

April 27, 1943.

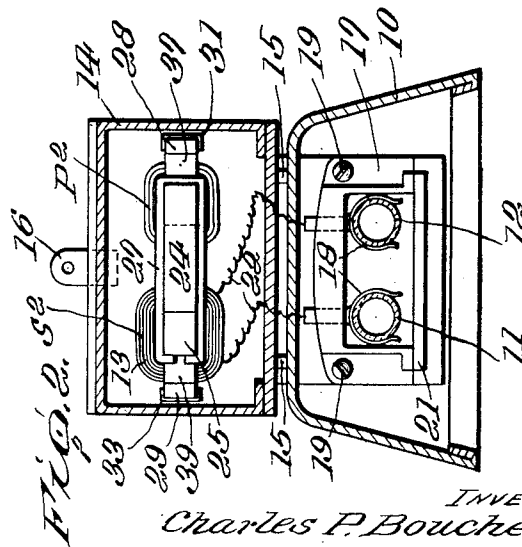
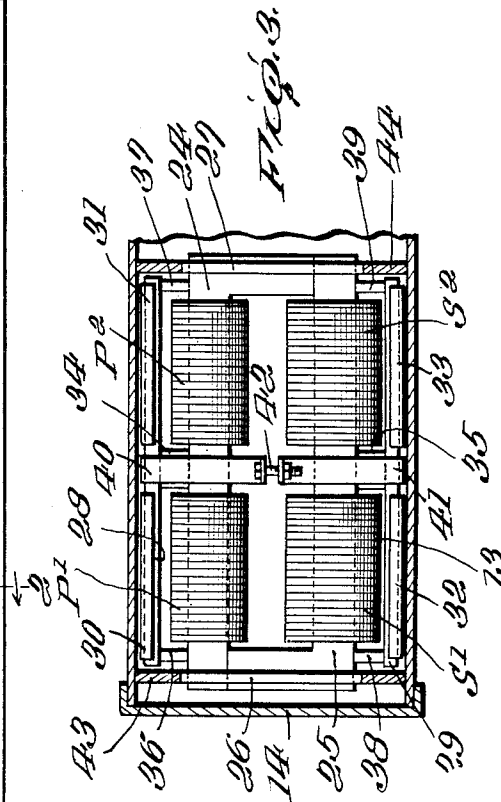
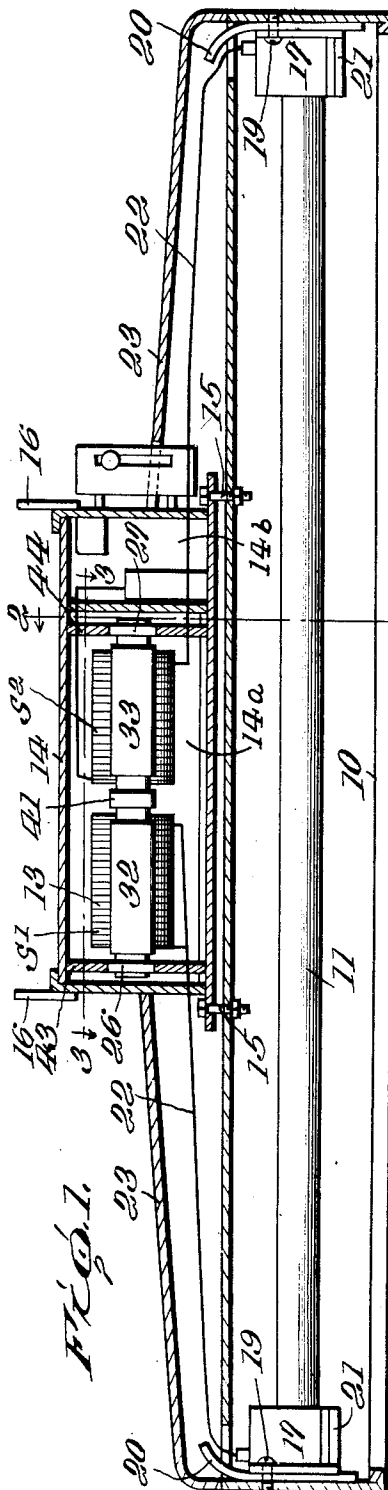
C. P. BOUCHER

2,317,845

LUMINESCENT TUBE LIGHTING APPARATUS

Filed Aug. 21, 1940

2 Sheets-Sheet 1



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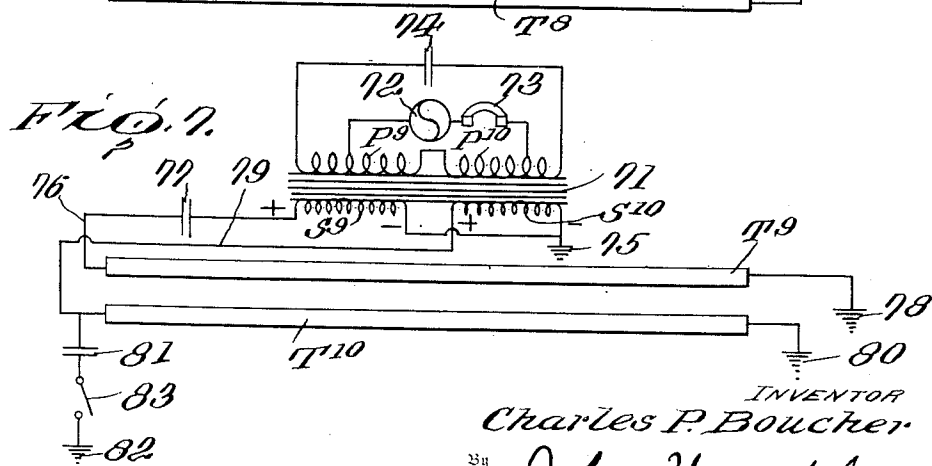
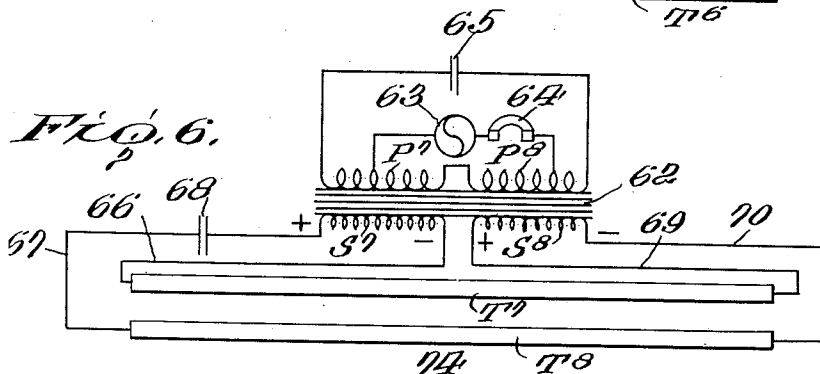
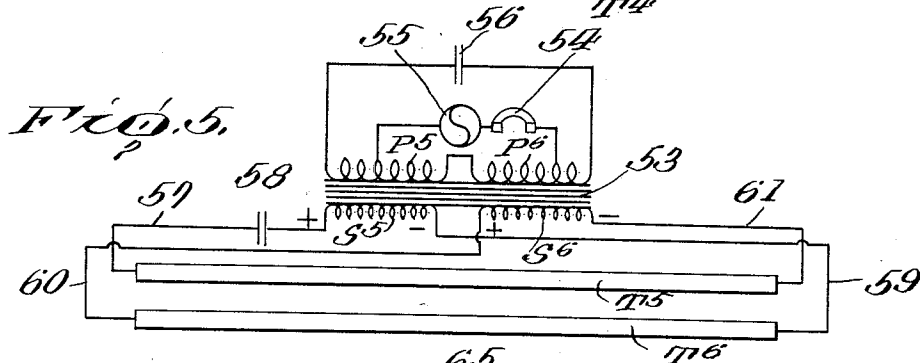
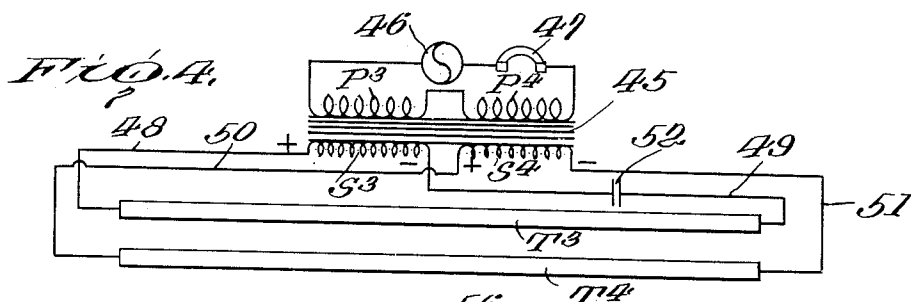
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LUMINESCENT TUBE LIGHTING APPARATUS

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,317,845

LUMINESCENT TUBE LIGHTING
APPARATUS

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5 Claims. (Cl. 176—124)

This invention relates to electrical transformers for energizing luminescent tube systems suitable for the illumination of signs or displays and to a mounting for the transformers and luminescent tubes.

One of the objects of my invention is to provide a mounting for the transformer and luminescent tubes of luminescent tube lighting apparatus such that all the parts are assembled in a compact unit.

Another object is to provide a luminescent tube system in which flickering or stroboscopic effect of the light from a group of tubes is substantially eliminated.

Still another object of the invention is to provide a luminescent tube system in which electrostatic stress between the tubes is reduced to a negligible value.

A further object is to provide a luminescent tube system in which the tubes operate at low voltage and with high efficiency.

Other objects will be obvious in part or in part pointed out hereinafter.

The invention accordingly consists in the combination of elements, features of construction and arrangement of parts as described herein, the scope of the application of which is set forth in the claims.

In the accompanying drawings illustrating certain features of my invention:

Figure 1 represents a sectional plan view of a luminescent tube lighting unit including the transformer and the luminescent tubes.

Figure 2 is an enlarged vertical side section on the line 2—2 of Fig. 1.

Figure 3 is an enlarged vertical section on the line 3—3 of Fig. 1, showing details of the transformer.

Figures 4, 5, 6 and 7 are diagrams of various circuits which may be employed.

Like reference characters refer to like parts in the several figures of the drawings.

As conducive to a clearer understanding of the nature of my invention, it may be noted at this point that, for example, in the illumination of a sign or display, employing for that purpose one or more luminescent tubes as a source of light, one or more high potential electrical transformers are required. These transformers have heretofore been mounted in a protected place either inside a building or in a casing separate from the luminescent tubes for lighting the sign or display structure, thus necessitating long high-tension cables and requiring several steps to be taken in fastening the parts in place and in making

electrical connections. It is apparent that such an arrangement is expensive, due to the cost of the high tension cables and of the casings where separate ones are used and also due to the separate labor charges for each step in the installation. To overcome these disadvantages is one of the objects of my invention.

In heretofore known luminescent systems for signs or displays employing one or more luminous tubes, it has been customary to operate these tubes from the same or separate transformers in such a manner that they all become ionized and conductive at substantially the same instant. Where a 60-cycle source of electrical energy is used, the tubes become luminous 120 times per second. Due to persistence of vision, the tubes appear to emit substantially a steady glow of light but even while being lighted as many as 120 times per second, some flickering is noticeable, particularly where the tubes are mounted in a group in front of the same reflector. This phenomenon is called a stroboscopic effect and is especially noticeable when the operation of the tubes is affected by variations in the voltage impressed across their terminals and in the wave form factor of the current. Aging of the tubes and variations in their operating characteristics due to changing temperature conditions also cause this stroboscopic effect to be particularly noticeable.

In the operation of luminescent tubes which are grouped closely together for illumination purposes, it is ordinarily necessary to mount the tubes so that they are spaced apart in order to avoid dielectric discharges between them. This spacing is undesirable because it exaggerates the flickering effect described above. Moreover, it reduces the concentration of light from the tubes and thus makes them less satisfactory for illumination purposes.

In luminescent tube systems now in use, it is necessary to employ high voltage to initiate operation of the tubes. This high voltage is not needed after the tubes have become started but is still impressed across their terminals. Complicated starting devices are used which require constant attention and frequent replacement or repair. This situation makes for an increased power consumption and a correspondingly lower efficiency and a high maintenance cost.

Accordingly, another object of my invention is the provision of a compact, rugged and efficient luminescent tube lighting unit of reduced stroboscopic effect, good and uniform light intensity and, moreover, of good operating power factor

all with a minimum of attention and a minimum of replacement or repair.

Referring now to the practice of my invention, attention is directed to Figs. 1 and 2 in which I have shown illustratively a casing and reflector 10 in which are mounted two luminescent tubes 11 and 12. These tubes are energized by a transformer 13 which is housed in transformer compartment 14a of an enclosure 14, also having a condenser compartment 14b, the enclosure being attached to the rear of the reflector 10, as by bolts 15. Lugs 16 are provided on the enclosure 14 for supporting the whole casing structure.

Tubes 11 and 12 are supported at their ends in porcelain housings 17 by spring clamps 18, which make firm electrical contacts with the tube terminals. The porcelain housings 17 are secured in place in the casing by screws 19, further insulation of the tube terminals from the metal of the casing 10 being provided by spacers 20 of insulating material. Porcelain cover plates 21 are placed over the front apertures of the housings 17 when the tubes are in position. The tubes 11 and 12 are energized thru spring clamps 18 and leads 22 from the transformer 13, which is shown in detail in Fig. 3.

The transformer 13 has a primary winding comprising two coil sections P and P₂ connected in series and mounted on the core member 24. Two secondary windings S and S₂ are mounted on the other core member 25. The core members 24 and 25 are held in abutting relationship by core bands 26 and 27. Magnetic shunt parts 28 and 29 are placed so as to form shunt paths around the primary and secondary windings and thereby decrease the sustaining voltage of the tubes or the voltage applied to the tubes each half-cycle following the striking. Silencing clamps 30, 31, 32 and 33 are fitted over the shunt parts 28 and 29 to prevent their laminations from chattering. Shunt pieces 34 and 35 are interposed between the shunt parts 28 and 29 and the core members 24 and 25 at their centers and insulating blocks 36, 37, 38 and 39 are fitted between the shunt parts and the core members at their ends to maintain the shunt parts firmly in position. The shunt parts are held in place by clamps 40 and 41 which are tightened by the bolt and nut 42. The transformer is maintained in a proper position in its casing 14a by spacers 43 and 44 of non-magnetic material which fit over the core bands 26 and 27.

Referring now to Fig. 4, there is diagrammatically represented one circuit which may be used in the transformer and tube system of my invention. The primary winding coil sections P₁ and P₂ are mounted on the core 45 and are connected in series at their inner terminals. It will be understood that in operation, core and coils are mounted within the transformer compartment of the lighting structure. Their outer terminals are connected to an alternator 46 or other source of alternating current electrical energy thru a thermal circuit breaker 47. The purpose of the circuit breaker is to prevent overloading of the primary winding. It operates to open the primary circuit when the temperature of the primary winding exceeds a value corresponding to the maximum safe load of the primary winding.

There are two secondary winding S₃ and S₄ energizing the tubes T₃ and T₄, respectively, by way of leads 48, 49, 50 and 51. A condenser 52 is connected in series with one of the tubes as by connecting it in the lead 49 to the tube T₃. In

operation, here again it will be understood that the condenser is located within the condenser compartment provided in the casing of the lighting structure. The condenser 52 is of such capacitance as to cause the current in the tube T₃ to substantially lead the current in tube T₄. By this arrangement the number of periods of illumination from the group of tubes is doubled from 120 to 240 times per second. Thus the flickering which is frequently noticeable in the ordinary installation is substantially eliminated. This is particularly true where the two tubes are mounted closely together, and where they are operated at high current densities. Such an arrangement is practical where the circuit of Fig. 4 is used because the adjacent tube terminals are always at potentials of about the same value since they are connected to corresponding terminals of their secondary windings, any difference being due to phase displacement by the condenser. Thus the left-hand terminals of tubes T₃ and T₄ are shown at one instant as being connected to the positive terminals of the windings S₃ and S₄ and the right-hand terminals of the tubes are connected to the negative ends of the secondary windings. Being always at about the same potential, there is no danger of dielectric discharge between adjacent portions of the tubes, even when the tubes are mounted in close proximity.

The presence of the condenser 52 in the circuit of the tube T₃ increases the reactance of that circuit. Accordingly, where the secondary windings S₃ and S₄ are of the same voltage rating during the conductive periods of the tubes the tube T₃ must be one operating at a lower voltage than tube T₄. Thus tube T₃ may be of larger diameter than tube T₄ or it may be one having electrodes of lower resistance. Tube T₃ may also operate at a lower voltage than tube T₄ because it contains a different gas or gas mixture. If it is desirable to have tubes which are identical in rating, which ordinarily is the case, the winding S₃ must be one which develops a higher tube sustaining voltage than winding S₄.

Considering now another circuit embodying my invention, attention is directed to Fig. 5 in which I show a transformer comprising a core 53, a primary winding consisting of two coil sections P₁ and P₂ connected in series, and two secondary windings S₅ and S₆. The central points of the primary winding sections are connected thru a thermal circuit breaker 54 to an alternator or other source of alternating current supply 55. A condenser 56 is connected across the outer terminals of the primary coil sections. The function of this condenser is to improve the power factor of the primary circuit. Inasmuch as the outer terminals of the primary winding present a potential in excess of the potential of the source of supply, the circuit has the advantage that the condenser may be of less capacity, and of less expense, than otherwise would be required.

One terminal of the secondary winding S₅ is connected to the left-hand terminal of a tube T₅ by the lead 57 thru the condenser 58. The other terminal of winding S₅ is connected to the right-hand terminal of tube T₆ by the lead 59. Likewise, one terminal of winding S₆ is connected to the left-hand terminal of tube T₆ by the lead 60 and the other terminal of winding S₆ is connected to the right-hand terminal of tube T₅ by lead 61. Thus it will be seen that the tubes are connected in series with the secondary windings, this connection giving a cir-

cuit of somewhat higher efficiency than a parallel circuit. It will be observed that in this circuit, as in that of Fig. 4, adjacent tube terminals are always near the same polarity, being connected to corresponding terminals of the secondary windings. The condenser 58 serves the purpose of causing the current in one tube to be out of phase with the current in the other tube and thus to double the number of periods of illumination from the group of tubes in any given time. The tube T_3 in series with condenser 58 must be one operating at a lower sustaining voltage than tube T_4 .

In the circuit of Fig. 6 the primary connections are the same as those in Fig. 5. The primary winding comprises the coil sections P_7 and P_8 connected in series and mounted on core 62 and energized by an alternator or other source of supply 63 connected through a thermal circuit breaker 64 to the center of the coil sections. A condenser 65 is connected across the ends of the primary coils to correct the power factor of the primary circuit current.

There are two secondary windings S_7 and S_8 in the transformer of Fig. 6. Winding S_7 is connected thru leads 66 and 67, respectively, to the left-hand ends of the luminescent tubes T_7 and T_8 , a condenser 68 being connected in series in the lead 67 to cause the current in tube T_8 to lead that in tube T_7 . The terminals of windings S_8 are connected by leads 69 and 70 to the right hand terminals of tubes T_7 and T_8 respectively. This circuit may be employed where there is little danger of dielectric discharge between the tubes, as where they are mounted with a substantial space between their walls or where the operating voltage is low. This series circuit is somewhat more efficient than a parallel circuit. The tube T_8 must be one operating at a lower tube sustaining voltage than tube T_7 .

Still another manner of connecting the transformer secondary winding is shown in Fig. 7. Mounted on the transformer core 71 are the primary coils P_9 and P_{10} connected in series and energized from the alternator or other source of supply 72 which is connected thru the thermal circuit breaker 73 to the centers of the coils. Condenser 74 is connected across their ends to improve the power factor of the primary circuit current.

The one terminals of the secondary windings S_9 and S_{10} are grounded at 75. The other terminal of winding S_9 is connected by lead 76 thru condenser 77 to one terminal of a luminescent tube T_9 , whose other end is grounded at 78, completing the circuit. The ungrounded end of winding S_{10} is likewise connected by lead 79 to one terminal of tube T_{10} , whose other terminal is grounded at 80. The tube T_9 which is in series with condenser 77, must be one operating at a lower tube sustaining voltage than tube T_{10} or secondary winding S_9 must be one developing a higher tube sustaining voltage than winding S_{10} . A condenser 81 may be connected between lead 79 and a ground 82 thru a switch 83. This condenser 81 may be used as a starting condenser, that is, a charge may be built up in it to aid the electromotive force impressed by the winding S_{10} across the terminals of tube T_{10} to strike an arc in the tube when operation of the system is first started. Because of this starting device, the operating voltage of the tube can be reduced to a minimum, with consequent low power consumption and high efficiency.

Thus it will be seen that I have provided a

unitary luminescent tube lighting structure and system in which the various objects set forth have been fully accomplished. The unit is compact and therefore can be conveniently handled. Labor charges for installation are low since few steps are involved in setting up the apparatus. For outdoor use, full protection from rain, snow, sleet and the like is provided for the transformer and the high potential leads at a minimum of expense in cost of cables and casings. Many of these advantages also are had in the unit where employed for indoor use. My transformer systems are so designed that there is little objectionable stress between parts of adjacent tubes and hence no dielectric discharges take place between them.

Due to the use of a condenser in the circuit of one tube, that tube becomes illuminated before the other and thus the rate of light pulsations is double. Thus any visible flickering or stroboscopic effect is minimized or substantially eliminated, regardless of fluctuations in line voltage, ambient temperature, or current wave form factor.

Where a starting condenser is used, as in Fig. 7, the operating voltage of the circuit is reduced to a minimum, with consequent reduction in power consumption and increased efficiency.

As many possible embodiments may be made of my invention, and as many changes may be made in the embodiments hereinbefore set forth, it will be understood that all matter described herein or shown in the accompanying drawings is to be interpreted as illustrative and not as a limitation.

I claim:

1. In a luminescent tube lighting system, the combination of a transformer having a plurality of secondary coil sections, a plurality of closely adjacent substantially parallel luminescent tube loads individually connected to individual secondary coil sections, condenser means included in the circuit of at least one of said tube loads and secondary coil sections for limiting current and for reducing stroboscopic effect, magnetic shunt means around at least one other of said secondary coil sections for limiting the current therein, and a reflector disposed adjacent said tubes.

2. In a luminescent tube lighting system, the combination of a fixture having a reflector and a housing mounted on the same, a transformer positioned within the housing and having a primary winding and a plurality of secondary coil sections, a plurality of luminescent tube loads mounted in the reflector and individually connected to individual secondary coil sections, condenser means positioned within the housing adjacent the transformer and included in the circuit of at least one of said tube loads and secondary coil sections for limiting current and for reducing stroboscopic effect, said transformer including magnetic shunt means to limit the current in at least one other secondary coil section.

3. In luminescent tube lighting apparatus, the combination of a fixture including a reflector and a housing having transformer and condenser compartments, two luminescent tube loads mounted in the fixture in front of said reflector, a transformer housed in said transformer compartment and having two secondary coil sections individually connected with said tubes, and condenser means in said condenser compartment and included in the circuit of one of said tubes

and secondary coil sections, said transformer including magnetic shunt means around at least the other secondary coil section for limiting the current therein.

4. In combination, a metallic housing including a transformer compartment and a condenser compartment, a transformer housed within the transformer compartment and having a core and a primary winding and a plurality of secondary coil sections positioned on the core, a corresponding plurality of luminescent tube loads individually connected to individual secondary coil sections, condenser means housed within the condenser compartment of said housing and included in the circuit of at least one of said tube loads and secondary coil sections, and magnetic core shunt means around at least one other of said secondary coil sections for limiting the current therein.

5. In combination, a metallic housing having a transformer compartment and a condenser compartment, a metallic fixture on which said housing is mounted, said fixture including a reflector, a transformer housed in the transformer compartment of said housing and having a core and a primary winding and two secondary coil sections positioned on the core and adapted to be individually connected to two tube loads when positioned within said reflector, condenser means housed within the condenser compartment of said housing and included in the circuit of one secondary coil section and its associated tube load, and magnetic core shunt means around at least the other secondary coil section.

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