

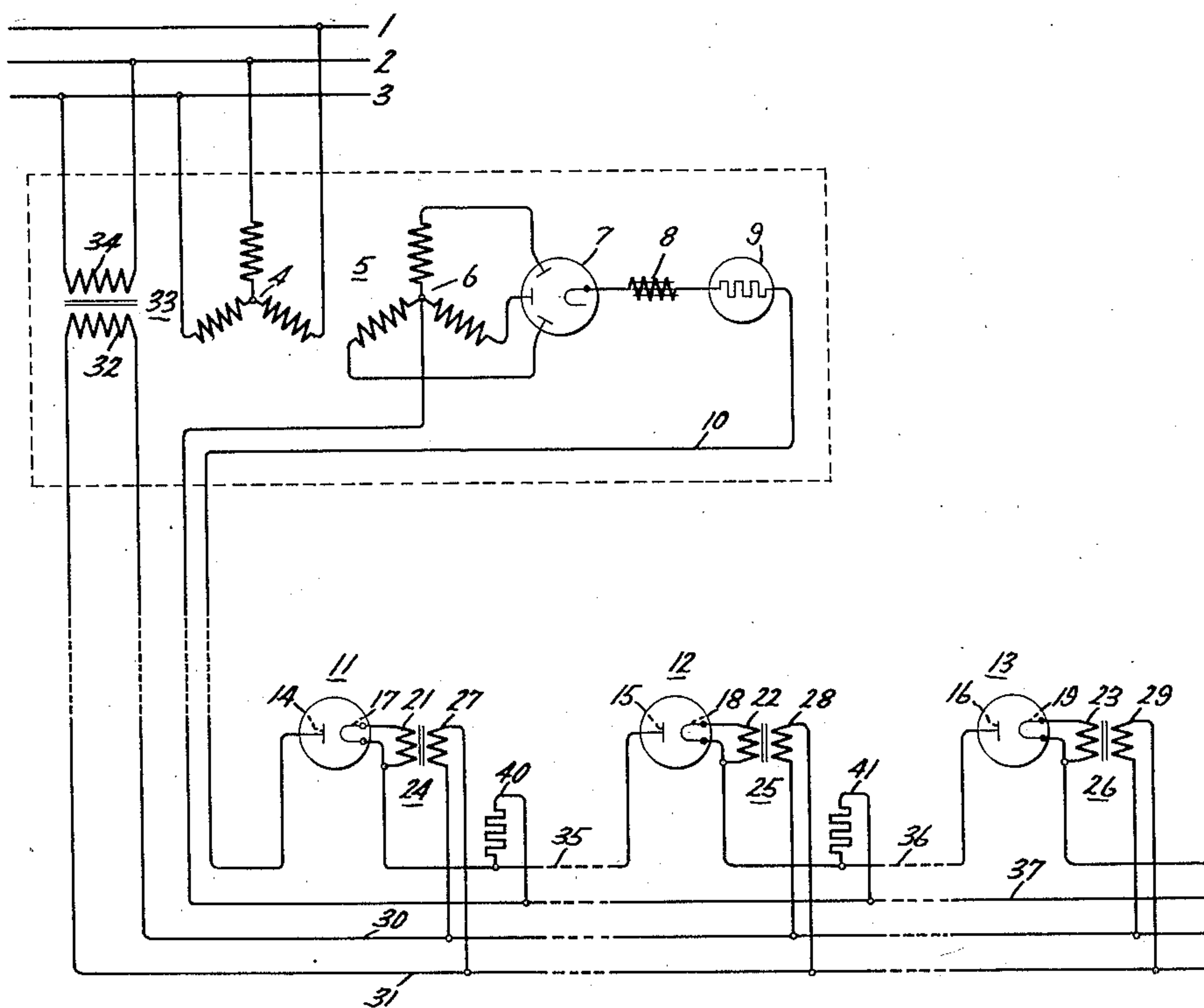
**June 5, 1934.**

E. G. DORGELO ET AL

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## SERIES LIGHTING SYSTEM

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Inventors:  
Eduard G. Dorgelo,  
Hendrik A.W. Klinkhamer,  
Cornelis Bol,  
by *Charles E. Fuller*  
Their Attorney.



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# UNITED STATES PATENT OFFICE

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## SERIES LIGHTING SYSTEM

Eduard G. Dorgelo, Hendrik A. W. Klinkhamer,  
and Cornelis Bol, Eindhoven, Netherlands, as-  
signors to General Electric Company, a corpora-  
tion of New York

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2 Claims. (Cl. 171—97)

Our invention relates to series lighting systems, and more particularly to series lighting systems using gaseous discharge tubes as lighting units.

Many of the gaseous discharge tubes used for lighting purposes require a higher potential for starting than for operation. This is inconvenient for series lighting purposes, since in such circuit the starting voltage of the system, being ordinarily the sum of the starting voltages for all of the lamps, becomes very large.

It is an object of our invention to reduce the starting voltage of a series lighting system, as above described, to substantially the starting voltage of one lamp irrespective of the number of lamps used in the system.

Further objects and advantages of our invention will be apparent, and the invention itself will be better understood, from the following description, when considered in connection with the single figure of the accompanying diagrammatic drawing, and the features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawing, 1, 2 and 3 indicate the conductors of a three-phase power source to which the primary 4 of a transformer 5 is connected. The secondary winding 6 of transformer 5 is a star-connected three-phase winding, the ends of which are connected to the anodes of a rectifier 7. Rectifier 7 may be of any suitable type. It may be a mercury arc rectifier or it may be a hot cathode mercury vapor discharge tube which is a type now known in the art. The rectifier is connected in series with an iron core inductance coil 8, a current regulator 9 and, through a conductor 10, to discharge tubes 11, 12 and 13.

The discharge tubes are of the thermionic, electron emitting cathode type and are filled with a mixture of a rare gas and a metal vapor, such as a mixture of neon and sodium vapor, or a mixture of argon and sodium vapor, for example. The gas or vapor filling in the lamp is dependent upon the color of the light that is desired and other factors, such as, for example, operating and starting voltages.

The discharge devices, or tubes, 11, 12 and 13 are respectively provided with anodes 14, 15 and 16 and thermionic cathodes 17, 18 and 19. The cathodes are respectively energized by the secondary windings 21, 22 and 23 of transformers 24, 25 and 26. The primary windings 27, 28 and 29 of these transformers are respectively connected in multiple to the conductors 30 and 31 and secondary winding 32 of transformer 33 whose primary 34 is connected to the source conductors 2 and 3.

Cathode 17 is connected to anode 15 by conductor 35 and cathode 18 is connected to anode 16 by a conductor 36. The cathode 19 may be connected to another anode and the number of

lamps may be thus increased. In the present case, however, it is connected to the return conductor 37, which is connected to the neutral point of the transformer winding 6. The discharge paths of the lamps are thereby connected in series with each other and the cathodes are each energized by a separate transformer winding, the respective primary windings of the transformers being connected, in multiple, to the main power source through another transformer.

In order to reduce the starting voltage of the system, leakage resistors 40 and 41 are connected between neutral conductor 37 and the conductors 35 and 36, respectively. These resistors are of a very high resistance, and permit the application of the starting voltage of the system to the lamps, in multiple, whereby the lamps start up at substantially the same time and with the system voltage substantially equal to the starting voltage of a single lamp.

For the purpose of regulating the current in the discharge circuit, the regulator 9 is connected in series with this circuit. Regulator 9 is preferably an iron wire placed in an enclosure filled with a non-oxidizing gas. The iron wire has a large positive temperature coefficient of resistance and is arranged to regulate the current within a smaller range of fluctuations, expressed in per cent, than the percentage of the voltage fluctuations.

The light efficiency of the sodium vapor type of lamp is greatly reduced by fluctuations in the operating current. It has been found that the quantity of light emitted per unit of consumed energy depends greatly upon the fluctuations of the effective value of the discharge current. Furthermore, the fluctuations of the discharge current, due to normal voltage fluctuations, are especially large, since the tubes operate in a manner analogous to the generation of a counter-electromotive force and small fluctuations of the impressed voltage cause relatively large fluctuations in the discharge current. The current regulator, such as mentioned above, is, therefore, arranged to regulate the current within a smaller range of fluctuations than the voltage fluctuations, although satisfactory results may be obtained if the fluctuations in the discharge current are maintained relatively smaller than twice the voltage fluctuations which cause the current to fluctuate.

In the operation of a system built in accordance with our invention, a starting voltage somewhat higher than the starting voltage of a single lamp is applied to the system. A potential substantially equal to the source is thereby built up across each lamp through the resistors, as above described, and a discharge through each lamp is thereby started simultaneously. Since the resistances between lamps are too high to carry the discharge current, the lamps thereafter operate



in series with each other and the system voltage is adjusted to the normal operating voltage. The current is thereafter regulated, as above described.

While many different types of gaseous electric discharge lamp devices can be used as sources of illumination in the above described circuit we prefer sodium lamp devices of the type in which the physical dimensions and electrical characteristics are such that the discharge is an arc discharge without a positive column. A potential of approximately 17 volts is sufficient to start lamp devices of this type into operation and the operating voltage is of course lower than the starting voltage thereof. Thirty of such devices can be used in the illuminating system described above in which case the voltage of the direct current provided by rectifier 7 is approximately 500 volts, the voltage of the secondary 32 of the transformer 33 is preferably 110 or 220 volts and the voltage of the secondaries 21, 22 and 23 of the transformers 24, 25 and 26 respectively is approximately 2 to 2½ volts. The current flow through the lamps during the operation thereof is approximately 5 amperes.

While we have shown and described our invention in considerable detail, we do not desire to be limited to the exact arrangement shown, but seek

to cover in the appended claims all those modifications that fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:—

1. In a series lighting system, the combination of a plurality of hot cathode vapor discharge lamps provided respectively with anodes and cathodes, a source of energy, means arranged to connect said lamps in series with each other to said source, and means arranged to effect the application of the starting voltage of said source to said lamps in multiple.

2. In a series lighting system, the combination of a plurality of hot cathode vapor discharge lamps provided respectively with anodes and cathodes, a source of energy, means for connecting said discharge lamps in series with each other to said source, and a plurality of resistances connected across said source between pairs of said discharge lamps and arranged to effect a multiple connection of said lamps for starting purposes and to effect a series operation of said lamps after said starting has been effected.

EDUARD G. DORGELO.  
HENDRIK A. W. KLINKHAMER.  
CORNELIS BOL.

30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150