Jan. 5, 1960 P. BERGER 2,920,237

APPARATUS FOR IGNITING AND OPERATING GASEOUS DISCHARGE DEVICES

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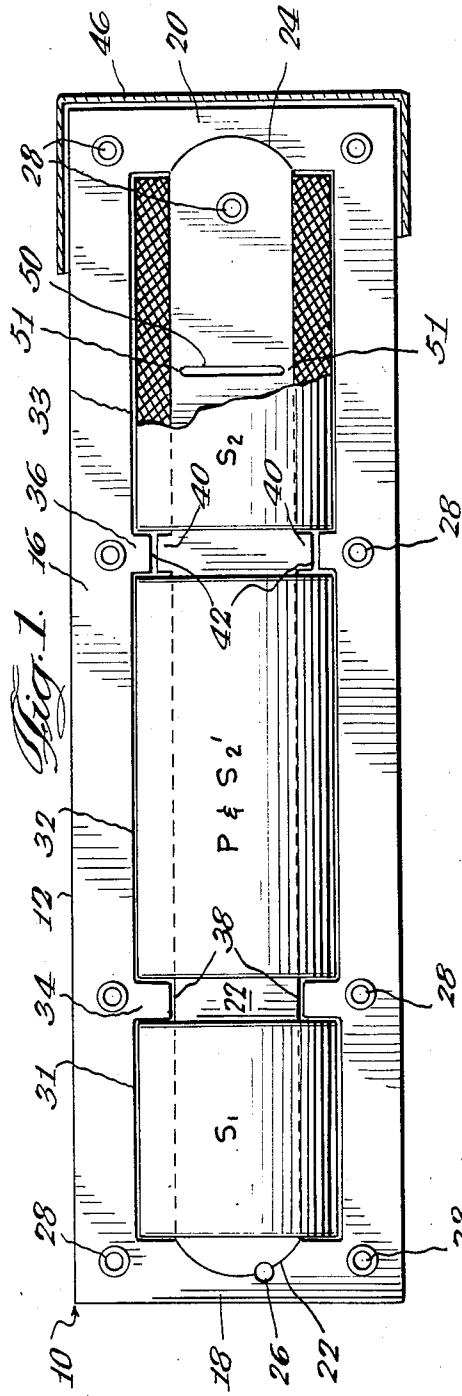

Fig. 1.

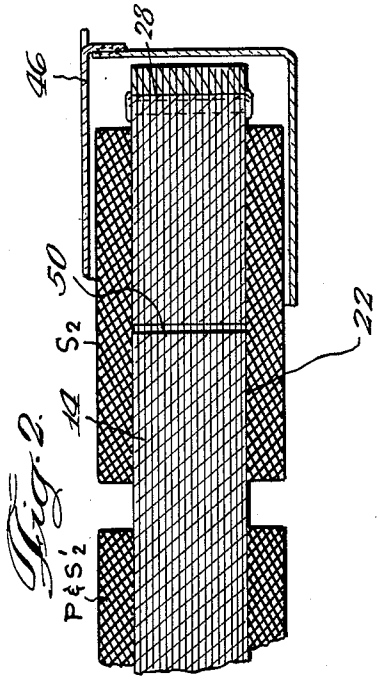

Fig. 2.

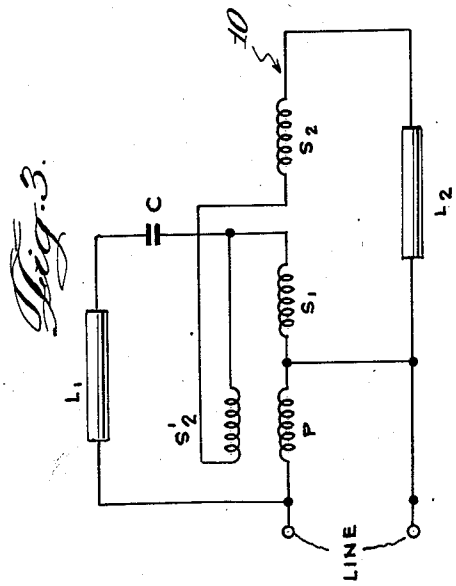

Fig. 3.

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APPARATUS FOR IGNITING AND OPERATING GASEOUS DISCHARGE DEVICES

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10 Claims. (Cl. 315—138)

This invention relates generally to apparatus for igniting and operating gaseous discharge devices and more particularly, is concerned with the construction of a novel and improved transformer for use with such apparatus.

The particular application of the invention is to provide devices known as ballasts for use in connection with fluorescent lamps or other gaseous lighting apparatus. Such ballasts serve several purposes. Where the discharge devices are of the type that ignite and operate at voltages substantially greater than the line voltage, transformation is required of the ballast. All gaseous discharge devices have negative resistance operating characteristics and hence, the ballast provides an impedance to flow of current to prevent self-destruction of the discharge devices. Other ballasts include anti-stroboscopic means, power factor correction means, and other structure providing special purpose function.

This invention is concerned primarily with a ballast for series-sequence operation of at least two gaseous discharge devices from a transformer the magnetic circuit of which has a single source of magnetic flux. Such a ballast is shown and described for example in Feinberg Patents 2,683,243 and 2,558,293 both of which are owned by the assignee of this application. The transformer is deliberately constructed to provide leakage reactance of a substantial amount, so that a large effective impedance to current flow is produced when the device is operating.

In recent years lighting fixtures have decreased cross section area of the space available for ballasts with the resulting tendency that such ballasts have been required to be longer. Increasing the length of the ballasts has increased leakage flux because of the distance of windings from the primary winding. In certain other cases, leakage flux is produced due to necessary structure, in addition to length. Thus, in the ballast which is intended for use with the above described circuit, I use a non-magnetic gap in the core adjacent the winding which carries the operating current, which as will be seen is leading in character. In circuits of the so-called lead-lag type, where there are at least two secondary windings, each being in auto-transformer relationship with the primary winding, but one having a condenser in series therewith and hence carrying leading current during operation, the non-magnetic gap is in the core adjacent the secondary winding having a condenser in series therewith. The purpose and advantages of such gaps is described and claimed in my Patent 2,461,957 but suffice it to say that it prevents core saturation in the vicinity of leading secondary windings and hence maintains good wave shape and hence good lighting efficiency.

Ballasts are usually "spotted," that is to say, enclosed in metal canisters along with condensers, charge-leaking resistors and the like, and the whole embedded in a pitch compound. In long ballasts and ballasts where there is a great deal of leakage flux, especially ballasts of the type using an end non-magnetic gap, flux fringing or spreading occurs, in which the canister body serves as a return path for flux. Such ballasts have therefore had a

tendency to buzz and sing with the frequency of the line and multiples thereof.

The primary object of the invention is to provide the benefits and advantages of a non-magnetic gap in the vicinity of a secondary winding carrying leading current with none of the disadvantages thereof.

It might be added that the placement of such gaps at the end of the winding leg of a shell type core is not simple, since a proper seat must be provided, together with accurate dimensioning likely to change when the winding leg is driven home. These disadvantages are also eliminated.

Other objects and advantages will become apparent from the description of a preferred embodiment which follows, in connection with which a drawing illustrates diagrammatically the nature of the invention.

In the figures:

Fig. 1 is a top plan view of a transformer embodying the invention, portions being cut away.

Fig. 2 is a fragmentary sectional view through the right hand end of the transformer.

Fig. 3 is a schematic electrical diagram of the circuit with which the transformer of Figs. 1 and 2 is used.

The reference character **10** designates generally a transformer of the so-called shell variety having an elongate iron core **12** of rectangular formation built up of a stack of laminations of electrical steel shown in section in Fig. 2 at **14**. Such core **12** is provided with elongate sides **16** and integral bridging ends **18** and **20**. A central winding leg **22** matingly engages at its opposite ends in suitable arcuate formations in the bridging ends **18** and **20** giving rise to abutted junctions **22** and **24**. A guide hole **26** is formed at one end of the core **12** with matching portions in bridging end **18** and the end of the winding leg **22** to properly seat the said winding leg. Grommets **28** retain stacks of laminations **14** in assembly.

In forming the transformer core, it is customary to punch the winding leg laminations out of the laminations forming the rectangular framing portion of the core. The only waste comprises the windows formed, since the windings are mounted on the winding leg which is pressed home into the framing portion of the core.

The transformer core **12** is formed with three coil windows **31**, **32** and **33** with the center window **32** separated from the other two by shunts **34** and **36**. The presence of the winding leg **22** produces opposite facing portions of the windows, so that the mounted coils pass around the central winding leg and through the parts of the respective window. Shunt **34** is formed by inward extensions stopping short of the sides of the winding leg providing non-magnetic gaps **38**. The shunt **36** also has inward extensions but they are shorter, and juxtaposed outward extensions **40** on the winding leg, aligned therewith and separated therefrom by gaps **42**. During the stamping of laminations the gaps are formed by shaving, as well known.

In Fig. 3 there is illustrated the circuit of the device to which the invention has been applied by way of example. The usual lines representing iron cores have not been used to avoid confusion. The circuit shown is that of Feinberg Patent 2,683,243 and comprises a primary winding P connected across a line whose A.C. voltage is less than the igniting or operating voltage of the gaseous discharge devices L_1 and L_2. The primary is connected to a first secondary winding S_1 which has a large number of turns of fine wire, and the first gaseous discharge device is connected in series with a condenser C, and together therewith connected across the combined primary P and first secondary winding S_1. The right hand terminal of the winding S_1 is connected to secondary windings S_2' and S_2, and the second gaseous discharge device L_2 is connected across all secondary windings S_1,

S_2' and S_2, considered connected in series. Note that winding S_2' is very closely coupled with the primary winding P.

The operation of the device requires the secondary S_1 to be in instantaneous voltage opposition to the combined secondaries S_2' and S_2; requires winding S_1 to be disposed at one end of the core 12 and separated from the other windings by a shunt to provide high leakage reactance; and results in a final operating circuit which has the discharge devices L_1 and L_2, the condenser C, and the windings S_2' and S_2 all in series with the major portion of operating current by passing winding S_1. The discharge device L_1 ignites first. The reasons for structure and operation are explained in said last-mentioned Feinberg patent.

Now, during operation, the current flow is leading, so that the core in the vicinity of winding S_2 tends to saturate with resulting poor wave form and decreased light efficiency. Prior structures used a gap at junction 24 to eliminate this saturation and third harmonic. This is illustrated in Fig. 1 of Feinberg Patent 2,683,243.

Certain factors gave rise to disadvantages which this invention eliminates. These factors are based upon the necessary practice of enclosing ballasts. The completed ballast, with condensers and the like is placed in a metal canister, walls of which are shown at 46, and potted with a pitch compound. Recent requirements for long, thin ballasts increase the physical distance from the primary winding P to remote parts of the secondary winding S_2 and this coupled with the increased reluctance of the gap normally at junction 24 caused "fringing" of flux. This means that flux sought a return path through the canister 46 rather than through the core 12. Flux flow in the non-laminated canister walls results in heating and low efficiency, but worst of all, is a source of noise in the form of humming and buzzing.

My invention comprises cutting a slot 50 in each lamination of the winding leg 22, leaving the connecting webs 51 top and bottom for support, and placing the slot 51 such that it is completely covered by the winding S_2. In this manner, all of the benefits of a gap in the core in the vicinity of winding S_2 are achieved with an elimination of flux fringing. Since junction 24 offers no reluctance to passage of flux the flux is channeled to the end of the winding leg, and whatever tendency to fringe occurs is a minimum. Obviously, since current is flowing through winding S_2 the flux is forced to be confined within the interior thereof.

The structure of this invention is to be distinguished from prior apparatus in which slots are provided adjacent the primary winding for drawing lagging exciting current in adjustment of power factor. Such prior apparatus does not show elimination of fringing to the canister and does not show the confinement of the fringing flux by the secondary winding of a series-sequence, series operating circuit mounted on a shell type core, having completely confined, accurate punched out slots in the central winding leg.

A practical example of the invention utilized a circuit as shown in Fig. 3 in which the number of turns of the respective windings were: P–570, S_1 3700, S_2 2085 and S_2' 770. Wire sizes were S_2 and S_2' 27 or 28 gauge, primary 22 gauge, and S_1 some fine gauge such as 32. The discharge devices were 75 watt T–12 hot cathode instant-start fluorescent lamps. The proportions of the core were as illustrated, the width of the winding leg being 1 inch and the stack height about ⅞". The gaps 38 and 42 were .030 inch and .058 inch respectively, while the slot 50 was .047 inch by .875 inch. Line voltage was conventional 120 volts A.C.

What I desire to claim by Letters Patent of the United States is:

1. Apparatus for igniting and operating a pair of gaseous discharge devices which comprises, a metal canister having at least a transformer and a condenser therein with leads extending from said canister for connection to gaseous discharge devices and a source of A.C. voltage, said transformer comprising an elongate shell-type core having a rectangular frame portion and a central winding leg, three windows formed along the length of the core and two gapped shunts separating the windows, the ends of the winding leg abutting in magnetic connection with the ends of the frame portion, a primary winding in the center window and secondary windings in the windows on opposite sides of the primary winding, and a transverse non-magnetic gap in the central winding leg spaced from an abutting magnetic connection and completely covered by a secondary winding.

2. Apparatus as claimed in claim 1 in which said last secondary winding is connected in series with said condenser and, said apparatus includes a pair of series connected gaseous discharge devices outside of said canister in series with said last secondary winding and together therewith connected in auto-transformer relation across the primary winding.

3. Apparatus for igniting and operating gaseous discharge devices which comprises, a metal canister of elongate configuration, a transformer having an elongate shell-type laminated core, including a substantially rectangular framing part and a central winding leg disposed in the framing part and having its ends abutting the opposite ends thereof, a primary winding and at least two secondary windings, a series-sequence starting and substantially series oprating circuit formed with said windings and including at least two gaseous discharge devices energized by said windings and a condenser, winding carrying windows formed in said framing part along the length thereof alongside the winding leg and shunts separating the windows, the primary winding being disposed in the center window and having the secondary windings in windows on opposite sides thereof, one secondary winding providing substantially greater leakage reactance than the other and having a greater number of turns than the other to aid in ignition but resist current flow therethrough during operation, the second secondary winding serving to carry substantially all of the operating current and being connected in series with said condenser and discharge devices during operation, and a bridged non-magnetic gap in the winding leg transverse thereof, spaced from an abutted end, said gap being completely covered by said second secondary winding, said transformer and condenser being enclosed within said canister.

4. Apparatus as claimed in claim 3 in which the gap comprises a single slot extending substantially across the winding leg completely through the thickness of the laminations thereof and aligned substantially with the center of the window carrying said second secondary winding.

5. A transformer provided with a magnetic core having an outer rectangular frame portion, a central forced-insert winding leg magnetically connected and physically abutted against the ends of the frame portion on the interior thereof, three windows each having two parts on opposite sides of the winding leg, two shunts separating the windows along the length of said winding leg and having facing extensions forming non-magnetic gaps with the leg, three generally cylindrical coils mounted in the windows and comprising a primary winding and two secondary windings with the primary winding in the center with their axes coincident, a metal canister surrounding the transformer, and a slot in the winding leg extending therethrough arranged transverse of the length thereof and located between the ends of a secondary winding considered along its axis and completely enclosed thereby.

6. Apparatus as claimed in claim 5 in which there are provided a pair of gaseous discharge devices and a source of A.C. voltage, all external of the canister, and a condenser in the canister, and the primary winding is connected across the source, the secondary windings are connected end to end after the primary winding, a discharge device is connected in series with the condenser

and together therewith across the primary winding and the next following secondary winding, the second discharge device is connected across both secondary windings together, and the second following secondary winding is the winding above referred to which encloses said slot.

7. In apparatus for igniting and operating gaseous discharge devices which includes a metal canister having at least a transformer and a condenser therein with leads extending from said canister for connection to said gaseous discharge devices and a source of A.C. voltage, said transformer having an elongate shell-type core with a rectangular frame portion and a central winding leg, windows along the length of the core and said transformer having at least a primary winding and a secondary winding disposed in said windows and each winding encircling and enclosing a different portion of said winding leg, and said secondary winding being connected with said condenser and the circuit constants being of value such that a leading current will flow through said secondary during operation; the improvement which comprises the ends of the central winding leg abutting with the ends of the frame portion in magnetic connection therewith, and a transverse non-magnetic gap in that portion of said central winding leg encircled by said secondary winding.

8. In an apparatus for igniting and thereafter providing the operating voltages for gaseous discharge device means and which includes an elongate iron core having a central winding leg, an outer rectangular framing part, windings including at least a primary winding and a secondary winding arranged encircling the winding leg along

the length thereof, the ends of the winding leg engaged with the ends of the outer framing part, a condenser, a canister housing the core, windings and condenser, connections between gaseous discharge device means external of the canister, said windings, condenser and a source of voltage forming a circuit in which a leading current flows through said secondary winding during operation of said gaseous discharge device means, and a non-magnetic gap in said core in the vicinity of said secondary winding to limit the flux thereat; means for limiting the fringing of flux to said canister by reason of said non-magnetic gap which comprises said gap being formed of a transverse slot in said winding leg between the ends of and confined by said secondary winding.

9. A structure as claimed in claim 8 in which the slot is closed at both ends thereof.

10. A structure as claimed in claim 8 in which the secondary winding is adjacent one end of the winding leg, and there is a shunt including a second non-magnetic gap separating the secondary winding from its next adjacent winding and the slot is located in said winding leg between the said one end and the said shunt.

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