July 6, 1954 C. R. PASSMORE 2,683,241

ELECTRIC LAMP CIRCUITS

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Fig. 1.

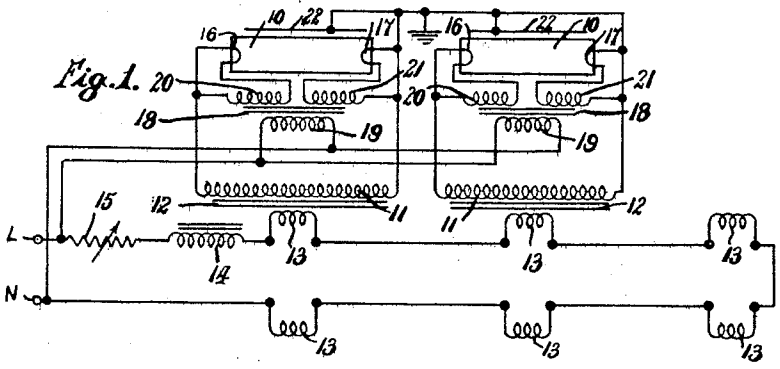


Fig. 2.

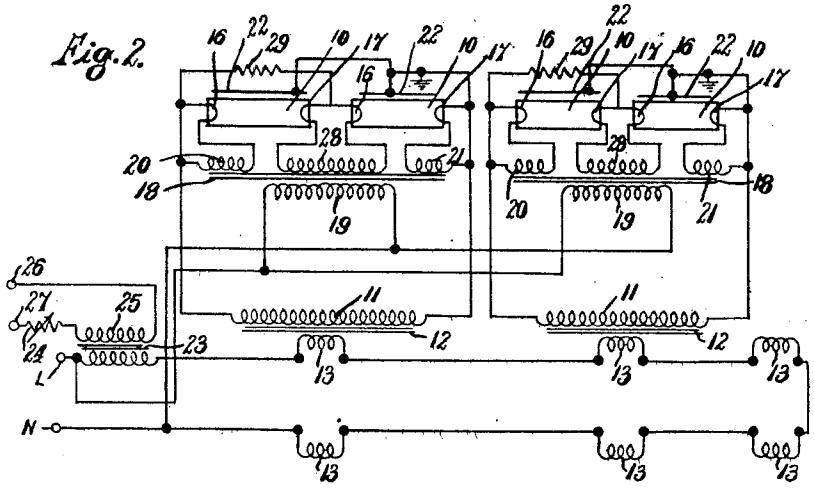
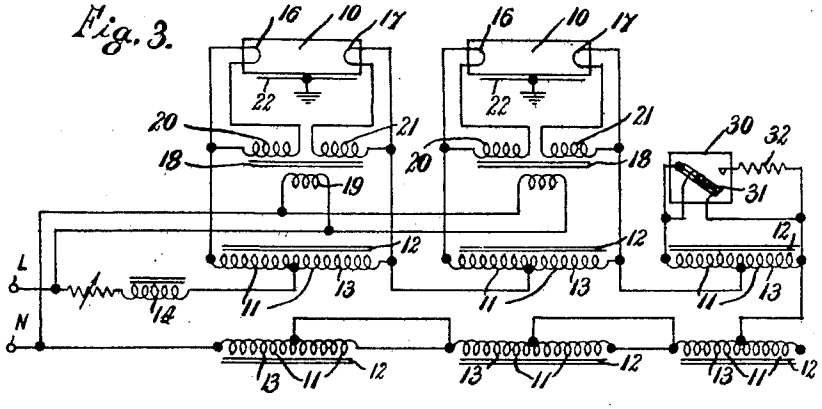


Fig. 3.



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Fig. 4.

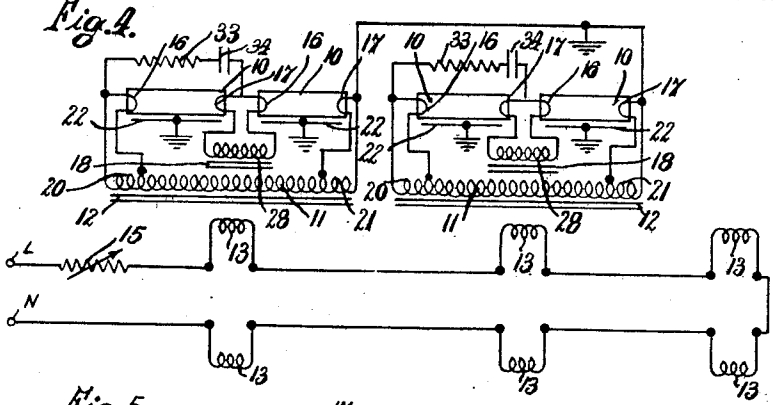


Fig. 5.

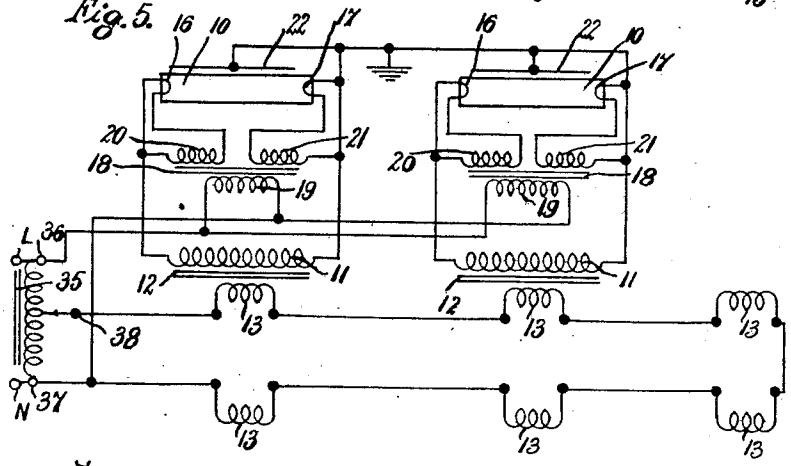
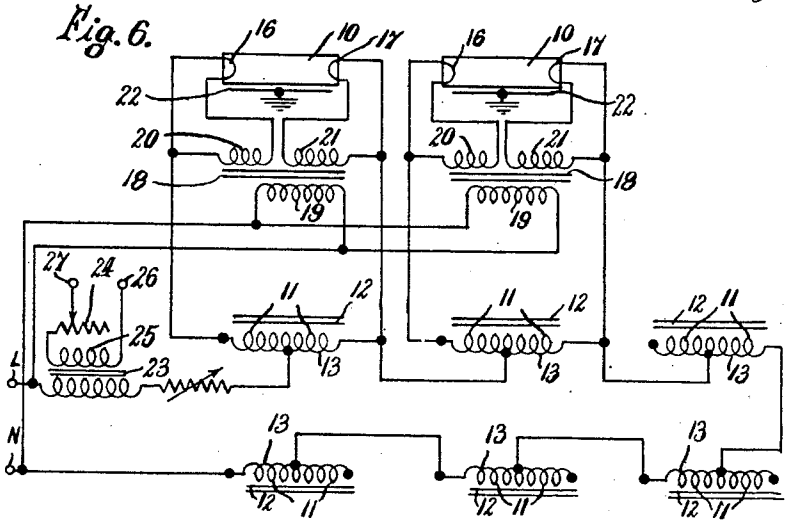


Fig. 6.



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ELECTRIC LAMP CIRCUITS

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Application February 23, 1951, Serial No. 212,212

2 Claims. (Cl. 315—97)

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This invention relates to circuits used to control the brightness of low-pressure discharge lamps of the hot-cathode type. A low-pressure discharge lamp is one which operates normally at a temperature which exceeds the ambient temperature by not more than 60° C.

Filament lamps may be fed through adjustable dimming means capable of reducing the light emission progressively to zero. If coloured light is required as, for example, in theatre lighting, colour filters can be fitted in front of the filament lamps. The efficiency of the combination of filament lamp and colour filter is very low. The use of fluorescent discharge lamps has been suggested for colour lighting, since, by suitable choice of the luminescent material, a wide range of colours can be produced without the use of filters. The disadvantage of such lamps is that with normal circuits, consisting of a lamp in series with a choke and the filamentary lamp electrodes connected in series for starting by a glow or thermal switch, only a limited range of brightness is available. Attempts to use low voltages result in erratic and intermittent operation. Circuits suitable for the brightness control of fluorescent lamps have been described in pending application Serial No. 116,756.

The principal object of this invention is to provide circuits in which two or more low-pressure discharge lamps can be dimmed substantially by operation of a dimmer control consisting of a single adjustable impedance.

Another object is to provide circuits in which two or more low-pressure discharge lamps can be dimmed substantially and which employ wiring arranged in known manner and constituting dimming circuits for incandescent lamps.

According to this invention an electric discharge lamp circuit includes two or more low-pressure electric discharge lamps of the hot-cathode type having two electrodes, or two or more groups of such lamps, each lamp or group of lamps being connected between the terminals of a secondary winding of an associated matching transformer, the primary windings of the matching transformers being connected in series, means for supplying to the series-connected primary windings a potential difference which is progressively variable by a dimmer control while the lamps are operating, and means for supplying heating current continuously to each of the electrodes of the lamps at least over the lower part of the operating range of brightness of the lamps, the arrangement being such that both said means are supplied from the same

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source of power, and the circuit including ballast impedance for limiting the lighting current flowing in each lamp. Such ballast impedance may be distributed among the separate secondary circuits including the discharge lamps or lumped in the series-primary circuit. It may be provided by one or more distinct impedance elements or combined, at least in part, with the matching transformers or the dimmer control. The said dimmer control may consist of an adjustable impedance or in some cases a variably-tapped transformer which may be an autotransformer.

Lamp circuits embodying the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, wherein—

Figures 1, 3, 5 and 6 show four lamp circuits suitable for the simultaneous dimming of six lamps by means of a common dimmer control, and

Figures 2 and 4 show another two circuits suitable for such simultaneous dimming of twelve lamps arranged in six groups of two.

Similar parts have the same reference numeral in all the figures of the drawings. All the lamps are of the type having two filamentary electrodes and only two lamps or groups of lamps are shown in each figure.

Referring now to Figure 1, the circuit includes six discharge lamps 10 each of which is connected between the terminals of a secondary winding 11 of an associated matching transformer 12. The six matching transformers 12 are each provided with a primary winding 13, the six windings 13 being connected in series with a ballast choke 14 and variable resistor 15 between two terminals L and N of an A. C. power source. The choke 14 and the resistor 15 constitute a common ballast impedance element and a common dimmer control respectively for all six lamps.

The filamentary electrodes 16 and 17 of each lamp 10 are supplied continuously with heating current from a filament heating transformer 18, having a primary winding 19 connected between the terminals L and N of the power source, and secondary windings 20 and 21 connected to supply electrodes 16 and 17 respectively. An earthed metal strip 22 is disposed in contact with each lamp envelope to assist starting of the lamps.

The filament transformers 18 are so designed that the lamp electrodes are quickly raised to and kept at a temperature such that they emit electrons freely. A stable discharge can be

passed between the two electrodes of each lamp with the dimmer control 15 set to limit the discharge current to a low value. As the dimmer control is operated to decrease the value of the variable resistance in circuit, the discharge current through the lamps increases until the lamps reach full brightness. Thus the brightness of all the lamps can be varied simultaneously from their maximum to a low value without instability by operation of the dimmer control. Although the lamps are operated in series, thus permitting the use of a single adjustable resistor as a dimmer control, the working voltages in the circuit need not exceed the voltage of the power source.

Instead of the common ballast choke 14 a separate ballast choke may be provided, connected in series with each lamp. Owing to the negative-resistance working characteristic of a discharge lamp it is always necessary to provide a ballast impedance in combination with the lamp to limit the total discharge current passing in the lamp. It will be apparent that the circuit can readily be adapted to operate lamp and ballast combinations of various voltage ratings from power sources of widely differing voltages, e. g. 230-volt combinations from a 110-volt power source or 110-volt combinations from a 230-volt power source. Where the ratio of power source voltage to rated voltage of each lamp and ballast combination is V_M/V_L and the number of matching transformers is n, the primary/secondary turns ratio of these transformers will be V_M/nV_L. For example, in the circuit described above, if it is assumed that $V_M=V_L=230$, then $V_M/V_L=1$; since $n=6$, $V_M/nV_L=\frac{1}{6}$.

The lamp circuit shown in Figure 2 differs from that in Figure 1 in that each lamp 10 is replaced by a group of two lamps 19 and the variable resistor 15 and the ballast choke 14 are replaced by a variable saturable reactor 23. The reactor 23 constitutes both the common dimmer control and the common ballast impedance, its saturation being varied by operation of a variable resistor 24, which is connected in series with a saturating winding 25 of the reactor between terminals 26 and 27 of a D. C. power source. It will be apparent that a separate ballast impedance can be provided; in which case the variable reactor 23 constitutes only the common dimmer control.

Each pair of lamps is connected in series across the secondary winding 11 of their associated matching transformer 12. The two electrodes 16 and 17 at the junction of the two lamps are connected in series and are supplied with heating current from a separate secondary winding 20 of the heating transformer 18. A resistor 29 is connected between the terminal L of the power source and the junction of the two lamps. The value of the resistor 29 is so chosen that a small glow discharge representing the lower limit of the controllable range of brightness is maintained in either or both of the lamps. The presence of the resistor ensures that all the lamps will begin to increase at substantially the same rates when the dimmer control is moved from the minimum brightness position. Although the resistor 29 is used in this circuit it will be apparent that any suitable impedance can be used, e. g. a resistor and a capacitor connected in series.

The lamp circuit shown in Figure 3 is similar to that shown in Figure 1 except that the matching transformers 12 are autotransformers. The portions of the autotransformer winding which are connected in series correspond to the primary windings 13 in Figure 1 and each portion is given the reference numeral 13. Similarly, the whole of each autotransformer winding corresponds to a secondary winding 11 in Figure 1 and is given the reference numeral 11. A thermally-responsive relay 30 has a heater winding 31 connected in parallel with its associated secondary winding 11 (only one relay is shown out of the six which would be provided). In response to failure of its associated lamp to strike, after a short delay, the relay 30 connects a dummy impedance 32, equal in value to the impedance of the lamp when struck, in parallel with the secondary winding. Alternatively, the matching transformer 12 may be so designed that the failure of its associated lamp causes saturation without excessive overheating.

The lamp circuit shown in Figure 4 includes six groups each of two lamps, the dimmer control being the variable resistance 15. The circuit differs from that shown in Figure 2 in that the electrodes of each group are supplied with heating current from secondary windings 20, 21 and 23 on the associated matching transformer 12. Thus both the heating currents for the electrodes and the discharge currents in the lamps are supplied through the matching transformers. The matching transformers should be so designed that adequate heating currents are supplied to the electrodes over the whole of the operating range of the lamps. With such a circuit only a single pair of leads are required to supply the lamps and existing wiring and existing dimmer controls of an incandescent lamp installation can readily be used. Alternatively, separate matching and electrode heating transformers can be provided, and each electrode heating transformer can have its primary winding (19) connected in the secondary circuit of its respective matching transformer and in parallel with the discharge path constituted by the lamp or lamps. The matching transformers 12 are of the leakage-field reactance type and each constitutes a ballast impedance for its respective pair of lamps. The resistor 29 of the circuit in Figure 2 is replaced by a resistor 33 and a capacitor 34 connected in series.

The lamp circuit shown in Figure 5 differs from that shown in Figure 1 in that the matching transformers 12 are of the leakage-field reactance type, each constituting the ballast impedance for its respective lamp, and the common dimmer control is constituted by a variably-tapped autotransformer 35. Terminals 36 and 37 of the autotransformer winding are connected to terminals L and N respectively of the power source. The series-connected primary windings 13 of the matching transformers are connected between the tapping terminals 37 and 38 of the autotransformer 35.

In the lamp circuit shown in Figure 6 the matching transformers 12 are autotransformers of the leakage-field reactance type and the common dimmer control is constituted by a variable resistor 15 and a variable saturable reactor 23 connected in series. The arrangement of this dimmer control can be made such that the reactor 23 controls the brightness from full brightness to, say, one-tenth full brightness, and the resistor 15 controls the brightness over the remainder of the range.

In all the above described lamp circuits and the alternatives thereto each single lamp or group of two lamps may be replaced by one of

the groups of lamps disclosed in pending application Serial No. 116,756. Also the modifications disclosed in the said application, enabling the brightness of the lamps to be reduced from full brightness to substantially zero brightness, may, if practicable, also be incorporated.

Although all the circuits described above are suitable for six single lamps or six groups of lamps, it will be apparent that circuits in accordance with this invention may include two or more such lamps or groups of lamps.

I claim:

1. A starting and operating circuit for a gaseous discharge lamp, said circuit comprising a transformer having a primary, a high voltage secondary and several filament-heating secondaries, two discharge lamps connected in series across said high voltage secondary, said lamps being elongated gas-filled tubes with a filamentary electrode at each end, said filamentary electrode being connected to said filament-heating

secondaries of said transformer, and a capacitative impedance across one only of said lamps.

2. An electric discharge lamp circuit including: two electric discharge lamps, each having two filaments; a transformer having a primary, a main secondary for supplying current to the discharges in the lamps, and filament-heating secondaries; said filament-heating secondaries being connected to heat said filaments; said main secondary being connected to supply discharge current to the said two lamps in series; and a capacitive impedance connected across one only of said lamps.

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