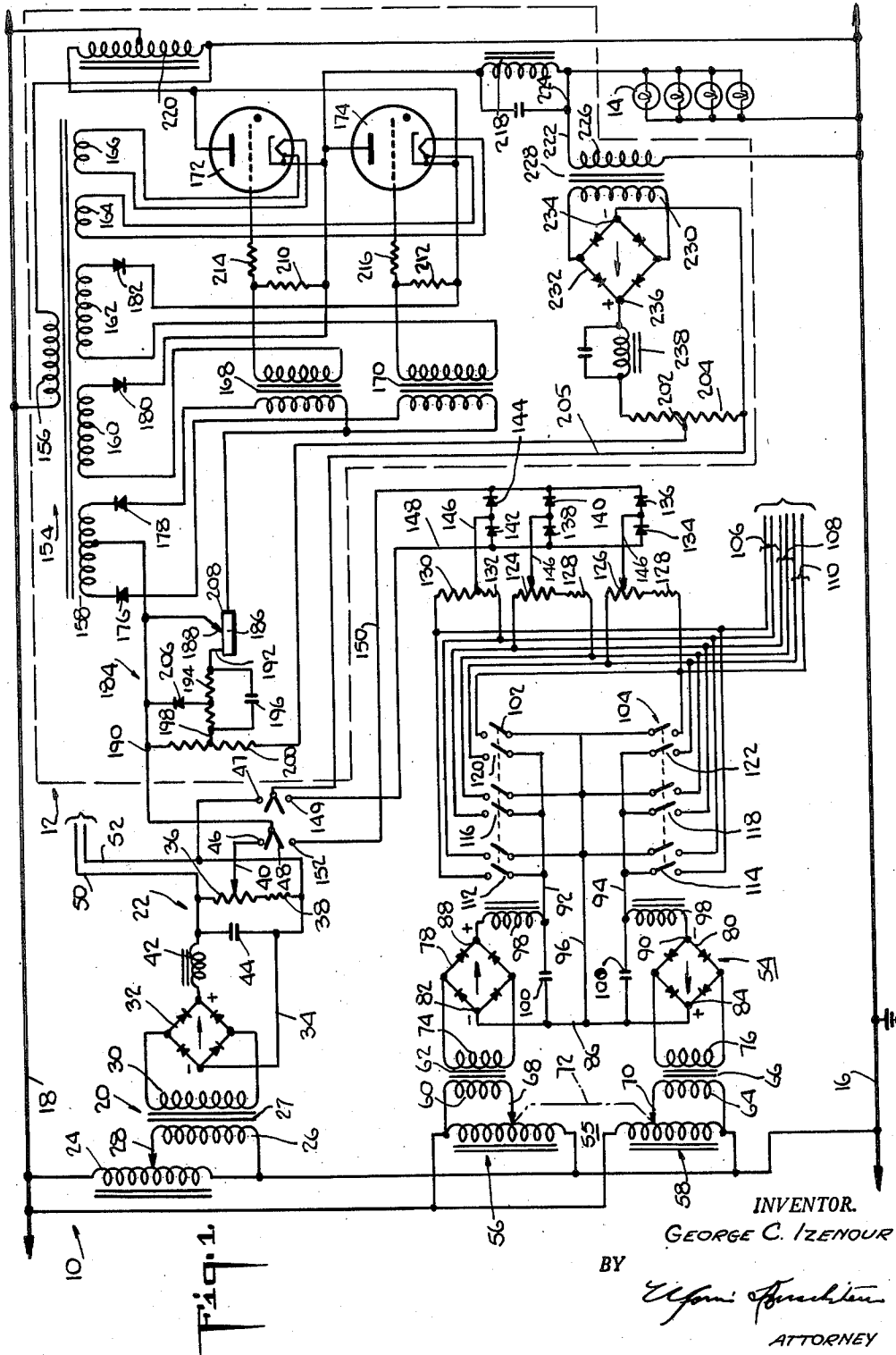


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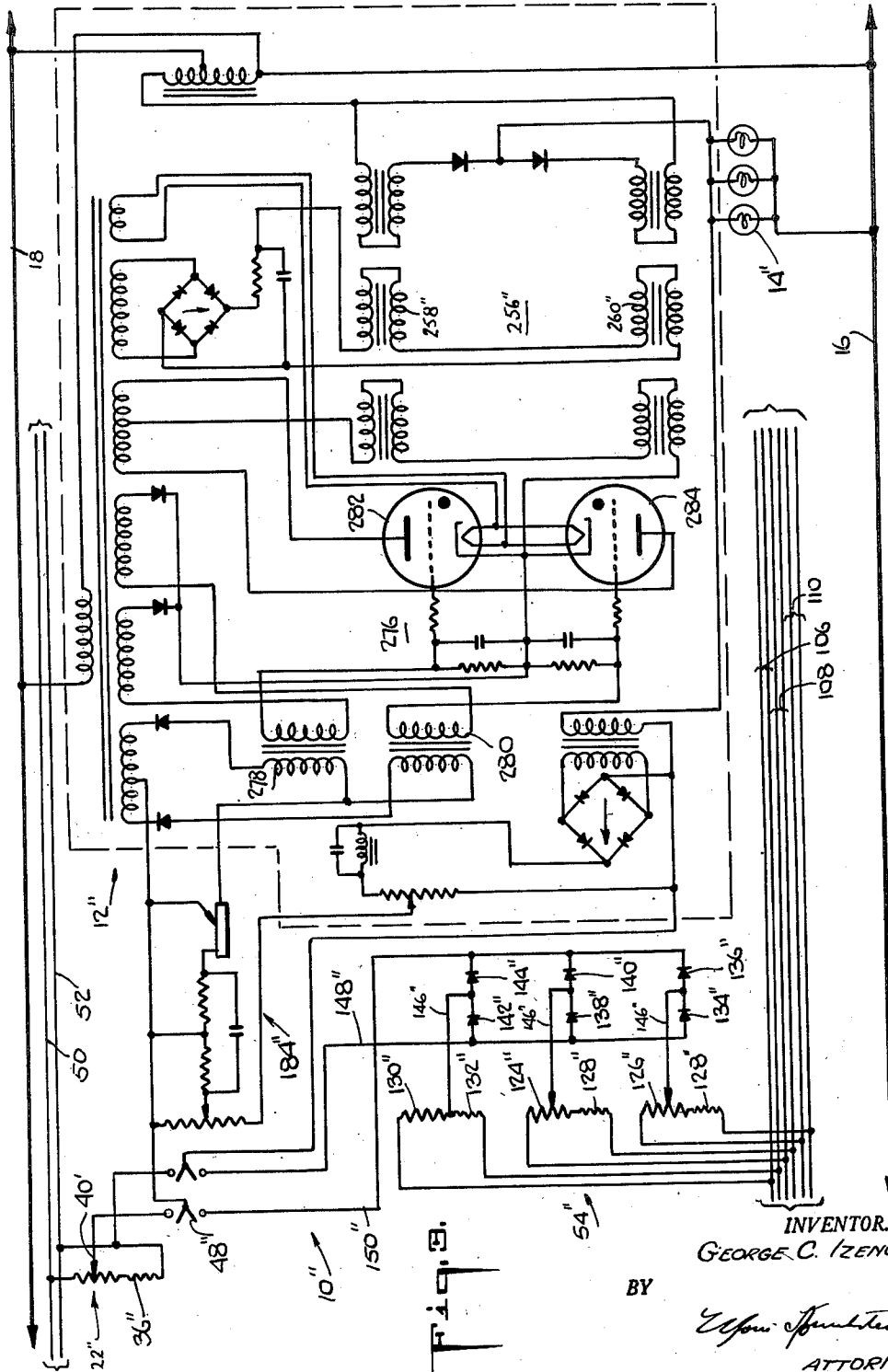
G. C. IZENOUR

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LIGHTING CONTROL CIRCUITS

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LIGHTING CONTROL CIRCUITS

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27 Claims. (Cl. 315-179)

This invention relates to electrical control circuits for lighting, as in theaters and in television studios.

The present invention constitutes an improvement over the lighting control circuit shown, described and claimed in my earlier Patent No. 2,463,463, reissued as No. Re. 23,575, on November 11, 1954, for Lighting Control Circuits.

This former circuit, although widely accepted by the art and recognized as a considerable improvement over older theater lighting control circuits, has certain drawbacks. For example, the circuit includes many electron tubes which in due course wear out and require replacement. Changing a tube, and particularly a vacuum tube which constitutes a variable resistance in a leg of the phase-shifting bridge circuit, necessitates resetting of other circuit components to compensate for the different characteristics of the new tube. Moreover, the circuit arrangement requires a different switch for each preset on each load and thus needs a very great number of switches on large installations having many presets and loads. The power units employ thyratrons which only are available in limited capacities. Color television requires much more light than black and white, and television studio lighting installations have been expanded to supply the additional requirements. However, thyratrons, due to their limited capacity, cannot handle the extra load in single load circuits.

It is an object of the present invention to provide a lighting control circuit of the character described which avoids the foregoing drawbacks.

More particularly, it is an object of my invention to provide a lighting control circuit of the character described which eliminates vacuum tubes from the regulating network and instead employs inert, i. e. static or steady state elements, that is, elements such for example as germanium diodes which do not have heated filaments.

In the latter connection it is an ancillary element of my invention to provide a lighting control circuit of the character described which entirely or in part eliminates tubes from the power network.

It is another object of my invention to provide in a lighting circuit of the character described a novel control network, hereinafter sometimes referred to as a "console," having fewer switches, fewer parts in general and less wiring than the control network of my former patent and which lends itself to a more compact construction.

It is another object of my invention to provide a lighting control circuit of the character described which can handle large power loads with power unit parts of comparatively small physical size.

It is another object of my invention to provide a lighting control circuit of the character described which constitutes relatively few and simple parts, is relatively inexpensive to manufacture and only infrequently will need repair.

Other objects of my invention in part will be obvious and in part will be pointed out hereinafter.

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My invention accordingly consists in the features of construction, combinations of elements and arrangements of parts which will be exemplified in the lighting control circuit hereinafter described and of which the scope of application will be indicated in the appended claims.

In the accompanying drawings in which is shown one of the various possible embodiments of my invention,

Figs. 1, 2 and 3 are consecutive sections of a single wiring diagram for a lighting control circuit constructed in accordance with my invention, Fig. 1 illustrating a complete console section connected to one type of power unit and Figs. 2 and 3 illustrating subsections of the console section connected to two other types of power units.

Referring now in detail to the drawings, and more particularly to Fig. 1, the reference numeral 10 denotes the console section of the circuit and the reference numeral 12 one typical power unit. The power unit is connected to energize a bank of incandescent lamps 14 or other suitable lighting equipment under the regulation of the console section 10. Both the console section and the power unit derive their energy from a pair of A. C. load buses 16, 18, the bus 16 being the neutral, i. e. ground, bus and the bus 18 the live bus.

The console section includes a group master control 20 and several individual dimmer controls 22 only one of which is shown in Fig. 1. The group master control constitutes a group master inductive potentiometer 24 connected across the load buses 16, 18 and controllably energizing the primary 26 of a group master control transformer 27 through a variable tap 28. The secondary 30 of the transformer feeds the input terminals of a master full wave rectifier bridge 32 the negative output terminal of which is tied to a manual control return lead 34. The positive output terminal of the rectifier is connected to one input terminal of an individual dimmer potentiometer 36, the other input terminal of said potentiometer being connected through a fixed resistance 38 to the return lead 34. Said fixed resistance insures maintenance of a predetermined minimum positive potential at the control tap 40 of the potentiometer. Voltage ripples from the full wave rectifier are smoothed out by a L-C filter network constituting a choke 42 and a capacitor 44.

The individual potentiometer control tap 40 is connected to the manual hot stationary contact 46 of a double-pole double-throw manual-preset selector switch 48 for a single power, i. e. load, circuit. The return lead 34 is connected to the manual return stationary contact 47 of said selector switch. The movable hot throw member of the selector switch feeds the live control input of the power unit 12 and the movable return throw member of said switch is connected to the return control input of the power unit, the internal circuit of said unit being such, as will be described hereinafter, that variation of positive D. C. voltage across its control inputs will change the output light intensity of the lamps 14.

The return lead 34 and the positive terminal of the master full wave rectifier bridge are connected by group master sub-buses 50, 52 to other console sub-sections 10', 10'' as shown, for example, in Figs. 2 and 3, these constituting further individual dimmer control potentiometers 36', 36'' whose control taps 40', 40'' are connected to further manual-preset double-pole double-throw selector switches 48', 48'' that in turn regulate the operation of other power units 12', 12'' having lighting loads 14', 14''.

It will be apparent that all of the lamp loads can be simultaneously manually controlled by manipulation of the group, i. e., master, inductive potentiometer 24, and that at any given setting of said master potentiometer the individual loads can be separately controlled manually by

manipulation of the individual dimmer potentiometers 36, 36' and 36''.

The console section 10 also includes a preset dimmer control subsection 54 the circuit for which is such as to greatly reduce the number of preset dimmer switches required. More particularly the preset dimmer control subsection 54 includes a fader 55 constituting two inductive potentiometers 56, 58 connected in parallel across the load buses 16, 18. The potentiometer 56 feeds the primary 60 of a transformer 62 and the potentiometer 58 feeds the primary 64 of a transformer 66, said primaries being connected so as to be series aiding.

The control taps 68, 70 of the fader potentiometers 56, 58 are mechanically interconnected by a ganging link 72 for joint operation, the ganging being such that the voltage output of the potentiometer 56 increases at the same rate that the voltage output of the potentiometer 58 decreases, and vice versa.

The secondaries 74, 76 of the fading transformers 62, 66 feed the input terminals of two full wave rectifier fader bridges 78, 80. One output terminal 82 of the bridge 78 and one output terminal 84 of the bridge 80 are joined by a lead line 86, the bridges thus being connected in series aiding relationship. The other output terminal 88 of the bridge 78 and the other output terminal 90 of the bridge 80 feed a pair of outer preset dimmer buses 92, 94. A floating middle dimmer bus 96 is connected to the lead wire 86 joining the two fader bridges. Chokes 98 and capacitors 100 serve as filters for the output of the fader bridges.

The fader potentiometers 56, 58 are alike, as are the fader transformers 62, 66 and the fader bridges 78, 80. Accordingly, since the ganging link 72 creates a like (but opposite) linear rate of movement of the two fader control taps 68, 70, since the primaries of the fader transformers are series aiding and since the fader rectifier bridges are series aiding, a constant D. C. voltage exists across the extremities of the two rectifiers, that is to say, across the outer preset dimmer buses, regardless of the position of the control taps 68, 70. In other words, the sum of the voltage from either of the outer preset dimmer buses to the floating middle bus 96 and the voltage from the other outer bus to the floating bus always will equal the constant voltage across the two outer buses.

As the ganging link moves the control taps 68, 70 downwardly from the central setting shown in Fig. 1, energization of the primary 60 is increased so that the positive voltage on the outer control bus 92 fed by the positive terminal 88 of bridge 78 will increase relative to the floating bus which now is being fed by the negative terminal 82 of said bridge 78. Concurrently the voltage on the other outer bus 94 will approach the voltage of the floating bus as energization of the primary 64 decreases. Movement of the ganging link to its other extreme, i. e., upper, position deenergizes the transformer 62 and energizes the transformer 66. Accordingly in said other position of the link the floating bus becomes positively charged at the potential of the terminal 84, the outer bus 92 being at the same potential and the other outer bus 94 becomes negative with respect to the floating bus. Thus in one extreme position of the ganging link the potential between the floating bus and one outer bus is at maximum and the potential between the floating bus and the other bus is zero; while in the other extreme position of the ganging link these conditions are reversed.

A gang 102 of double-pole single-throw preset selector switches has one throw member of each switch connected to one of the outer preset dimmer buses, e. g., the bus 92, and the other throw member connected to the floating dimmer bus 96. A similar gang 104 of preset selector switches has one throw member of each switch connected to the other outer preset dimmer bus 94 and the other throw member to the floating bus.

For stage work all the switches of each gang are interlocked in a manner well known to the art so that only

one switch in each gang can be in closed, i. e., actuated, position at any given time and actuation of any switch in either gang will automatically release any still actuated switch in that gang and two switches cannot be simultaneously actuated. For television work where, without unduly increasing the number of presets required, it sometimes is desired to energize one or a group of power circuits while another single or group of power circuits is in operation (in order to light up a second scene while another scene remains lit) it is desirable to enable two or more switches of each gang to be closed at any time. Thus for television the switches of each gang are not interlocked.

Each switch in one of the gangs has a physically and electrically associated switch in the other gang. The switches of the two gangs are so interlocked in a manner well known to the art that when any given switch of one gang is closed, the associated switch of the other gang cannot be closed whereby, as soon will be appreciated, short circuiting of the outputs of the bridges 78, 80 is avoided.

I have shown three preset selector switches in each of the gangs 102, 104. This represents the minimum number of switches practical for use in the present system. However, it is to be understood that in a commercial embodiment of my invention there conventionally will be many more switches in each gang and the switches which have been illustrated have been kept to a minimum for simplicity of explanation. It also will be apparent as the description proceeds that, if desired, one of these three switches in each gang can be eliminated although with it a certain convenience is lost.

The present dimmer control subsection 54 includes a plurality of pairs of fader preset selector buses 106, 108, 110. The pair of buses 106 is connected to a preset selector switch 112 in the gang 102 and to the associated preset selector switch 114 in the gang 104. It may be mentioned at this time that the selector switches 112, 114 are known as "blackout" switches, being employed as a matter of convenience, and as noted heretofore not as a necessity. Another preset selector switch 116 in the gang 102 and its associated preset selector switch 118 in the gang 104 is connected to the pair of buses 108. A third preset selector switch 120 in the gang 102 and a third preset selector switch 122 in the gang 104 are connected to the third pair of buses 110.

Each pair of fader preset selector buses feeds at least one preset dimmer control potentiometer, there being a single such potentiometer for each pair of fader preset selector buses for each power unit; that is to say, if there is but a single power unit 12, as illustrated in Fig. 1, and if there only are two pairs of associated preset selector switches, there will be only two preset dimmer control potentiometers 124, 126. In a typical commercial embodiment of my invention where each gang of switches 102, 104 includes many individual preset selector switches, for example, as many as a dozen, and where there are many power circuits that will be controlled by the two gangs of switches, there will be far more preset dimmer control potentiometers. For instance, if the preset dimmer control subsection has six individual preset selector switches (exclusive of the blackout switches) in each gang 102, 104 and if there are ten power circuits controlled by the subsection 54, there will be sixty preset dimmer control potentiometers.

In order to limit the minimum voltage present at the tap of each of said potentiometers, I provide a fixed resistance 128 in series with each potentiometer.

The pair of buses 110 connected to the two blackout switches 112, 114 feeds a pair of series connected fixed resistances 130, 132.

Pairs of rectifier doublers 134 and 136, 138 and 140, and 142 and 144, respectively, are provided, a different pair being associated with each preset dimmer control potentiometer as well as the pair of blackout resistances.

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A lead line 146 runs from the tap of each of said potentiometers and from the junction of the pair of blackout resistances to the junction between the associated pair of doublers. A lead line 148 connects the negative terminals of all the doubler pairs to the preset return stationary contact 149 of the selector switch 48. Another lead line 150 connects the positive terminals of all the doubler pairs to the present hot stationary contact 152 of the switch 48. Accordingly when the throw members of the switch are in their "down" position, said switch will apply to the power unit 12 a control potential determined by the settings of the gangs of switches 102, 104 and of the preset dimmer control potentiometers 124, 126.

In order to understand the operation of the preset dimmer control subsection 54, let it be assumed that the selector switch 48 is in its down (preset) position to render the subsection effective. Let it also be assumed that the ganging link 72 has been so manipulated that the primary 60 of transformer 62 is short circuited and the primary 64 of transformer 66 has maximum potential applied thereto. Further, let it be assumed that switches 118 and 120 are closed, that potentiometer 124 is at a certain setting and that potentiometer 126 is at a certain setting.

The outer preset dimmer bus 92 will be at the same potential as the floating middle bus 96, and the other outer bus 94 will be negative with respect thereto. Potential is applied through switch 118 and the pair of buses 108 across the fixed resistance 128 and the potentiometer 124 in series therewith. Accordingly a positive potential will be applied to the lead wire 150 and the switch 48. If now the ganging link 72 is moved to its other extreme position, the potential across the buses 94, 96 gradually will diminish and at the same time the potential across the buses 92, 96 gradually will increase until at said other extreme position full potential will be applied through the closed switch 120 across the resistance 128 and potentiometer 126 in series therewith and there will be a zero potential across the potentiometer 124 and fixed resistance 128 in series therewith. Thus as the fader is moved, the positive voltage on the lead line 150 will gradually change from the voltage corresponding to the setting for the potentiometer 124 to the voltage corresponding to the setting of the potentiometer 126 without at any time falling below the voltage corresponding to either of said settings.

The doublers 134, 136, 138, 140, 142, 144 act as inert switches. For example, when the transformer 62 is fully energized with switches 118, 120 closed positive potential is applied through potentiometer 120 and rectifier 136 to line 150. Return current flows from line 148 through rectifier 138 and potentiometer 124. The rectifier 134 prevents the application of positive potential to any other preset potentiometers. Similarly, when energization is transferred to the transformer 66 (with the same notches closed) rectifier 138 prevents backflow of current.

The other console subsections 54', 54'' similarly include banks of preset dimmer control potentiometers 124', 126', and 124'', 126'', respectively, fixed resistances 128', 128'' and pairs of blackout resistances 130', 132', and 130'', 132'' connected across the pairs of fader preset selector buses 106, 108, 110 in a manner such as described above with respect to the preset dimmer control subsection 54. Likewise the potentiometer taps in the other console subsections 54', 54'' and the junctions between the pairs of blackout resistances are connected to the junctions of rectifier doublers 134' and 136', 138' and 140', 142' and 144', 134'' and 136'', 138'' and 140'', 142'' and 144'', respectively.

Each of the subsections 54, 54', 54'' is associated with and regulates a different power unit 12, 12', 12'', the connections from the rectifier doublers of the subsections 54', 54'' to the control terminals of the units 12', 12'' be-

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ing effected by means of the return and hot lead lines 148' and 148'' and 150', 150'', respectively.

It thus will be seen that the two gangs of switches 102, 104 by themselves can simultaneously control as many power units as are connected thereto, the number of individual preset selector switches in each of the two gangs being determined by the number of presets it is desired to have available. One additional preset selector switch must be added to each gang for each additional available preset. This arrangement is in contrast to that employed in my aforesaid patent wherein it was necessary to provide an extra gang of preset selector switches for each additional power unit to be controlled by the same fader thus substantially complicating the electrical and mechanical arrangements. It will be understood, however, that the console section 10 must have for each additional power unit an extra set of preset dimmer control potentiometers, an extra set of rectifier doublers, and an extra manual-preset selector switch.

Attention is called to the fact that the console section 10 entirely consists of inert, i. e. solid state, parts, all the rectifiers preferably being components other than electron tubes and constituting, for example, germanium diodes. Thus the section has only a tiny power drain and will operate almost indefinitely without repair or replacement of parts.

Each of the individual dimmer potentiometers and each of the preset dimmer control subsections 54, 54', 54'' is capable of regulating any power unit whose power output to a lighting load can be varied by changing D. C. potential applied to a control terminal of the unit. Various types of such power units are illustrated in the different figures. The power unit 12 shown in Fig. 1 constitutes a solid state input stage controlling firing reactors which regulate a pair of back-to-back thyratrons that feed a lighting load. The power unit 12' shown in Fig. 2 constitutes a solid state input stage cascaded with a magnetic amplifier that controls a magnetic amplifier power output stage which feeds a lighting load. The power unit 12'' shown in Fig. 3 constitutes a steady state input stage controlling firing reactors which regulate a pair of thyratrons. The thyratrons control a magnetic amplifier power output stage which feeds a lighting load. It will be observed that in the power units 12', 12'' the output stage which feeds the lighting load consists of a magnetic amplifier and, therefore, is capable of handling very large lighting currents, far beyond the capacity of present day thyratrons.

Referring now in detail to the power unit 12, said unit includes a feed transformer 154 which constitutes the source of energy for the various components of the unit, but not the load. The transformer has a primary winding 156 connected across the two load buses 16, 18 and a plurality of secondary windings 158, 160, 162, 164, 166. The secondary 158 energizes the primaries of firing reactors 168, 170, the secondaries of which are connected to the control grids of thyratrons 172, 174. The secondaries 160, 162 furnish the cathode-grid potential for the thyratrons. All three secondaries 158, 160, 162 energize their respective circuits through diodes, preferably steady state diodes such as germanium rectifiers 176, 178, 180, 182. The secondaries 164, 166 are for the thyratrons filament heaters.

The input stage of the power unit 12 and, indeed, of all the power units herein disclosed constitutes a solid state amplifier 184, e. g., an amplifier utilizing a germanium junction transistor 186. The transistor emitter 188 is connected to the hot (positive) input control terminal 190 of the power unit. The transistor base 192 is connected to the return lead 148 through a tuned filter constituting a resistance 194 and capacitor 196 in parallel, the control tap 198 of an adjustable gain potentiometer 200, the control tap 202 of an adjustable negative feedback potentiometer 204, lead wire 205 and selector switch 48. A crystal rectifier, e. g., a germanium diode 206,

connects the midpoint of the resistance 194 to the positive input terminal and functions to minimize voltage surges and power harmonic frequency (120 C. P. S.) from the negative feedback. The positive input terminal also is connected to the midpoint of the energizing secondary winding 158 for both firing reactors. The transistor collector 208 is connected to the primaries of the two firing reactors 168, 170. Said reactors are of the type, well known to the art, which produce a spike, i. e., impulse, voltage, the phase of which is displaced by varying the potential applied thereto.

The input solid state amplifier stage 184 is able to sensitively respond to a very low power input and provides a high input impedance which does not impose a large drain on the console section. A typical input is in the order of one-half milliamperere at 15 volts. A typical flow of emitter current is about 80 microamps at $\frac{3}{4}$ of a volt. A typical current flow at the collector is about 5 milliamperes at $2\frac{1}{2}$ volts. Accordingly, it will be seen that the amplification of this stage is quite small. However, the stage functions to provide the high input impedance above referred to and to couple the negative feedback shortly to be described. It may be mentioned that the adjustable gain potentiometer has a value of 10,000 ohms and the resistance in the tuned filter a value of 1,000 ohms. The tuned filter is adjusted to reject a 120 cycle frequency and also acts to dephase noise in the negative feedback. The adjustable negative feedback potentiometer 204 has a typical value of 500 ohms.

A fluctuation in the positive voltage applied to the control terminal 190 varies the output at the transistor collector, this in turn varies the phases of the voltage spikes of the firing reactors 168, 170. Inasmuch as the secondaries of the firing reactors are connected across the grids and cathodes of the thyratrons, a variation in the phase of the voltage spikes will change the firing times of the thyratrons. As is well known changing the firing times of the thyratrons regulates the energy output, the earlier the firing the greater the energy transferred to the lighting loads.

The secondaries of the firing reactors are provided with load resistances 210, 212. In addition grid limiting resistors 214, 216 are inserted in the grid circuits of the thyratrons.

The plate circuits of the thyratrons include the lamps 14 connected in series with the thyratrons, a hash filter 218 being utilized to reduce power line disturbances caused by ignition of the thyratrons. Plate potential is supplied by a booster auto-transformer 220 connected across the load buses and feeding the two thyratrons connected in back-to-back relationship whereby A. C. voltage will be fed from the thyratrons to the lamps, the length of the half-cycles through the alternately firing thyratrons depending upon the phases of the firing pulses supplied by the firing reactors.

To minimize the effects on regulation of increasing or decreasing current flow in the lighting loads as lamps are added to or subtracted from the load circuit, I provide a negative feedback line 222 which is tapped into the load circuit at a junction 224 between the hash filter and the lighting load. Said line energizes the primary 226 of a negative feedback step-down transformer 228 whose secondary 230 is connected to the input terminals of a full wave rectifier bridge 232. The negative output terminal 234 of the bridge is connected to the return lead 205 and the positive output terminal 236 is connected through a 120 cycle LC filter 238 to the positive terminal of the negative feedback potentiometer 204.

It will be appreciated that by proper adjustment of the gain potentiometer 200 the input amplifier stage can be set to furnish sufficient gain properly to energize the firing reactors despite the loss of gain caused by the negative feedback, the latter being adjusted to stabilize the circuit.

The thyratrons 172, 174 are insufficient for large

power loads. For example, if the lighting load is about 20 kilowatts or more, this being a conventional power requirement for a single lighting circuit in a color television studio, two back-to-back thyratrons are not enough.

In lieu of the thyratrons, I may employ an inert power amplifier stage as the last stage in the power unit. A unit 12' embodying such a stage is illustrated in Fig. 2. Said unit includes an input transistor type steady state amplifier stage 184'.

The output of the stage 184' feeds a high gain inter-stage magnetic power amplifier 240 constituting a pair of in-phase toroids 242, 244 with grain oriented high permeability steel cores. The output winding of the toroids obtain their drawing power from a secondary winding 246 on the transformer 154'. The stage 240 has a gain of from 2000 to 3000. Rectifier doublers 248, 250 maintain a D. C. output for the interstage amplifier.

The toroid amplifier output regulates the control windings 252, 254 of a magnetic power amplifier 256 having a grain oriented silicon core and a power gain of about 400. Bias windings 258, 260 on the amplifier 256 are fed from a full wave rectifier bridge 262 which draws power from a secondary winding 264 on the transformer 154'. A resistance 266 limits current flow in the bias winding. The output windings 268, 270 of the amplifier 256 draw power from an auto-transformer 272 connected across the load buses 14, 16. The output windings alternately feed the lamps 14' through series connected rectifiers 273, 274. A negative feed-back is provided that is identical with the one described in connection with Fig. 1.

Optionally the toroid interstage amplifier can be replaced by a thyatron interstage amplifier 276 as shown in Fig. 3. Said amplifier includes peaking reactors 278, 280 controlled by an input solid state amplifier 184' and in turn controlling thyratrons 282, 284. The thyratrons energize the control windings 258', 260' of a magnetic power amplifier 256' such as described with respect to Fig. 3. The same negative feed-back mentioned hereinabove also is utilized.

It thus will be seen that I have provided an electrical control circuit which achieves all the objects of my invention and is well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiment above set forth, it is to be understood that all matter herein described, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of a transistor amplifier at the input of the power unit, said amplifier being regulated by the regulating network and controlling the output of the power unit.

2. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, at least the first stage constituting a transistor amplifier.

3. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control

of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, all of said stages constituting steady state amplifiers.

4. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, the first stage being a transistor amplifier, and the subsequent stages constituting magnetic amplifiers.

5. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, the first stage constituting a transistor amplifier and the last stage constituting a magnetic amplifier.

6. An electrical lighting control circuit including a regulating network providing at least two D. C. voltages which are concurrently energizable and are independently variable as definite functions of desired intensities of lighting, and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network and having a high impedance amplifier at the input thereof.

7. A circuit as set forth in claim 6 wherein the said high impedance input amplifier is a transistor amplifier.

8. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, the first stage constituting a transistor amplifier and the last stage constituting thyatrons.

9. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network; that improvement comprising the provision of cascaded amplifier stages in the power unit, the first stage constituting a transistor amplifier, the second stage constituting peaking reactors and the last stage constituting thyatrons.

10. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, the first stage constituting a transistor amplifier, the second stage constituting toroid amplifiers and the last stage constituting magnetic power amplifiers.

11. In an electrical lighting control circuit including a regulating network providing an electrical characteristic which is variable as a definite function of a desired intensity of lighting and an A. C. power unit for energizing an A. C. lighting load, said unit being under the control of the regulating network: that improvement comprising the provision of cascaded amplifier stages in the power unit, the first stage constituting a transistor amplifier, the second stage constituting peaking reactors, the third stage constituting thyatrons and the fourth stage constituting magnetic amplifiers.

12. In an electrical lighting control circuit, including a regulating network providing a D. C. voltage which is variable as a definite function of a desired intensity of lighting, and an A. C. power unit for energizing an A. C.

lighting load, said unit being under the control of the regulating network: that improvement comprising a transistor amplifier at the input of the unit, a phase shifting network under the control of said amplifier, and a phase controlled power amplifier stage at the output of the unit under control of the phase shifting network.

13. A combination as set forth in claim 12 wherein the phase shifting network constitutes a peaking reactor.

14. A combination as set forth in claim 12 wherein the phase shifting network constitutes a toroid magnetic amplifier.

15. In a method of controlling illumination intensity of an A. C. lamp, that improvement comprising the steps of supplying D. C. voltages variable in magnitude as definite functions of the desired intensities, selectively employing said voltages to control the output of an amplifier, employing the output of the amplifier to control the output of an A. C. power amplifier, and utilizing the output of the A. C. power amplifier to energize the lamp.

16. In a method of controlling illumination intensity of an A. C. lamp, that improvement comprising the steps of supplying voltages variable in magnitude as definite functions of the desired intensities, selectively employing said voltages to control the output of a steady state amplifier, employing the output of the steady state amplifier to control the output of an A. C. power amplifier, and utilizing the output of the A. C. power amplifier to energize the lamp.

17. In a method of controlling illumination intensity of an A. C. lamp, that improvement comprising the steps of supplying D. C. voltages variable in magnitude as definite functions of the desired intensities, selectively employing said voltages to control the output of a steady state amplifier, employing the output of the steady state amplifier to control the output of an A. C. power amplifier, and utilizing the output of the A. C. power amplifier to energize the lamp.

18. An electrical lighting control system including a regulating network and a D. C. controlled A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, said regulating network including means to supply a selectable pre-settable D. C. voltage, means to supply a manually controlled D. C. voltage, and means to selectively apply either of said D. C. voltages to said input terminals.

19. In an electrical lighting control circuit including an A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, that improvement comprising a regulating network for controlling said power unit, said network including two sources of power, means for oppositely varying the voltage supplied by said sources, at least two adjustable voltage dividers, means for selectively connecting one of said sources to one of said voltage dividers and the other source to a different voltage divider, and inert switching means connecting all of said voltage dividers in common to the input terminals of the power unit.

20. A network as set forth in claim 19 wherein the inert switching means constitutes rectifier doublers.

21. A regulating network as set forth in claim 19, wherein the inert switching means constitutes a plurality of rectifier doublers, each doubler being associated with a different one of the voltage dividers and having its center point connected to the tap thereof.

22. In an electrical lighting control circuit including an A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, that improvement comprising a regulating network for controlling said power unit, said network including two sources of power, means for oppositely varying the voltage supplied by said sources, at least two adjustable voltage dividers each of which has a tap point, manually controllable switching means for selectively connecting one of said sources to one of said voltage dividers and the other source to a different voltage divider, at least two head-to-tail rectifier doublers, means connecting a tap point of each voltage

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divider to the center point of a different rectifier doubler, and means connecting the opposite ends of all said rectifier doublers in common to the input terminals of the power unit.

23. In an electrical lighting control circuit including an A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, that improvement comprising a regulating network for controlling said power unit, said network including two sources of power, means for oppositely varying the voltage supplied by said sources, a plurality of pairs of lines, manually controllable switch means for selectively connecting one of said sources to at least any one of said pairs of lines and the other source to at least any other one pair of lines, a set of voltage dividers, means connecting each voltage divider to a different pair of lines, a plurality of head-to-tail rectifier doublers, each rectifier doubler being associated with a different voltage divider, means connecting the tap point of each voltage divider to the center point of its associated rectifier doubler, and means connecting the opposite ends of all the rectifier doublers in common to the input terminals of the power unit.

24. A network as set forth in claim 23 wherein the two sources of power are full wave rectifiers connected in series aiding relationship.

25. In an electrical lighting control circuit including an A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, that improvement comprising a regulating network for controlling said power unit, said network including two sources of power, means for oppositely varying the voltage supplied by said sources, a plurality of pairs of lines, a gang of switches for selectively connecting any selected ones of said pairs of lines to one of said sources, a second gang of switches for selectively connecting any other ones of said pairs of lines to the other source, a different adjustable voltage divider connected across each pair of lines, and inert switching means connecting all of said voltage dividers in common to the input terminals of the power unit.

26. In an electrical lighting control circuit including an A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, that improvement comprising a regulating network for controlling said power unit, said network including two sources of D. C.

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power, means for oppositely varying the voltage supplied by said sources, a plurality of pairs of lines, a gang of switches for selectively connecting any selected ones of said pairs of lines to one of said D. C. sources, a second gang of switches for selectively connecting any other ones of said pairs of lines to the other D. C. source, a different adjustable voltage divider connected across each pair of lines, and switching means connecting all of said voltage dividers in common to the input terminals of the power unit.

27. In an electrical lighting control circuit including an A. C. power unit for energizing an A. C. lighting load, said unit having input terminals, that improvement comprising a regulating network for controlling said power unit, said network including a pair of full wave rectifiers, means for supplying A. C. power to said rectifiers, means for manually controlling the power supply to said rectifiers so that as the output of one rectifier is increased the output of the other rectifier is decreased, three buses, means connecting one output terminal of one of the rectifiers to a first one of the buses, means connecting the other output terminal of said one rectifier to an output terminal of opposite potential of the second rectifier and to a second one of the buses, means connecting the other output terminal of the other rectifier to the third bus, a plurality of pairs of lines, a first gang of switches for connecting any selected ones of said pairs of lines to said first and second buses, a second gang of switches for connecting any other selected ones of said pairs of lines to the second and third buses, a plurality of voltage dividers, a different one being energized by each different pair of lines, a plurality of head-to-tail rectifier doublers, each rectifier doubler being associated with a different voltage divider, means connecting the tap point of each voltage doubler with the center point of its associated rectifier doubler, and means connecting the opposite terminals of all the rectifier doublers in common to the input terminals of the power unit.

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