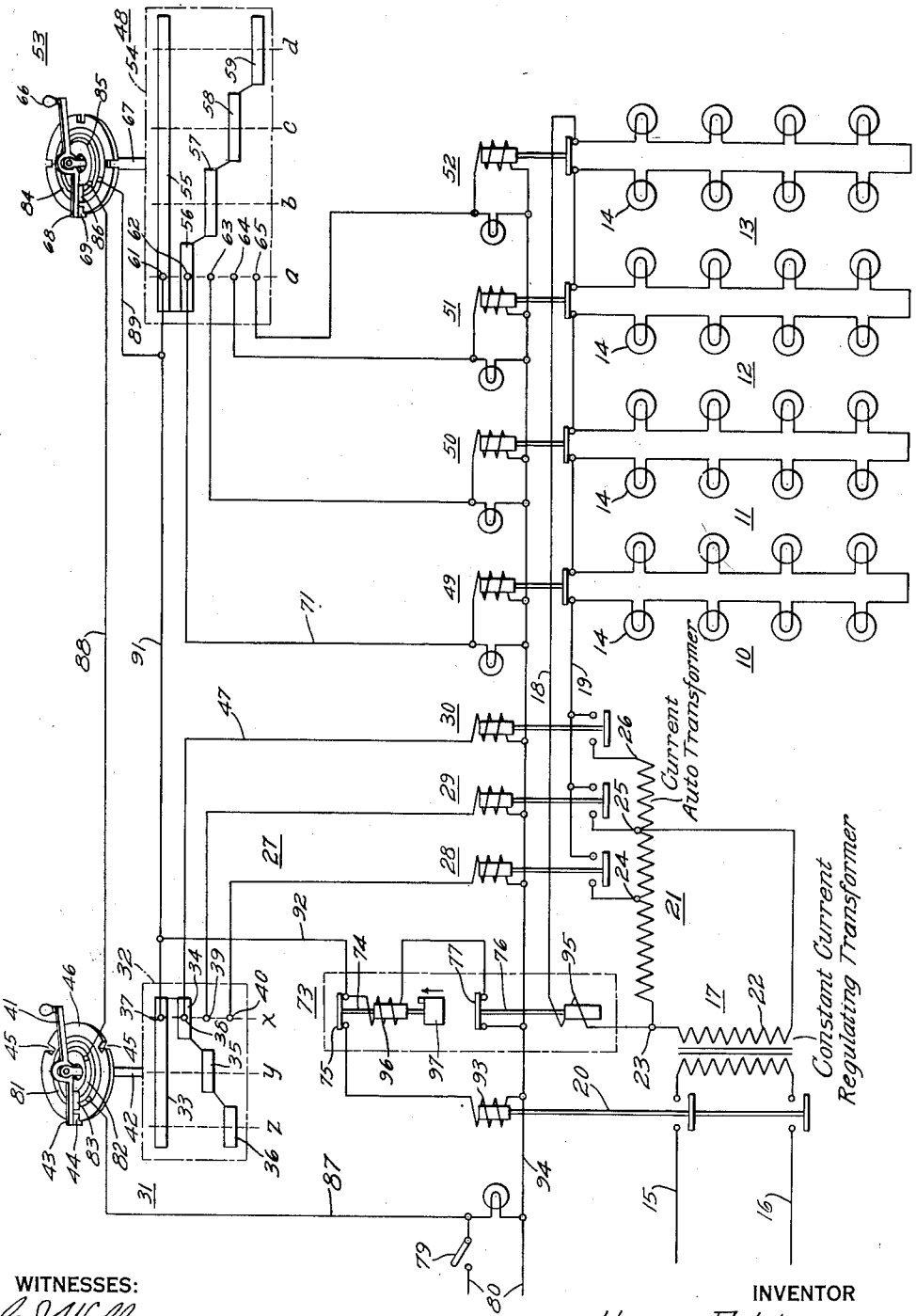
March 28, 1944. H. E. LIPPMAN 2,345,135

LIGHTING CONTROL SYSTEM

Filed April 17, 1940



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Patented Mar. 28, 1944 2,345,135

UNITED STATES PATENT OFFICE

2,345,135

LIGHTING CONTROL SYSTEM

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Application April 17, 1940, Serial No. 330,091

13 Claims. (Cl. 315—293)

My invention relates, generally, to lighting control systems, and, more particularly, to systems for selectively controlling the operation of runway marker or contact lights for airports and the like.

Large airports and landing areas for aircraft are usually provided with a plurality of runways for the landing and taking off of aircraft, which extend in different predetermined directions and which are lined or marked on either side by contact lights usually partially embedded in the runway surface in spaced relation to project beams with maximum candlepower approximately 10 degrees above the horizontal, having a narrow vertical divergence and being either uniform throughout all angles of azimuth or consisting of two main beams emitted in essentially opposite directions.

The contact lights of each runway are usually operated on a series circuit, and heretofore have been operated at a predetermined definite brightness as determined by a constant current of 6.6 amperes, for example. It has been determined, however, that it is desirable, and even necessary in certain instances, to change or vary the brightness of the contact lights to conform to various degrees of atmospheric transmissivity for the reason that at normal light output the brightness will be too great during clear weather, of about the correct brightness during light fog, and inadequate during heavy fog or when visibility is quite low.

Since only one runway is used at a time depending on the wind direction or other factors determining the proper selection of a runway direction, it is also desirable to provide an effective arrangement for selecting the runway to be lighted and the brightness of the contact lights thereof by means of a single control system.

Accordingly, it is the object of my invention, generally stated, to provide a system for selectively controlling the operation of the contact lights on airport runways.

A more specific object of my invention is to provide for selectively controlling the brightness of a plurality of contact lights associated with the runway of an airport or the like.

Another object of my invention is to provide a system for controlling the operation of contact lights which may be operated to select the contact lighting circuit associated with any one of a plurality of runways, and select or predetermine the brightness of the contact lights of the circuit before the circuit is energized.

A further object of the invention is to provide for selectively operating any one of a plurality of contact lighting circuits from a single source of supply and selectively controlling the brightness of the contact lights of the selected circuit.

A still further object of my invention is to provide, in a control system of the above-described character, for so interlocking the runway selector control with the brightness control that neither one may be operated during the time the selected contact lighting circuit is energized and in operation without automatically deenergizing the energized lighting circuit.

Another object of my invention is to provide, in a selection and brightness control system for contact lighting circuits, for automatically disconnecting the source of power supply from the circuit in response to failure of the energized lighting circuit.

These and other important objects of my invention will become more apparent from the following detailed description when read in conjunction with the drawing, wherein the single figure is a diagrammatic view of a control system embodying the principal features of my invention.

In practicing my invention in accordance with one exemplary embodiment thereof, a plurality of series contact lighting circuits are connected for operation from a single supply source through a plurality of runway selector relays, a plurality of brightness control relays, an autotransformer, a constant current regulator, and a main line switch. The runway selector relays are selectively controlled by a runway selector controller, and the brightness control relays by a brightness selector controller. These selector controllers function to preselect the particular runway selector and brightness control relays which will be operated when a master switch is closed to energize the main line switch. The master switch, the runway selector controller, the brightness controller, and a protective relay device are so electrically interlocked that the contact lighting circuit in use will be automatically deenergized upon the attempted operation of either the runway selector controller or brightness selector controller to a different position, and also the protective relay device will function to open the main line switch upon failure of the contact lighting circuit which is energized and in use.

Referring to the drawing, the numerals 10, 11, 12 and 13 designate the contact or runway marker lighting circuits of an airport, each circuit being associated with a different runway, and the lamps or lighting units 14 thereof being con-

nected in series circuit relation to provide the well-known arrangement of a series lighting circuit which is usually operated at a predetermined value of constant current on the order of 6.6 amperes.

The lighting circuits may be energized from any suitable power source represented by conductors 15 and 16 through a constant current regulating transformer 17 of well-known construction. The connection of the primary winding of the regulating transformer 17 to the supply conductors 15 and 16 may be controlled by a line switch 20 having an operating winding which is remotely controlled, as will be described more in detail hereinafter. In this instance, the series lighting circuits are all normally connected in series circuit relation to the supply conductors 18 and 19, although it is to be understood that any other suitable circuit arrangement may be used.

In the operation of systems of this kind, it is desirable to provide for operating any one of the lighting circuits depending upon the runway which is desired to be used, and also to provide for controlling the brilliancy or brightness of the contact lights in accordance with atmospheric conditions. Under weather conditions where a light fog prevails, the lighting circuit in use may be operated at the normal current value of 6.6 amperes to produce satisfactory illumination to enable the pilots of the airplanes to determine the limits of the runway. This normal light output has been found to be too bright under clear or more favorable weather conditions, and inadequate during adverse weather conditions, as during a heavy fog. Accordingly, it is desired to provide for operating the lighting circuit at a brightness which is less or greater than the normal value which may be produced by operating at different values of current above and below the normal value.

In this instance, this result is accomplished by utilizing an autocurrent transformer 21, which is connected across the secondary or output winding 22 of the regulating transformer 17, as shown. The supply conductor 18 is connected to one terminal 23 of the autocurrent transformer, and provision is made for connecting the other supply conductor 19 to any one of the current taps 24, 25 and 26. In this instance, the tap 25 is the one which is used to produce normal light output or brightness, tap 26 produces a light output or brightness below normal, and tap 24 a light output or brightness above normal.

The control of the brightness of the lighting circuits may be effected by means of the brightness control arrangement 27, which comprises control relays 28, 29 and 30 and a brightness selector controller 31.

In this instance, the brightness selector controller 31 is of the manually operable type, and comprises a movable drum 32 having a plurality of segments 33, 34, 35 and 36 thereon, which are disposed to engage stationary contact fingers 37, 38, 39 and 40. The drum may be actuated by means of an operating handle 41 connected thereto by means of a shaft 42, the operating handle being provided with an extension 43 carrying a detent 44 disposed to engage any one of the three notches 45 in the stationary plate 46 which determines the operating position of the drum.

The controller 31 is utilized to predetermine or preselect which one of the brightness control relays 28, 29 and 30 is to be operated. When the controller is in the first position x, as shown, an operating circuit is partially established for the control relay 30 through the conductor 47. Operation of the drum to positions y and z likewise partially establish operating circuits for the control relays 29 and 28, respectively.

In order to provide for selecting one of the lighting circuits and rendering it effective for operation, a runway selector control 48 is provided. This control may comprise a plurality of selector relays 49, 50, 51 and 52 and a manually operable drum controller 53. This controller is similar to the brightness selector controller 31, except that it is provided with an additional contact segment on the drum, making it a four-position controller instead of a three-position controller, as in the case of the controller 31. It comprises a drum 54 having segments 55, 56, 57, 58 and 59 which are disposed to engage the stationary fingers 61, 62, 63, 64 and 65, respectively. The drum is connected to the operating handle 66 through a shaft 67, and the handle is provided with an extension 68 provided with a locking detent 69.

In this instance, the selector relays 49 through 52 are provided with normally closed contact members which short-circuit their associated lighting circuits. Any one of the lighting circuits may be rendered effective for energization by opening the relay, which performs the same function as that of connecting the lighting circuit to the source of supply. Any other suitable arrangement may be used to produce the same general results.

When the controller 53 is in the position a, as shown, an operating circuit is partially established for the selector relay 49 through the conductor 71. Operation of the controller to positions b, c and d likewise partially establishes operating circuits for the selector relays 50, 51 and 52, respectively.

In order to provide for automatically effecting the disconnection of the lighting circuit in operation from the power source upon failure of the circuit, such, for example, as a break in the conductor comprising the secondary circuit of the transformer 17, a protective relay device 73 is utilized. This device may comprise a delayed opening relay 74 having normally closed contact members 75, and a second relay 76 also having normally closed contact members 77. The operation of this device will be described more in detail in the description of the operation of the system.

In describing the operation of the system, it will be assumed that the operator desires to utilize the lighting circuit 10 and operate it at a lower brilliancy than normal. As described hereinbefore, the setting of the controllers 31 and 53, as shown, is such as to preselect this lighting circuit and predetermine its brightness when energized.

The energization of the selected lighting circuit at the selected brightness is controlled by a master switch 79 connected in the control circuit which is energized from the control source 80, the control arrangement being such that the operation of the master switch 79 effects the simultaneous operation of the main switch 20 and the preselected control and selector relays—in this instance, the relays 30 and 49.

The control is also arranged to provide for effecting the automatic release of the line switch 20 in the event that an attempt is made by use of either one of the controllers 31 and 53 to change to a different brightness or to a different

lighting circuit while the master switch 79 is closed.

These features are provided by extending the control circuit for the line switch 20 and control and selector relays through suitable interlocking switches on the controllers 31 and 53. In this instance, the controllers 31 and 53 are so arranged that, in the event the actuating handle is operated to release the drum for movement, the operating circuit for the line switch, etc., is interrupted. Any suitable switch arrangement may be utilized. However, in this instance, it is shown on the controller 31 in the form of a pair of contact rings 81 and 82 bridged by a contact element 83 carried on the extension 43 of the controller handle. The construction of controller 53 is identical, and need not be described in detail except to point out that the contact rings are indicated by numerals 84 and 85 and the bridging contact element by 86. It will be understood that this arrangement provides an effective electrical interlock, and while it does not prevent operation of either one of the controllers 31 and 53, it does prevent any new selection of lighting circuits or brightness thereof without first deenergizing the circuit in use.

When the master switch 79 is closed, an operating circuit is established from the upper conductor of the source 80 through the master switch 79, conductor 87, the contact rings 81 and 82 bridged by the element 83, conductor 88, contact rings 84 and 85 bridged by the element 86, conductors 89, 91 and 92, contact members 75 of the protective device, operating coil 93 of the line switch and conductor 94 to the other side of the source 80. The energization of this circuit effects the operation of the line switch 20 to connect the regulating transformer 17 to the power supply.

Concurrently with the establishment of this circuit, the operating circuits for the control relay 30 and selector relay 49, which were partially established by the setting of the controllers 31 and 53 in positions x and a, respectively, are also completed through the controller drums. The operating circuit for the selector relay 49 extends from the energized conductor 89 through contact fingers 61 and 62 bridged by the segments 55 and 56, conductor 71, coil of the relay 49, and the common conductor 94 to the other side of the control source 80. The energization of this circuit effects the opening of relay 49 and renders the lighting circuit 10 effective. The operating circuit for the control relay 30 extends from the energized conductor 91 through the contact fingers 37 and 38 bridged by the segments 33 and 34, conductor 47, coil of the relay 30 and common conductor 94 to the other side of the control source 80.

Since all three of these circuits are established at the same time, it will be understood that operation of the main switch and the control and selector relays takes place at substantially the same time.

As stated hereinbefore, the protective device 73 functions to automatically open the line switch in the event that a break occurs in the secondary circuit of transformer 17. In order to effect this result, the relay element 76 of the protective device has its operating coil 95 connected in series with the lighting circuit in operation across the transformer 21, so that, as soon as the lighting circuit is energized, the relay is operated to open its contact members 77. As shown, these contact members are connected in series with the operating coil 96 of the relay element 74, and in parallel with the operating coil 93 of the line switch, such that when the contact members 77 are closed the relay element 74 is actuated to its open position, which opens its contact members 75 and deenergizes the operating circuit of the line switch. In order to delay the opening of the contact elements 75 of the relay element 74 a sufficient length of time to effect the closure of the line switch, the opening operation of the relay element 74 is delayed in any suitable manner, such, for example, as by the use of a dashpot 97 as shown. By means of this arrangement, the contact members 75 are held closed until the line switch 20 closes and effects the opening of the contact members 77 of the relay element 76. After these contact members are opened, the relay element 74 remains closed until such time as the lighting circuit in operation becomes open circuited to effect closing of the relay element 76 and subsequent energization of the relay element 74.

While in the system disclosed manual control is utilized, it is to be understood that automatic control of both the brightness controller and runway selector controller may be readily provided. For example, the brightness selector controller may be automatically operated or controlled by a device responsive to atmospheric transmissivity, which may embody the controller as one of its elements, or by means of any other remote control arrangement. Likewise the runway selector controller may be operated or controlled by a wind vane device, which may embody the controller as one of its elements, or by means of any other remote control arrangement.

Any desired number of brightness control positions may be provided, and any desired number of runway lighting circuits may be controlled. Likewise the brightness and runway selector controllers and master switch may be interlocked mechanically, instead of electrically, as disclosed.

It is also to be understood if but a single lighting circuit is provided, the brightness control also may be used with equal advantage, as the desirability of providing brightness control applies to a one-circuit installation as well as to an installation having a plurality of lighting circuits.

The system illustrated utilizes series lighting circuits, but it will be apparent that the principles of the invention may be also applied to the control of multiple or parallel lighting circuits.

In view of the foregoing description of the exemplary embodiment of my invention, it will be apparent that there is provided a control system for lighting circuits which is particularly adapted for the control of contact lighting circuits of airports and the like, and which provides for readily preselecting the desired lighting circuit to be operated and also for preselecting the desired brightness at which it will be operated. The use of a system of this kind makes it possible for the operator to readily select the runway desired and determine its brightness, as well as the turning of the runway lights off and on from a remotely located control room, and the system is of such nature that these operations may be effected by a minimum number of operations.

It may be stated in conclusion that, while the illustrated example constitutes a practical embodiment of my invention, I do not wish to limit myself strictly to the exact details herein illus-

trated, since modifications of the same may be made without departing from the spirit of the invention as defined in the appended claims.

I claim as my invention:

1. The combination with a plurality of lighting circuits and a power source therefor, of transformer means disposed to be connected to the power source for supplying currents of different predetermined values to the circuits, a main switch for connecting the transformer means to the source, means including a plurality of selector relays selectively operable to determine which of said lighting circuits is to be energized, means including a plurality of control relays selectively operable to effect the connection of the selected circuit to the transformer means and determine the current value to which it is to be subjected, and means for collectively controlling the operation of the main switch and control and selector relays.

2. In a control system for lighting circuits, comprising, a constant current regulating transformer, a line switch operable to connect said regulating transformer to a supply source, an autotransformer having a plurality of different output current taps connected to the output terminals of the regulating transformer, means including a plurality of control relays for preselecting the output current tap on the autotransformer to which a selected lighting circuit is to be connected, means including a plurality of selector relays for preselecting a desired lighting circuit for operation, and means for collectively effecting the operation of the line, control and selector switches to connect the selected lighting circuit to the selected output current tap and the regulating transformer to the supply source.

3. A control system for lighting circuits, comprising, a constant current regulating transformer, a main switch operable to connect said regulating transformer to a supply source, a transformer connected to the output side of the regulating transformer and having a plurality of different current taps, a plurality of selector relays each of which is operable to render an associated lighting circuit effective for energization, means operable to preselect a desired selector relay for operation, a plurality of control relays each operable to connect the selected lighting circuit to one of the current taps of the transformer, means operable to preselect the desired control relay for operation, and a master switch operable to effect the collective operation of the main, selector and control switches.

4. A control system for a plurality of lighting circuits, comprising, a constant current regulator for supplying current to the lighting circuits, a main switch for connecting the regulator to a power source, a transformer connected to the output side of the regulator and having taps for subjecting the lighting circuits to different values of current when connected thereto, a plurality of control relays one of which is associated with each tap for connecting a lighting circuit thereto, a plurality of selector relays each associated with a lighting circuit, a manually-operable switch for selecting any one of the control relays for operation, a second manually-operable switch for selecting any one of the selector relays for operation, and a master switch for simultaneously controlling the operation of the main line, control and selector switches.

5. The combination with a plurality of groups of lighting units having the units of each group connected in series circuit relation and the groups connected in series to a supply circuit, of a group of selector relays, each relay of the group being operable to render its associated group of units effective for energization from the supply circuit, control means for selectively predetermining which of said selector relays is to be operated, transformer means operable to energize any one of the selected groups of units with substantially constant currents of different values, a plurality of control relays each operable to connect the supply circuit to the transformer means for energization with a current of one of the different values, additional control means operable to selectively predetermine which one of the control relays is to be operated, a main switch operable to connect the transformer means to a power source, and a master switch operable to effect the collective operation of the main switch and the selected selector and control relays whereby the selected group of units is energized at the selected current value.

6. A control system for lighting circuits, comprising, transformer means operable to maintain substantially constant currents of different predetermined values in a lighting circuit, a main switch for connecting the transformer means to a power source, a plurality of selector relays each operable to render its associated lighting circuit effective for energization, a first controller operable to predetermine the desired selector relay for operation, a plurality of control relays each operable to connect a selected lighting circuit to the transformer means to be energized by a constant current of the desired value, a second controller operable to predetermine the desired control relay for operation, a master switch for controlling the operation of the main switch and the selector and control relays which have been predetermined for operation, said master switch and the first and second controllers being electrically interlocked to effect the opening of the main switch in response to the attempted operation of either one of the first and second controllers when the master switch is in its closed position and the lighting circuit is energized.

7. A control system for lighting circuits, comprising, a regulating transformer operable to maintain a substantially constant current in a lighting circuit, a main switch for connecting the regulating transformer to a power source, a transformer connected to the output terminals of the regulating transformer and having a plurality of output terminals of different current values for operating a connected lighting circuit on different predetermined values of constant current, a plurality of control relays each operable to connect a lighting circuit to one of said output terminals, a manually-operable brightness controller for preselecting the desired control relay for operation, a plurality of selector relays each operable to render an associated lighting circuit effective for energization, a manually-operable selector controller for preselecting the desired selector relay for operation, each of said controllers being provided with actuating means including a normally closed switch, an energizing circuit for the main switch and control and selector relays extending through the normally closed switches on the controllers, and a master switch for controlling said energizing circuit.

8. A control system for lighting circuits, comprising, a regulating transformer operable to maintain a substantially constant current in a lighting circuit, a main switch for connecting

the regulating transformer to a power source, an autocurrent transformer connected to the output terminals of the regulating transformer and having a plurality of output terminals of different current values for operating a connected lighting circuit on different predetermined values of constant current, a plurality of control relays each operable to connect a lighting circuit to one of said output terminals, a manually-operable controller for preselecting the desired control relay for operation, a plurality of selector relays each operable to render an associated lighting circuit effective for energization, a manually-operable controller for preselecting the desired selector relay for operation, each of said controllers being provided with actuating means including a normally closed switch, an energizing circuit for the main switch and control and selector relays, a protective relay device including a delayed opening relay and a second relay for controlling the energization thereof, said energizing circuit extending through the normally closed switches on the controllers and the contact elements of the delayed opening relay of the protective device, and a master switch for controlling the energizing circuit, said second relay of the protective device being operable in response to an open circuit condition of the connected lighting circuit for energizing the delayed opening relay to interrupt the energizing circuit to effect the opening of the main switch.

9. A brightness selector control system for a lighting circuit comprising, transformer means having a plurality of output taps operable to energize the circuit at different predetermined degrees of brightness, control means including a main switch operable to connect the transformer means to a power source, and additional control means including a plurality of control relays selectively operable to preselect the output tap of the transformer means to which the lighting circuit is to be connected and thereby preselect the degree of brightness of the circuit when connected to the output taps of the transformer means, and means including one of said control relays responsive to the operation of the said control means for effecting the connection of the lighting circuit to the selected output tap of the transformer means to effect its energization a the predetermined degree of brightness determined by the additional control means.

10. A control system for lighting circuits, comprising, means including a plurality of selector relays each operable to preselect one of a plurality of associated lighting circuits for operation, means including a plurality of control relays operable to preselect the connection of the one selected lighting circuits to any one of a plurality of output terminals having different predetermined current outputs of a constant current source of supply, and means for collectively effecting the operation of the selector and control relays to effect the connection of the selected lighting circuit to the selected output terminals of the source.

11. A control system for a plurality of series lighting circuits comprising, a transformer means operable to maintain substantially constant currents of different predetermined values in a lighting circuit, a main switch for connecting the transformer means to a power source, means including a plurality of selector relays for predetermining which one of the lighting circuits is to be connected to the transformer means, means including a plurality of control relays for predetermining the connection of the selected one of the lighting circuits to the transformer means at the desired predetermined current value, means for collectively controlling the operation of the main line switch, selector and control relays to effect the energization of the selected lighting circuit at the selected predetermined current value, and means operable in response to an open circuit condition of the connected lighting circuit to effect the opening of the main line switch to disconnect the transformer means from a power source.

12. A control system for a plurality of lighting circuits, comprising, a constant current regulating transformer having primary and secondary windings, a main switch for connecting the primary winding of said transformer to a power source, an autocurrent transformer connected to the secondary winding of the regulator and having output terminals providing different predetermined constant currents, and control means including a plurality of control and selector relays selectively operable to preselect any one of the series lighting circuits for subsequent connection to any one of the different output terminals of the autocurrent transformer, and a master switch operable to simultaneously effect the closure of the main switch and operation of the control and selector relays, thereby to effect the energization of the selected series lighting circuit with a constant current of the selected value.

13. A system for selectively controlling the degree of brightness of a lighting circuit comprising, transformer means provided with a plurality of output taps each of which produces a predetermined degree of brightness of the lighting circuit when said circuit is connected thereto, switch means operable to connect the transformer means to a power source, selector means including a plurality of control relays each individual to an output tap operable to preselect a desired one of said plurality of output taps on the transformer means for connection to the lighting circuit, and control means cooperative with said selector means operable to effect the operation of said switch means and one of said control relays individual to the selected output tap to effect energization of the lighting circuit at the degree of brightness determined by the output tap to which it is connected.

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