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TRANSFORMER

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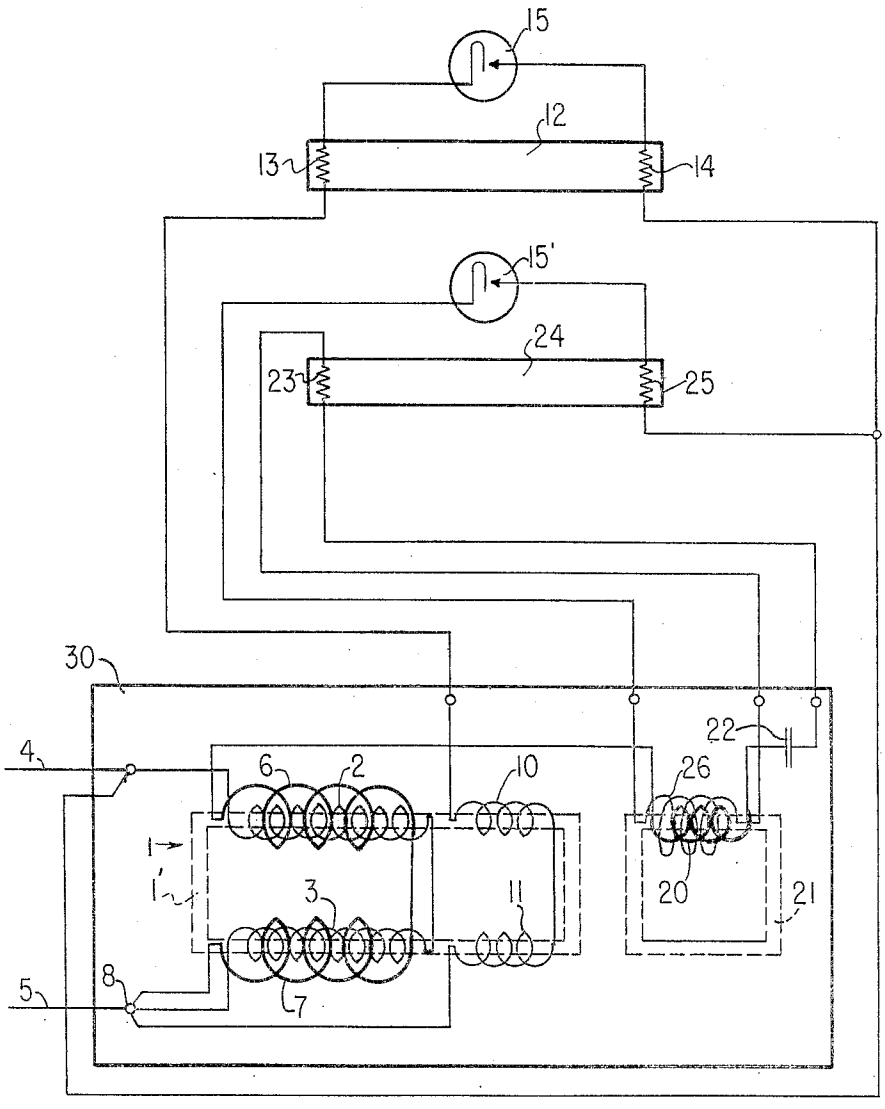

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TRANSFORMER

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This invention relates to electric transformers and reactors for hot cathode glow discharge tubes, particularly such as fluorescent tube lighting lamps.

Transformers of the type of the present invention are designed generally to operate a plurality of lamps in a circuit including a condenser in series with one of the lamps to produce a phase difference of the currents in the two lamps, thereby effecting stroboscopic correction and also correcting the power factor of the combination.

It is one of the objects of the present invention to provide a simple, compact, sturdy, reliable and inexpensive transformer having the necessary leakage reactance so that the action of either one of the lamps will not adversely affect the other to any substantial extent.

In a transformer of the above mentioned character it is desirable that the windings that supply current to the respective lamps shall be so spaced from one another that each will produce a minimum effect on the other. I have found that when a transformer is provided with separate secondaries for the respective lamps and both secondaries are connected in autotransformer relationship with the primary, that it is then desirable to have a close coupling between the primary and that secondary which supplies current to the leading lamp, and to have a loose coupling between the primary and that secondary which supplies current to the lagging lamp. I have also found that in such an arrangement wherein a condenser is provided in series with one of the lamps an economic advantage is obtained by interposing an additional reactance or choke in series with the condenser. This added reactance increases the voltage across the condenser and thus permits the use of a smaller condenser for carrying the requisite current. The saving in the cost of the condenser by reason of the use of a smaller condenser more than offsets the cost of the additional reactor. If desired the reactor may be provided with an additional winding which is connected in series between the two filaments of the associated lamp so that during starting of the lamps the additional winding increases the voltage applied to the lamp and thus facilitates starting. Once the lamp is started and the usual starting switch has opened, the additional coil on the reactor is open circuited and no longer functions.

The attainment of the above and further objects of the present invention will be apparent from the following specification taken in conjunction with the accompanying drawing forming a part thereof.

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The single figure of drawing is a diagrammatic view of a circuit embodying the present invention.

Reference may now be had more particularly to the drawing wherein like reference numerals designate like parts throughout. The transformer of the present invention, indicated at 1, consists of an elongated laminated rectangular core 1' which is built up by stacks of L-shaped laminations interlaced in the manner known in the art. The transformer has two series connected primary coils 2—3 which are adapted to be connected across a source of current 4—5 which may be a commercial 120 volt 60 cycle alternating current line. Superimposed on the primary coils 2—3 are secondary coils 6—7 which are connected in series with one another and are connected at 8 in step-up autotransformer relationship with the primary coils 2—3. The coils 2 and 6 constitute in effect one coil, and the coils 3 and 7 constitute in effect one coil, suitable taps being provided to effect the connections illustrated in Figure 1. The transformer core 1 has in addition two additional secondary coils 10 and 11 which are connected in series with one another and are also connected in autotransformer relationship with the primary coils 2—3.

The coils 10 and 11 supply current to a glow discharge lamp 12 which may be the usual hot cathode fluorescent type of lamp having heating filaments 13—14 that are connected together in series by a usual type of starter switch 15 which is normally closed and which opens after current flows therethrough for a short interval of time. During this time interval the filaments become sufficiently hot to permit an arc to form between the cathodes in the tube. The filament 14 is connected back to the line 4. The secondary 6 is connected in series with a winding 20 on a laminated iron core 21 which is physically and magnetically separate from the core 1. The coil 20 is then connected in series with a condenser 22 which in turn is connected to the filament 23 of a hot cathode glow discharge fluorescent type lamp 24. The filament 23 is connected in series with a similar filament 25 of the lamp as by means of an auxiliary coil 26 and a starter switch 15' similar to the starter switch 15. The filament 25 is then connected back to the line 4. If desired the auxiliary coil 26 may be entirely omitted in which event the upper terminal of the filament 23 of the lamp 24 would be connected directly to the starter switch 15' in the same manner as the filament 13 is connected to the starter switch 15.

The transformer 1 and the reactor 21 and the

condenser 22 are all enclosed in a single sheet-iron container, indicated at 30, the free space of which is then filled with the usual type of tar-like insulating compound. The walls of the container provide a path for any leakage flux from the respective secondary coils 6—7 and from the respective secondary coils 10—11, so that none of the leakage flux from either sets of secondaries is likely to produce any appreciable effect on the other set of secondaries. The iron core of the reactor 21 preferably contains an air gap in its magnetic circuit to prevent magnetic saturation of that core.

In one structure which I have made for use with two hot cathode fluorescent lamps of 40 watts capacity the primaries 2—3 were each of approximately 1,030 turns, the secondaries 6—7 were each of approximately 775 turns, the secondaries 10—11 were each of approximately 1,000 turns, the winding 29 of approximately 900 turns and the winding 26 approximately 500 turns. The voltage across the line 4—5 was approximately 120 volts and the operating voltage across the condenser 22 was approximately 260 volts.

In compliance with the requirements of the patent statutes I have here shown and described a preferred embodiment of my invention. It is, however, to be understood that the invention is not limited to the precise construction here shown, the same being merely illustrative of the principles of the invention. What I consider new and desire to secure by Letters Patent is:

1. Apparatus for operating two discharge tube loads comprising a transformer having a primary winding, a secondary winding concentric with the primary winding, a second secondary spaced from the primary and less closely coupled thereto than is the first mentioned secondary, both secondaries being electrically connected to the primary in step-up autotransformer relationship, leads from the respective secondaries for individual connection to different tube circuits, a condenser in the circuit of the lead from the first mentioned secondary, a reactor including a first coil permanently in series with the condenser and including a second coil adapted to be selectively connected in series with the first coil and selectively disconnected therefrom, said reactor having an iron core and being outside of the magnetic circuit of the transformer, and magnetic means joining the transformer, condenser and reactor into one unit, said magnetic means extending along the windings and providing a path for leakage flux.

2. Apparatus for operating two discharge tube loads comprising a transformer having a primary winding, a secondary winding concentric with the primary winding, a second secondary spaced from the primary and less closely coupled thereto than is the first mentioned secondary, both secondaries being electrically connected to the primary in step-up autotransformer relationship, said transformer having a rectangular core including opposite longitudinal sides joined by transverse ends, said windings being on the two opposite longitudinally extending sides of the core, leads from the respective secondaries for individual connection to different tube circuits, a condenser in the circuit of the lead from the first mentioned secondary, a reactor coil in series with the condenser, said reactor having an iron core and being outside of the magnetic circuit of the transformer, an additional coil magnetically coupled to the reactor coil, a discharge tube starter switch in the circuit of the tube that is connected in series with the condenser,

and circuit connections including said switch for connecting said additional coil in the starting circuit of said last mentioned tube and open circuiting said additional coil upon opening of the starting circuit of said last mentioned tube.

3. Apparatus for operating two discharge tube loads comprising a transformer having an elongated rectangular core having outer longitudinal sides joined by outer transverse sides, two coil units each located at an end of different ones of the longitudinal sides of the core, each unit comprising a primary winding and a secondary winding concentric with one another, the two primaries being connected in series, the two secondaries being connected in series with one another and in step-up autotransformer relationship to the primaries, additional secondaries located also on the respective longitudinal sides of the core and at the ends opposite the ends where the first mentioned coil units are located, and less closely coupled to the primaries than are the first mentioned secondary windings, and leads from the respective secondaries for individual connection to different tube load circuits.

4. Apparatus for operating two discharge tube loads comprising a transformer having an elongated rectangular core having outer longitudinal sides joined by outer transverse sides, two coil units each located at an end of different ones of the longitudinal sides of the core, each unit comprising a primary winding and a secondary winding concentric with one another, the two primaries being connected in series, the two secondaries being connected in series with one another and in step-up autotransformer relationship to the primaries, additional secondaries located also on the respective longitudinal sides of the core and at the ends opposite the ends where the first mentioned coil units are located, and less closely coupled to the primaries than are the first mentioned secondary windings, leads from the respective secondaries for individual connection to different tube load circuits, a reactor coil outside of the magnetic flux path of the transformer, and a condenser in series with the reactor coil, said condenser and reactor coil being connected in series with the leads from the first mentioned secondaries.

5. Apparatus for operating two discharge tube loads comprising a transformer having a primary winding, a secondary winding concentric with the primary winding, a second secondary spaced from the primary and less closely coupled thereto than is the first mentioned secondary, both secondaries being electrically connected to the primary in step-up autotransformer relationship, leads from the respective secondaries for individual connection to different tube circuits, a condenser in the circuit of the lead from the first mentioned secondary, and a reactor including a first coil permanently in series with the condenser and including a second coil adapted to be selectively connected in series with the first coil and selectively disconnected therefrom, said reactor having an iron core and being outside of the magnetic circuit of the transformer.

6. Apparatus for operating two hot cathode discharge tube loads, comprising a transformer having a primary winding, a leading secondary winding, a lagging secondary winding spaced from the primary and less closely coupled thereto than is the first secondary, a core for said windings, leads from the respective secondaries for individual connection to different tube cir-

cuits, a condenser in the circuit of the lead from the leading secondary, and a two coil reactor having an iron core separate from the aforementioned core and magnetically coupling the coils of the reactor, one of the reactor coils being connected in series circuit with the condenser and the leading secondary and the other reactor coil having conductor leads therefrom for permitting the selective connection thereof into said series circuit during starting of the tubes and out of said series circuit during operation of the tubes, so that the value of the reactance may be changed as the associated tube changes from starting condition to operating condition.

7. Apparatus for operating two hot cathode discharge tube loads comprising a transformer having a primary, a first secondary, a second secondary spaced from the primary and less closely coupled thereto than is the first mentioned secondary, both secondaries being electrically connected to the primary in step-up autotransformer relationship, said transformer having a core forming a magnetic circuit for the primary and the secondaries, leads from the respective secondaries for individual connection to different tube circuits, a reactor coil and a condenser in series and connected in series with a lead from the first secondary, said reactor coil having an iron core and being outside of the magnetic circuit of the transformer, an additional coil magnetically coupled to the reactor coil, and leads from the additional reactor coil for selectively connecting and disconnecting the additional coil in series with the first reactor coil.

8. Apparatus for operating filament heater type leading and lagging hot cathode discharge tube loads comprising a transformer having a primary, a first secondary, a second secondary spaced from the primary and less closely coupled thereto than is the first mentioned secondary, both secondaries being electrically connected to the primary in step-up autotransformer relationship, said transformer having a core forming a magnetic circuit for the primary and the secondaries, leads from the respective secondaries for individual connection to different tube circuits, a reactor coil and a condenser in series and connected in series with a lead from the first secondary, said reactor coil having an iron core and being outside of the magnetic circuit of the transformer, an additional coil magnetically coupled to the reactor coil, a starter switch in the circuit of the leading tube with the condenser, and circuit connections including said switch and said additional coil in circuit between the heating filaments of said last mentioned tube and open circuiting said additional coil upon opening of the starting circuit of said last mentioned tube.

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