June 3, 1958 P. BERGER 2,837,697

APPARATUS FOR IGNITING AND OPERATING GASEOUS DISCHARGE DEVICES

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Fig. 1.

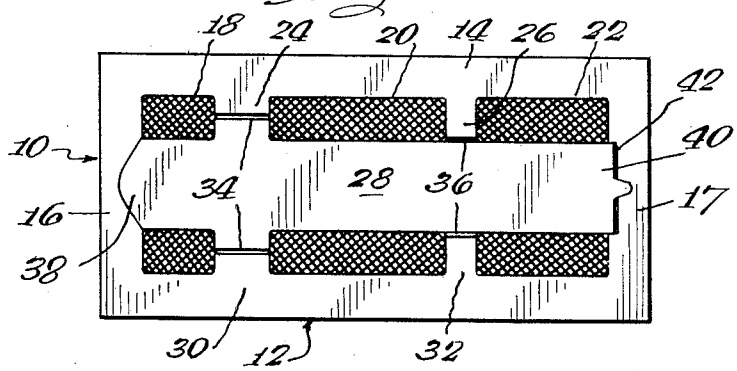


Fig. 2.

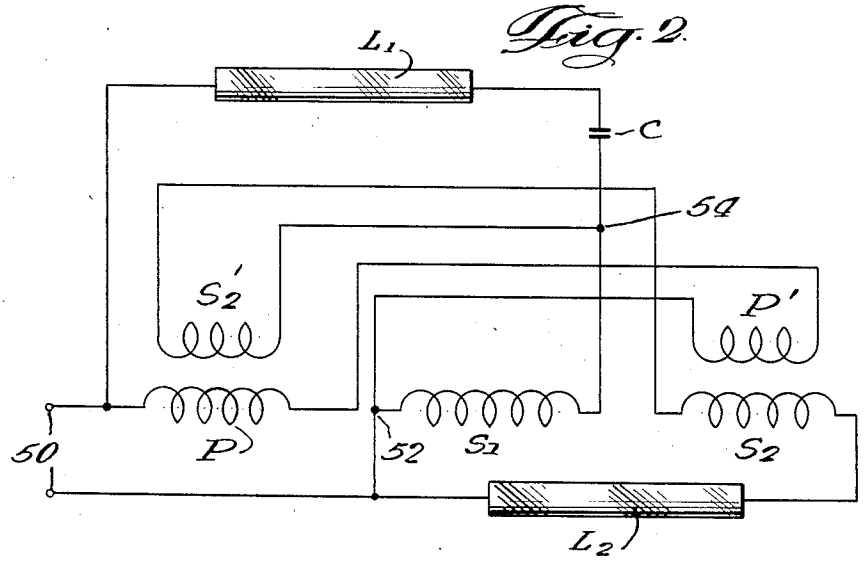
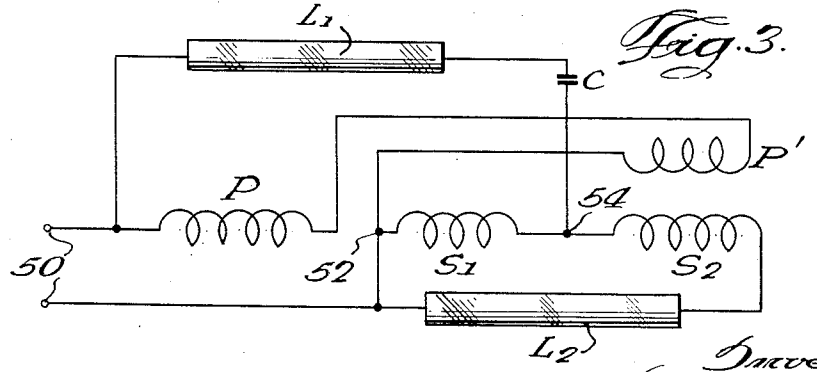


Fig. 3.



Inventor
Paul Berger
By Silverman & Mullin
attorneys

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Fig. 4.

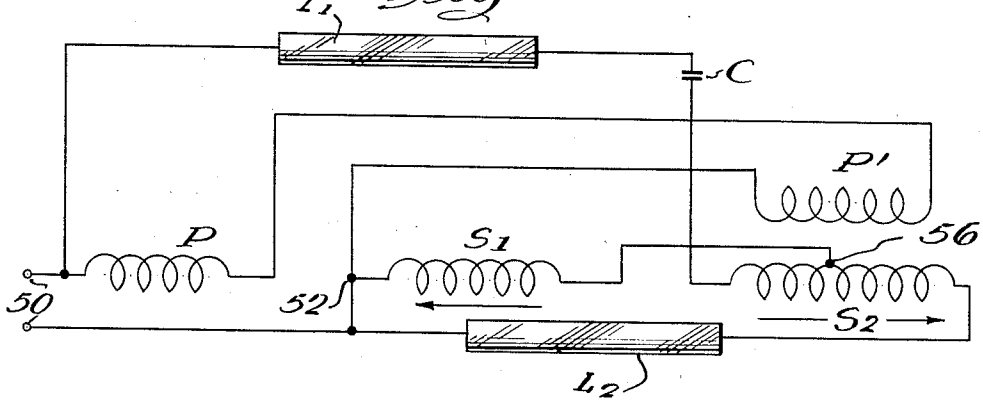


Fig. 5.

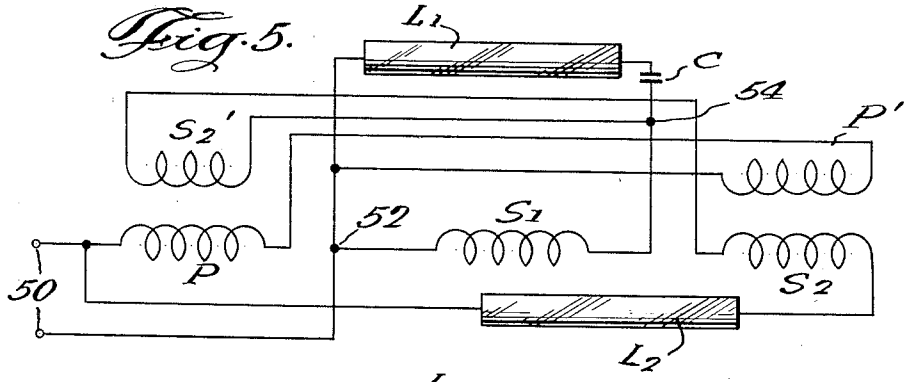


Fig. 6.

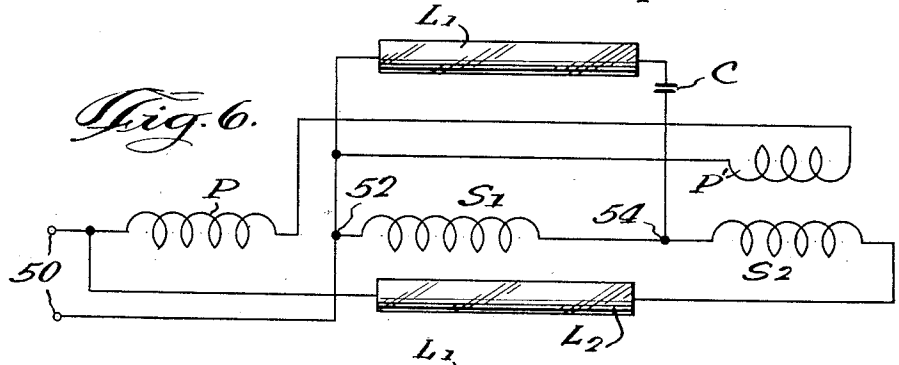
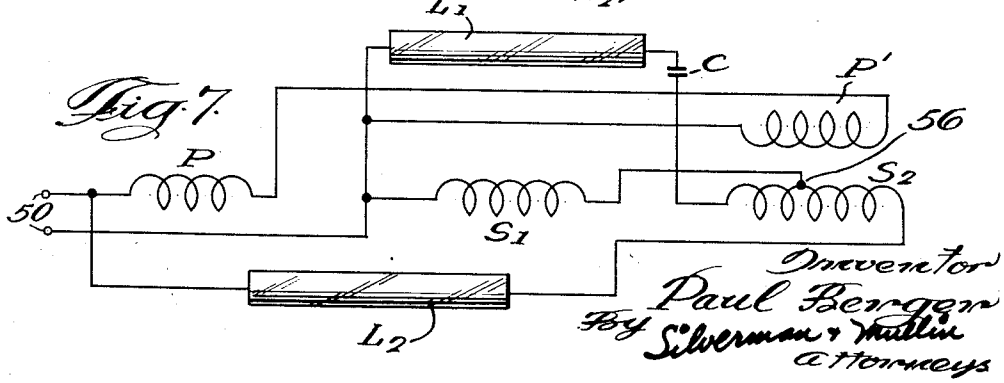


Fig. 7.



Inventor
Paul Berger
By Silverman & Mullin
Attorneys

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APPARATUS FOR IGNITING AND OPERATING GASEOUS DISCHARGE DEVICES

Paul Berger, Chicago, Ill., assignor to Advance Transformer Co., Chicago, Ill., a corporation of Illinois

Application January 5, 1956, Serial No. 557,550

12 Claims. (Cl. 315—138)

This invention relates generally to apparatus for providing the igniting voltage for two gaseous discharge devices from an A. C. source of relatively low voltage, and thereafter providing the proper operating voltages for the devices. More particularly this invention is concerned with the construction of a so-called "ballast" for fluorescent lamps which is characterized by a substantial decrease in the primary exciting current decreasing the likelihood of burn-out under abnormal heating conditions.

The principal object of the invention is the provision of apparatus referred to above, and in the provision of such apparatus which will be highly efficient and economical.

This invention comprises an improvement upon the basic structure of apparatus described and claimed in U. S. Patents 2,558,293 and 2,683,243. The former patent is one which discloses a ballast having three windings P, S_1 and S_2 connected end to end and mounted upon an elongate iron core with the primary in the center and the first secondary winding S_1 spaced from the primary winding by means of a magnetic shunt, and with the second secondary winding S_2 on the opposite side of the primary winding coupled substantially closer to the primary winding P than is the first secondary winding. Two gaseous discharge devices are connected across the windings of the transformer of the apparatus in such a way that they ignite seriatim, the first device being connected in series with a condenser and together therewith connected across the primary and first secondary windings in one embodiment, and connected only across the first secondary winding S_1 in a second embodiment. In the first embodiment, the second discharge device is connected across both secondaries and in the second embodiment, the second gaseous discharge device is connected across all three windings. In both embodiments, the secondary windings are in open circuit voltage bucking relationship, but in the first the open circuit voltage of the primary winding is additive to that of the first secondary winding S_1 and in the second embodiment the open circuit voltage of the primary winding P is additive to that of the second secondary winding S_2.

In both embodiments of said Patent 2,558,293, the energization of the primary winding will initially result in voltage being provided only across the first gaseous discharge device to ignite it. With flow of current the voltage of the winding S_1 shifts its phase to provide a voltage additive to those windings across which the second gaseous discharge device is connected to ignite the same. Due to the high leakage reactance of the secondary winding S_1 current through the lamps is principally as in a series connection through the lamps, condenser and secondary S_2.

The apparatus herein uses the basic circuit of the above described apparatus, as to both embodiments, and the gaseous discharge devices herein are ignited and operated in the same way.

The second mentioned patent is an improvement on the first, in which the patentee wound a part of the secondary winding upon the primary winding P to lower the voltage requirements of the winding S_2.

In this invention, an additional object is to decrease the leakage between the winding S_2 and the primary which decreases the number of turns required of the winding S_2 in order to achieve the desired starting and operating voltages, and to that end a part of the primary winding P, for example 20% is closely coupled with the secondary winding S_2, and for better results, a portion of the second secondary winding S_2 may also be closely coupled with the primary winding P.

The drawings accompanying this specification illustrate preferred embodiments of the invention in different forms, the invention being applied to the two different circuits of the Patent 2,558,293 above referred to, for the purpose of rendering the detailed explanation hereinafter set forth more understandable, and as well for complying with the patent laws.

To the extent practicable, the same characters of reference are used throughout the figures of the different forms of the invention, to illustrate and designate the same elements.

Fig. 1 is a top plan view of a transformer constructed in accordance with the invention for use with the apparatus thereof with the windings being shown in section.

Figs. 2 through 7 are electrical diagrams of the apparatus of the invention showing different forms and variations which the invention assumes, and all being capable of use with the transformer of Fig. 1.

In Fig. 1 there is illustrated a transformer **10** of so-called shell type construction, the same having an iron core **12** providing elongate sides **14**, bridging ends **16** and **17** and three winding windows **18**, **20** and **22** for receiving therein the windings to be described. Inwardly directed extensions **24** and **26** cooperate with an elongate central winding leg **28** to provide shunts **30** and **32** having gaps **34** and **36**. The ends **38** and **40** of the central winding leg **28** are matingly engaged in the bridging ends **16** and **17** respectively, with the end **40** providing a bridging gap **42** if desired.

The winding window **18** is intended to have a first secondary winding designated S_1 therein. The window **20** is intended to have either a part of the primary winding designated P therein, and in some cases a part of the second secondary winding S_2' may also be disposed therein. The window **22** may have either the entire second secondary S_2 or a part therein, and also has a part of the primary winding P' therein.

Referring now to the various forms of the invention, in Fig. 2 there is illustrated a form of the invention in which the first gaseous discharge device is connected in series with a condenser and together therewith connected across the primary and first secondary windings together, and the second gaseous discharge device is connected across both of the secondaries. Part of the primary is closely coupled to the second secondary winding, and part of the second secondary winding is closely coupled to the primary winding.

Specifically, the primary winding consists of two parts designated P and P'. Both parts are in series and connected together across the relatively low voltage A. C. line **50**. The right hand terminal of the primary winding P, P' is connected to the left hand terminal of a high leakage reactance secondary winding S_1 at a junction **52**. The second secondary winding is formed of two parts S_2 and S_2' connected in series, and the left hand terminal of the second secondary winding S_2, S_2' is connected to the right hand terminal of the first secondary winding S_1 at a junction **54**. A gaseous discharge device L_1 which may be a fluorescent lamp, is connected

in series with a condenser C and together therewith connected across the primary winding P, P' and the first secondary winding S_1, that is from one side of the line 50 to the junction 54.

There is a second gaseous discharge device L_2 connected across both secondary windings, that is, from the junction 52 to the right hand terminal of the winding S_2.

The open circuit instantaneous voltages of the primary winding P, P' and the first secondary winding S_1 are additive. The open circuit instantaneous voltages of the first secondary winding S_1 and the second secondary winding S_2, S_2' are in opposition. The discharge device L_1 ignites first, and flow of current through S_1 causes a phase reversal giving a component of voltage additive to the open circuit voltage of second secondary winding S_2, S_2' causing seriatim ignition of the second discharge device L_2. Thereafter, since winding S_1 has high reactance, current will prefer to flow in series through the discharge devices L_1, L_2, the condenser C, and the second secondary winding S_2, S_2' with the reactive relationship between the condenser C and second secondary winding S_2, S_2' determining the power factor.

A portion of the primary winding designated P' is closely coupled to the portion of the second secondary winding which is designated S_2. Likewise a portion of the second secondary winding which is designated S_2' is closely coupled to that portion of the primary winding which is designated P. In practise, a small coil is either wound on top of or alongside each of the coils which would otherwise be the primary and second secondary windings, and the connections are made to the small coils so that circuit-wise they are respective parts of the primary and secondary windings. Thus, although the primary winding of Fig. 2 is formed of two coils P and P', the term "winding" will be used to collectively designate both as P, P'. Likewise, the second secondary winding of Fig. 2 is formed of two physically separated coils S_2 and S_2' but for convenience, the word "winding" will also be used collectively to designate both, composed of the two coils or parts.

In describing the structure of Fig. 2, it may therefore be said that a minor part of the primary winding is closely coupled to a major part of the second secondary windings, and a minor part of the second secondary winding is closely coupled to the major part of the primary winding.

The structure of Fig. 3 is similar to that of Fig. 2, except that the second secondary winding is not formed of two parts, and hence there is only one coil designated S_2 which will be disposed in window 22 together with the minor part P' of the primary winding P, P'.

The operation of the apparatus of Figs. 2 and 3 is quite similar. The existence of an end gap such as shown at 42 in Fig. 1 is not always desirable because of the increase in primary excitation current which it causes. Primary exitation current adversely affects heating and efficiency, but the eventual results of increased lighting through improved wave shape are desired through the use of the end gap.

By placing a portion of the primary winding in close coupled relationship with the second secondary winding and cutting down the leakage between the two windings, at least as to that portion P' of the primary which is closely coupled, the voltage available from the second secondary winding is increased. Many adjustments of windings and placement of the gap can be made to achieve unusually good results, without materially increasing the cost or size of the apparatus. Thus, the placement of the part P' in close coupled relationship with the winding S_2 can eliminate the need for an end gap, thereby eliminating the likelihood of high primary current under abnormal conditions. The wave shape is improved, and likewise better balance of currents between lamps is achieved, especially by the use of the structure of Fig. 2.

The structure of Fig. 4 is quite similar to that of Fig. 3, except that the secondary winding S_1 is tapped into the second secondary winding S_2 at 56. In this manner, although the secondary windings S_1 and S_2 are in open circuit instantaneous voltage opposition, the portion of the winding S_2 to the left of the tap 56 can be used to provide a starting voltage for the discharge device L_1 additive to the voltage of the winding S_1.

The structures of Figs. 5, 6 and 7 operate the same way as the structures of Figs. 2, 3 and 4 respectively. The difference lies in the arrangement of the discharge device in the circuit and the open circuit instantaneous voltage relationships between the windings. Where in the above described structures the device L_1 was connected across the primary winding and first secondary winding together, in Figs. 5, 6 and 7 the discharge device L_1 is connected across the winding S_1 alone, that is, in series with condenser C and together therewith from junction 52 to junction 54 or from junction 52 to tap 56 in Fig. 7. Likewise, instead of being connected cross the secondary windings only, as in Figs. 2, 3 and 4, in Figs. 5, 6 and 7, the second gaseous discharge device L is connected across all of the windings, that is, from the left hand end of the primary winding P, P' to the right hand end of the second secondary winding S_2, S_2' (or S_2 alone).

In Figs. 5, 6 and 7 the secondary windings are still in open circuit voltage opposition to one another, but the open circuit voltage of the primary winding is additive to that of the second secondary winding, so that the first secondary winding S_1 alone is required to provide sufficient open circuit voltage to ignite discharge device L_1. Of course in Fig. 7 it is assisted by a part of the winding S_2.

As previously stated, it has been found that the proportion of the minor parts of the windings P, P' and S_2, S_2' to the whole which seem to give the best results is about 20%. Likewise, the starting aid of the tapped secondary winding S_2 of Figs. 4 and 7 is about best when the tap 56 includes about 20% of the total winding to the left of the tap as viewed in the drawings.

In a circuit like Fig. 2, using the form of core of Fig. 1 two instant start 75 watt lamps were successfully ignited and operated when the various windings and their parts were made up as follows:

With an end gap:

S_1, 3100 turns of #32 wire
S_2, 1500 turns of #28 wire
S_2', 400 turns of #28 wire
P, 410 turns of #23 wire
P', 50 turns of #23 wire

It was found that the end gap could be eliminated by merely shifting the number of turns on the parts of the primary winding. P was decreased to 360 turns, and P' was increased to 100 turns. The width of the winding leg 28 was $1\frac{3}{32}$ inch and other dimensions proportional.

It is believed that no further explanation is required, other than to point out that the results which are achieved, namely low primary exciting current, good wave shape, and excellent current balance between the lamps, are directly attributable to the structures described, irrespective of whether the theoretical explanation of operation is correct or not. It is desired to be limited in the structure only by the claims appended hereto.

What it is desired to claim is:

1. Apparatus for igniting and providing the operating voltages of gaseous discharge devices comprising: a source of low voltage A. C. current, a transformer having a primary winding connected across the source and having first and second end terminals, a first secondary winding having first and second end terminals with the first end terminal connected to the second terminal of the primary winding, and a second secondary winding having first and second end terminals with the second end terminal

of said first secondary winding connected to said second secondary winding at a point other than said second terminal thereof, an elongate iron core mounting all of the windings with the first secondary winding disposed on one end of the core and there being a shunt between the said first secondary winding and the remainder of the windings, a first gaseous discharge device having a condenser connected in series therewith and connected from the first terminal of the second secondary winding to one of the first and second terminals of the primary winding, a second gaseous discharge device connected from the second terminal of the second secondary winding to the other of said first and second terminals of said primary winding, and the open circuit voltage relationship of the secondaries being in opposition, the second secondary winding being disposed on the end of said core opposite the first secondary winding, with the major portion of the primary winding physically disposed between the two secondary windings on said core and closer coupled with the second secondary winding than the first, and a minor portion of the primary winding closely coupled with the second secondary winding and physically separated from the major portion of said primary winding, the coupling between the minor portion of the primary winding and the second secondary winding being substantially closer than the coupling between the major portion of the primary winding and the second secondary winding.

2. A structure as described in claim 1 in which there is a second magnetic shunt between the major portion of primary winding and the second secondary winding, the minor portion of said primary winding being on the same side of said second shunt as said second secondary winding.

3. A structure as described in claim 1 in which the point of said second secondary winding comprises its first terminal.

4. A structure as described in claim 1 in which the point of said second secondary winding comprises a tap electrically closer to its first than its second terminal.

5. A structure as described in claim 1 in which the first gaseous discharge device has an end thereof connected to the first terminal of the primary winding, and the second gaseous discharge device has an end thereof connected to the second terminal of the primary winding.

6. A structure as described in claim 1 in which the first gaseous discharge device has an end thereof connected to the second terminal of the primary winding, and the second gaseous discharge device has an end thereof connected to the first terminal of the primary winding.

7. Apparatus for igniting and providing the operating voltages of gaseous discharge devices comprising: a source of low voltage A. C. current, a transformer having a primary winding connected across the source and having first and second end terminals, a first secondary winding having first and second end terminals with the first end terminal connected to the second terminal of the primary winding, and a second secondary winding having first and second end terminals with the second end terminal of said first secondary winding connected to said second secondary winding at a point other than said second terminal thereof, an elongate iron core mounting all of the windings with the first secondary winding disposed on one end of the core and there being a shunt between the said first secondary winding and the remainder of the windings, a first gaseous discharge device having a condenser connected in series therewith and connected from the first terminal of the second secondary winding to one of the first and second terminals of the primary winding, a second gaseous discharge device connected from the second terminal of the second secondary winding to the other of said first and second terminals of said primary winding, and the open circuit voltage relationship of the secondaries being in opposition, the major portion of the second secondary winding being disposed on the end of said core opposite the first secondary winding, with the major portion of the primary winding physically disposed between the first secondary winding and the said major portion of the second secondary winding, and there being a minor portion of the primary winding closely coupled with the major portion of the second secondary winding and a minor portion of the second secondary winding closely coupled with the major portion of the primary winding.

8. A structure as described in claim 7 in which there is a second shunt substantially narrower than said first shunt, and disposed between the major portions of the primary and second secondary windings.

9. A structure as described in claim 7 in which the point of said second secondary winding comprises its first terminal.

10. A structure as described in claim 7 in which the point of said second secondary winding comprises a tap electrically closer to its first than its second terminal.

11. A structure described in claim 7 in which the first gaseous discharge device has an end thereof connected to the first terminal of the primary winding, and the second gaseous discharge device has an end thereof connected to the second terminal of the primary winding.

12. A structure as described in claim 7 in which the first gaseous discharge device has an end thereof connected to the second terminal of the primary winding, and the second gaseous discharge device has an end thereof connected to the first terminal of the primary winding.

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