device 49, member 27 and battery 50, thence through conductor 43 to the source of alternating current. In so doing, battery 50 is maintained in a charged condition.

It will be observed that the end of conductor 48 is so placed with respect to resistance 45 that but a relatively small part of said re-

sistance is included in the aforesaid charging circuit for the battery 50. A substantially greater portion of resistance 45 is included in the circuit of primary winding 41 but there is little or no flow of current from the alternating-current source through the primary winding 41, although some alternating current flows through the lower part of resistance 45, conductors 44, 51, 48, contact plate 27, battery 50, and conductor 43, but this is small compared with the uni-directional current passing through the rectifying device 49.

Battery 50, when the parts are positioned as indicated in Fig. 2, in the course of time establishes and maintains a strong electromagnetic field in the core of transformer 40 and without effect on the filament 8. Current for thus establishing this magnetic field flows from one terminal of battery 50 through the conductor 48 including the contact member 27, conductor 51, conductor 44, the primary winding 41, and thence by way of conductor 43 back to the other terminal of battery 50.

The relay 28, upon the occurrence of a transient or other event, is energized and moves its conductive member 27 from the contacts coacting therewith, rather than into engagement with said contacts as in the system illustrated in Fig. 1. Upon thus moving the contact member 27 from its coacting contacts, the prior-existing circuit of the primary winding 41 through the battery 50 is opened and, as a result, the stored energy in the magnetizable structure of the transformer 40 suddenly induces a current in the secondary winding 42, which, by means of conductors 46 and 47, is transferred to the filament 8. The transformer 40 and the current from battery 50 should be so designed, dependent upon the characteristics of the incandescent filament, that as was the case with the construction illustrated in Fig. 1, an excessive quantity of energy is momentarily supplied to filament 8, whereby it is quickly brought to substantially its normal luminous condition or to some degree of super-luminosity, if desired.

When the circuit through the conductor 48 was broken by the conductive member 27, current from the alternating-current source, not shown, flows by way of conductors 43 and 44 to the primary winding 41. By the time the stored energy in the transformer 40 has been discharged, as described above, the current from the alternating-current source has been established in the primary winding 41 and thereafter, so long as the circuit through the conductors 43 and 44 remains closed, or while the contact member 27 remains removed from its coacting contacts, current is induced in the secondary winding 42 of sufficient magnitude to maintain the filament 8 substantially at, or somewhat above its normal state of luminosity. The current taken by the transformer 40 to supply the filament 8 is so small that the

drop in potential in the portion of resistance 45 which parallels the valve 49 is less than the normal operating potential of the valve 10; accordingly, the latter is substantially eliminated during the operation last described.

It will be understood that, in lieu of the quick-acting relay 28 shown in Figs. 1 and 2 any suitable structure of different character may be utilized, which structure, however, shall be responsive to the transient or other event and shall function to connect the source of light to its supply of energy.

By utilizing the system shown in Fig. 1, an initial discharge of stored energy to the source of light is established somewhat more quickly than with the generally equivalent system illustrated in Fig. 2. Moreover, with the system illustrated in Fig. 1, the stored energy of the condenser 21 is more expeditiously applied to the filament 8 than with the system illustrated in Fig. 2, although, in the latter case, other things being equal, a relatively greater amount of energy may be generated when the control relay 28 is opened. Hence, it is ordinarily desirable, with the system illustrated in Fig. 1, to utilize an evacuated bulb containing a suitable filament of refractory material, while, for the system illustrated in Fig. 2 a very much larger filament in an evacuated bulb containing an inert gas may be provided. Also, with the arrangement last named, a suitable structure, not shown, and comprising a narrow slot should be interposed between the bulb 7 and mirror 6 in the path of the light beam passing thereto.

It is to be understood that the quick-acting relay, or equivalent device, may be actuated in any suitable manner or connected in any suitable arrangement with respect to the circuit to be observed. Thus, said relay, or equivalent device, may be connected in the secondary of a current transformer or, should it be desirable to initiate operation of the oscillograph or recording system in response to abnormal low voltage, such relay, or equivalent device, might be connected to the secondary winding of a voltage transformer.

It is also to be understood that my invention comprehends the utilization, in an oscillograph or recording system, of galvanometer mechanism of any desired character, which galvanometer mechanism may have the coil of its vibratory system, or equivalent, so connected as to obtain a record or indication of changes in a characteristic of any quantity which it is desired to observe. Thus, although the drawings illustrate a system for recording variations in voltage across a power circuit, it is obvious that the conductors 18 and 19 leading to the conductors of the vibratory system may be connected across a current shunt, whereby a record of current variations in the power circuit during persistence

of an abnormal circuit condition is obtained. Or, the current-carrying conductors of the vibratory system, or equivalent, may be traversed by a current, the instantaneous magnitude of which varies in accordance with changes in a characteristic of any quantity, electrical or otherwise.

It shall also be understood that the deflecting system of the galvanometer mechanism may be suitably damped or controlled whereby there may be obtained a record of average, instead of instantaneous, values of the quantity being observed.

I claim as my invention:

1. In a system for recording a disturbance on a line a vibratory system including a mirror, a light-sensitive surface, a source of light for transmitting a beam of light to said mirror and thence to said surface, means including a relay directly connected to said line and responsive to the occurrence of an event for supplying said source of light first with an excessive quantity of energy and immediately thereafter with energy at a reduced rate, means for holding said relay closed after a response to said event and means for stopping the flow of energy to said lamp after a predetermined time.

2. A recording system comprising a vibratory system including a mirror, a light-sensitive surface, means including an incandescent lamp for transmitting a beam of light to said mirror and thence to said surface, a condenser, a direct-current voltage source connected to said condenser through the heater coil of a thermal relay, means, including a relay responsive to the occurrence of an event, for connecting said lamp across said condenser, means for holding said relay closed after a response to said event, and means, including said thermal relay, for stopping the flow of energy to said lamp after a predetermined time.

In testimony whereof, I have hereunto subscribed my name this 21st day of April, 1927.

JOSEPH W. LEGG.

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