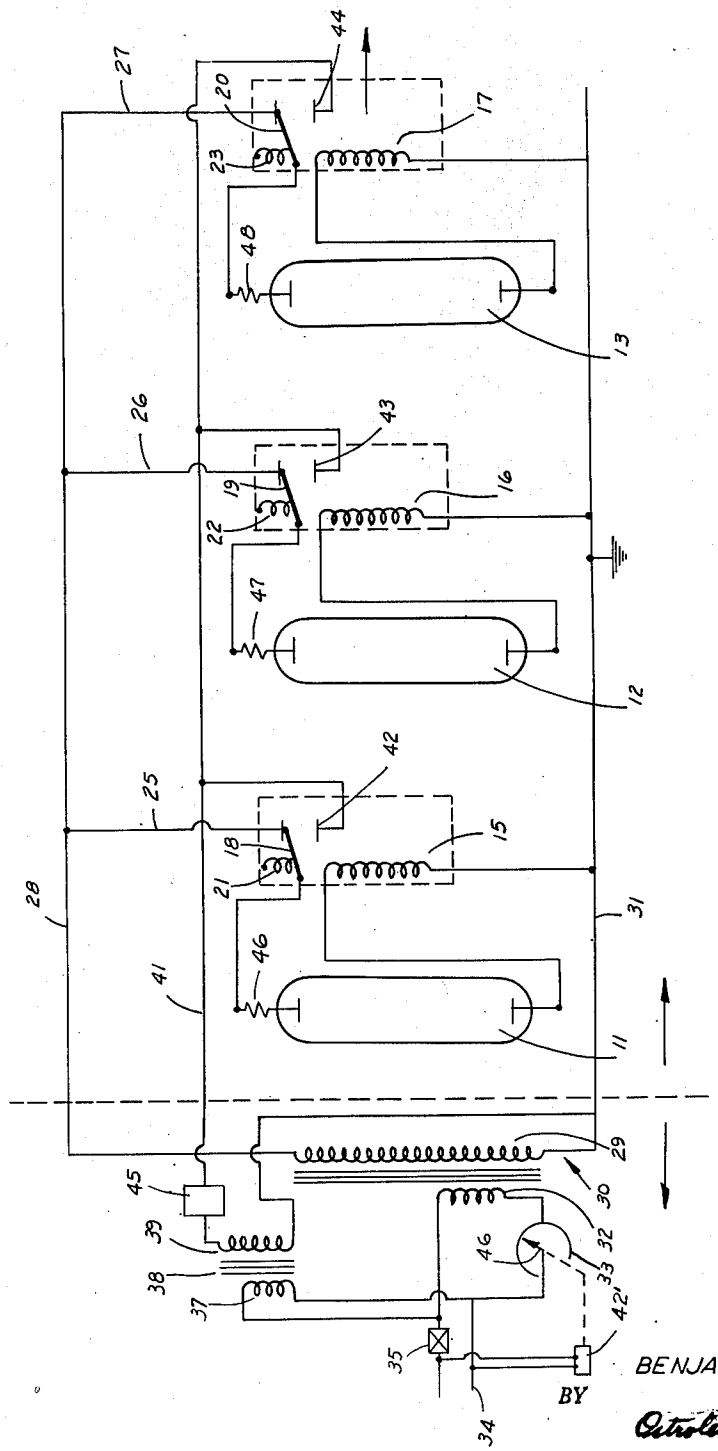
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GASEOUS DISCHARGE TUBE CIRCUIT

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GASEOUS DISCHARGE TUBE CIRCUIT

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My invention relates to a novel system for the operation of gaseous discharge tubes of either the glow or arc type, and more specifically relates to a system for operating neon signs.

Because of stability problems during ignition, such gaseous tubes have heretofore often been connected in series. Such series connections make for high voltage requirement and therefore involve complicated wiring to meet the necessary Underwriters' approval. Moreover, all of the discharge lamps must constantly be in operation since failure of any one of the lamps renders the entire system inoperative.

Series systems have the further disadvantage of being inflexible whereas in parallel circuit arrangements, lights can be inserted or removed in operation as desired.

Accordingly it is desirable to operate these discharge tubes in parallel particularly where they are employed for advertising since in such cases the insertion or removal of signs to change the advertising matter is a relatively simple accomplishment.

Attempts therefore to connect the glow lamps in parallel have not been successful where the energy supply has been attempted through a single transformer. In such cases the tube offering the lowest ignition potential is discharged. Once this tube in the system was ignited by the high voltage supply, the voltage was dropped to the operating potential of that tube and thereafter the voltage was insufficient to ignite the remaining tubes of the system.

To correct for this, it has been found necessary to employ a high leakage transformer and individual current limiting reactances for each tube. This, however, entails considerable power loss in the transformer. In a further attempt to solve this problem, separate secondaries have been employed for each of the tubes but here again disadvantages reside in the excessive cost of providing such individual transformer windings.

In accordance with my invention I provide a simple circuit arrangement which by the provision of two transformers enables the operation of any desired number of discharge tubes in parallel. In general, I employ one transformer common to all the tubes for providing the high or striking voltage and a second transformer common to all of the tubes for providing an operating voltage with simple relay arrangement for switching from one to another.

Accordingly an object of my invention is to provide a novel circuit arrangement for operating discharge tubes in parallel.

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A further object of my invention is to provide a novel circuit arrangement for operating discharge tubes in parallel having a common high voltage striking source and a separate common low voltage operating source.

Still another object of my invention is to provide a novel circuit arrangement for operating discharge tubes in parallel in which inexpensive relay means are the only individual provisions for each of the discharge tubes.

These and other objects of my invention will become clear in connection with the description of the invention which is to follow in describing the accompanying drawing which is a schematic illustration of my novel circuit arrangement.

Referring to the drawing, a plurality of glow discharge devices 11, 12 and 13 are here illustrated, it being understood that these may be of different sizes with respect to each other having individual break-down voltage characteristics. It will also be understood that they may be of the neon type used for advertising or any other well known form of gaseous discharge tube.

Associated with each of the discharge devices and individual thereto are the relays 15, 16 and 17 each provided with its armatures 18, 19 and 20 biased against its back contact by their individual springs 21, 22 and 23.

The back contacts with each of the armatures are connected over individual conductors 25, 26 and 27 to a common conductor 28 which is connected to the secondary 29 of a high voltage transformer 30, the return circuit being over the common conductor 31.

One terminal of the primary 32 of high voltage transformer 30 is connected through an interrupter 33 to a source of supply 34, the other terminal of the primary being connected through a switch device 35 to the source of supply 34. The source of supply 34 is also connected through the switch device 35 to a primary 37 of transformer 38, the secondary 39 of which is in turn connected over conductor 41 to the individual front contacts 42, 43 and 44 of the relays.

From the above it will now be clear that on the closing of the switch 35 connecting the primary 32 to the source of supply 34, a high voltage current will be applied across the conductors 28 and 31 of the secondary 29, the circuit extending over conductor 25 through the back contact and armature 18 and through the current limiting reactance 46 of tube 11 to ignite the tube 11. A similar circuit extends through the current limiting reactance 47 for tube 12 and through the current limiting reactance 48 of tube 13 and to similar tubes in the system.

The particular tube in the system whose striking voltage is lowest will be ignited over its individual circuit. Immediately this tube ignites, the voltage will drop because of the high leakage reactance of the transformer **30**, thus preventing ignition of any of the remaining tubes of the system.

It will be noted that the circuit including the ignited tube which for the present will be assumed to be tube **11** includes its individual relay winding **15**. Relay winding **15** is thereupon energized to operate its armature **18** from its back contact against tension spring **21**, the armature **18** moving to engage its front contact **42**. Because of the high voltage in the circuit, arcing may occur between the armature and its back contact. This arcing may continue until the armature engages its front contact **42**. In order to extinguish this arc after the armature engages its front contact, and before any appreciable contact wear can take place, the interrupter **33** is provided in the primary circuit of transformer **30**. This interrupter is arranged to keep the circuit closed to the power supply **34** sufficiently long to permit ignition of tube **11**. The interrupter **33** is constructed to open the circuit after the tube ignition occurs for a period sufficiently long to extinguish the arc formed between the armature **18** and its back contact. This period may be $\frac{1}{10}$ of a second in each period of a second or in ratio of time to the ignition period depending on the period of time in practice found necessary to actually extinguish the arc for the particular sizes of ignition devices employed.

In order to provide such interruption, the interrupter **33** may be a commutator engaged by a wiping brush **46** which is rotated on a shaft rotated from a motor **42'** driven by power from the source **34**.

As here illustrated, approximately 90° of the rotating period or 25% thereof is the open period of the interrupter but this will vary depending on the size of neon or other lights employed.

The armature **18** having now been moved to engage its front contact **42** on energization of the relay winding **15** switches the circuit for the glow lamp **11** from the high voltage bus **28** to the low voltage bus **41** which is connected to the secondary **39** of the low voltage transformer **38**, the opposite terminal of the secondary **39** being connected to the common lead **31**. Thus the operating or lower voltage for the glow lamp **11** is now provided from the secondary **11** immediately following the extinction of the arc formed at the armature **18**. The primary circuit **29** of the high voltage transformer **30** is now again available to supply high voltage for the next largest tube in the system.

This tube which now has the lowest breakdown or ignition voltage characteristics of the system is ignited in the manner described in detail in connection with the glow lamp **11** and if, for example, this happens to be glow lamp **13**, its individual relay winding **17** is energized in the manner described above to switch the circuit of the glow lamp to the low voltage supply source.

At the same time the interrupter **33** again functions to break the arc which is formed between the back contact and the armature **20** and its back contact. In this manner all of the tubes are sequentially ignited from a common high voltage source and are maintained in operation in parallel over a common low voltage supply source.

With the parallel circuit arrangement herein shown, and the separate high and low voltage sources, one for igniting and the other for operating the discharge tubes, an entire bank of as much as 50 tubes can be illuminated within a period of 4 to 5 minutes.

Moreover, should any one of the tubes be extinguished, the relay winding associated therewith will be de-energized so that it re-engages its back contact, re-applying a high potential thereto from the secondary **29** during the interval while the interrupter **34** closes the circuit to the source.

If the tube is in operative condition, it will be re-ignited and set into operation in the manner described above. For this purpose it will be understood that the interrupter **33** should normally be in operation during the period while all of the tubes are in use. Thus in the event a tube does for any reason lose power, it can be re-ignited without any difficulty.

With my novel arrangement when all the tubes are in operation, no power flows over the high voltage bus **28** since the armatures of all of the tubes are on their front contacts connected to the low potential conductor **41** and the interrupter **34** is merely called upon to break current for the power losses of the transformer **30**, and accordingly there will be appreciably little contact wear. Thus the maximum interrupting capacity of interrupter **33** need only be the necessary kva. required to operate one discharge tube since only one tube is operated at a time through transformer **30**.

It will be noted that each of the lamps are shown with their individual current limiting reactors **46**, **47** and **48** providing the necessary reactance for the lamp depending on its size and current consumption. However, it will be understood that if desired the necessary reactance may be secured in the relay windings **15**, **16** and **17**, each of which may be individually constructed to provide the necessary current limiting reactance for its associated glow lamp.

With the present novel arrangement, only sufficient current need flow in the high potential secondary **29** for the current consumption of one tube since only one tube will break down at a time, and as soon as the tube does break down its energy supply is switched over to the low voltage line **41**.

Accordingly the high voltage transformer **30** may be of much smaller design than would normally be necessary in attempting to operate a similar large bank of tubes as may be used in this system.

Although in the above described system discharge tubes, such as neon lights utilized for advertising, are described, it will be obvious that other forms of discharge tubes may be employed with corresponding modifications of the circuit arrangement. Thus, for example, if the system were to be used for street lighting or home lighting, the current values would not be much different than that described above and the same system would still be feasible.

In the use of alternating current over the conductor **41**, the voltage must be sufficiently high to overcome de-ionization tendencies between cycles whereas with the use of a direct current, a lower voltage and higher tube efficiency may be as much as 40% over alternating current. It will be apparent therefore that if desired the low voltage supply over conductor **41** may be a D. C. voltage of the desired value, thus producing a

more efficient kva. operation. Such a D. C. voltage may be secured at the source or by a rectification of A. C., as by a rectifier 45.

In such a system employing direct current over conductor 41, the high voltage bus 28 may be A. C. or D. C., but preferably would be A. C. as here shown.

Although I have shown an interrupter 41 comprising a rotary member, motor driven, it will be obvious that this is merely a schematic illustration of an interrupter and any other well known arrangement for periodically interrupting the supply to the transformer 30, such as thermal relays, may be employed.

My invention has definite advantages in controlling fluorescent house lighting lamps which at present are controlled by starters and inductances acting as current limiters. By the use of my invention it is possible to employ a tube whose operating voltage can be higher than is presently possible. Thus, a slender and longer tube can be employed.

As now practiced, the inductance is used to obtain a kick for starting by breaking the circuit suddenly. This provides a momentary high voltage for ignition, the same inductance thereafter functioning as a current limiter. However, since the amount of voltage obtainable for starting in this manner is limited, the tube must be constructed to have a relatively low starting voltage and therefore in turn a relatively low operating voltage.

In accordance with my invention the starting and operating voltages are more easily and simply regulated to any desired value. Thus it is possible to employ a higher voltage which effects a current economy since there is a material drop in the IR square loss. Moreover, the power factor is considerably improved.

I claim:

1. In a system for operation of gaseous discharge tubes comprising a source of energy of a predetermined frequency, a source of relatively high voltage comprising a transformer having a primary and connected to said first-mentioned source of energy and a secondary comprising the high voltage output; means for simultaneously connecting said tubes in parallel to said high voltage output for igniting one of said tubes; a second transformer having a primary connected to said first-mentioned source of energy and a secondary comprising an operating voltage output, switching means in the high voltage output circuit individual to each tube opening the high voltage circuit to said tube when the tube is ignited and connecting the tube to the operating voltage output in parallel with other tubes in the system.

2. In a system for operation of gaseous discharge tubes comprising a source of energy of a predetermined frequency, a source of relatively high voltage comprising a transformer having a primary and connected to said first-mentioned source of energy and a secondary comprising the high voltage output; means for simultaneously connecting said tubes in parallel to said high voltage output for igniting one of said tubes; a second transformer having a primary connected to said first-mentioned source of energy and a secondary comprising an operating voltage output, switching means in the high voltage output circuit individual to each tube opening the high voltage circuit to said tube when the tube is ignited and connecting the tube to the operating voltage output in parallel with other tubes in the system, a common return circuit for each of the high voltage and operating voltage outputs; said switching means comprising a relay coil individual to each tube and connected between each tube and the return circuit; a set of switch contacts individual to each of the high voltage and operating voltage outputs at each of the tubes; a movable contact member individual to each tube and connected to the input side of each tube; said movable contact member being biased to the high voltage contact; each movable contact member having an armature; said armature being movable by said coil when the coil is energized by the completion of the circuit through the tube on ignition of the tube to be moved with its movable contact member to engage the operating voltage contact.

3. In a system for operation of gaseous discharge tubes comprising a source of energy of a predetermined frequency, a source of relatively high voltage comprising a transformer having a primary and connected to said first-mentioned source of energy and a secondary comprising the high voltage output; means for simultaneously connecting said tubes in parallel to said high voltage output for igniting one of said tubes; a second transformer having a primary connected to said first-mentioned source of energy and a secondary comprising an operating voltage output, switching means in the high voltage output circuit individual to each tube opening the high voltage circuit to said tube when the tube is ignited and connecting the tube to the operating voltage output in parallel with other tubes in the system, a common return circuit for each of the high voltage and operating voltage outputs; said switching means comprising a relay coil individual to each tube and connected between each tube and the return circuit; a set of switch contacts individual to each of the high voltage and operating voltage outputs at each of the tubes; a movable contact member individual to each tube and connected to the input side of each tube; said movable contact member being biased to the high voltage contact; each movable contact member having an armature; said armature being movable by said coil when the coil is energized by the completion of the circuit through the tube on ignition of the tube to be moved with its movable contact member to engage the operating voltage contact, and apparatus for periodically interrupting current in said high voltage output circuit.

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