

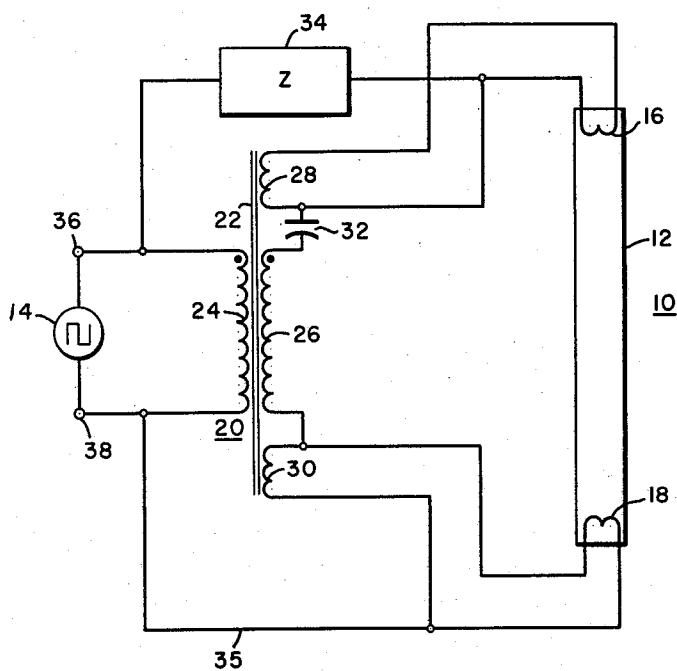
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CIRCUIT ARRANGEMENT FOR ENERGIZING DISCHARGE DEVICES

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WITNESSES

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CIRCUIT ARRANGEMENT FOR ENERGIZING DISCHARGE DEVICES

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The present invention relates to circuit arrangements for energizing load apparatus and, more particularly, for energizing discharge devices such as fluorescent lamps.

In order to form a circuit arrangement for energizing a discharge device, or a fluorescent lamp as exemplified, various factors have to be taken into consideration. Characteristically, such a lamp requires an elevated voltage, relative to the voltage ordinarily available from conventional sources, to be started for subsequent normal operation, because considerable potential gradient is necessary to ionize the lamp path through which a discharge is to occur. With the use of certain lamps, for example those of the type commonly known as "rapid start lamps," another function is necessarily provided, in that filaments ordinarily included in the lamp have to be heated to enable electrons to be emitted for initiating the discharge.

Once a lamp, of any general type, is started, it is desirable that the elevated starting voltage be removed from application to the lamp to maximize the lamp life and that normal operating voltage be employed in its place to sustain the discharge. What is more, the employed circuit arrangement should provide an impeding or ballasting effect to limit the current or discharge through the lamp which, when ionized, offers relatively reduced resistance or impedance to the discharge. Of course, the energizing function of the employed circuit arrangement should, in practical terms, be accomplished with optimal economy through relative minimization of energy transmittal losses and through the use of circuit components which are optimally few in number and which can be constructed with reduced cost.

In the event employment is made of a voltage source having an elevated frequency, relative to the frequency of conventional voltage sources, added efficiency can be provided in the operation of a lamp (or lamps), particularly in that generally smaller circuit components can be employed and in that the inherent efficiency of the lamp is elevated with the use of frequencies in determinable elevated portions or bands of the frequency spectrum. For example, the circuit components which contribute to providing the aforementioned ballasting function can present the required ballasting impedance with design specifications which are smaller in size than similar specifications of circuit components employed in conventionally energized arrangements. As a direct result, the objectives of relatively minimizing energy transmittal losses and optimally economizing the construction of the circuit component are thereby approached, if not obtained.

Of course, by uniquely arranging and employing selected circuit components to energize the lamp, economic and technical benefits can be obtained in addition to those generally provided either with conventional operation or with operation at an elevated frequency. In conjunction with the more specific and ensuing descriptive matter, the preceding general remarks will provide a fuller perspective of the invention.

Accordingly, it is an object of the invention to provide a circuit arrangement for energizing load apparatus or discharge devices such that economy is obtained through improved operational efficiency and through reduced component costs.

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It is another object of the invention to provide a circuit arrangement of the character described which enables a starting of the apparatus and which transmits operational energy to the apparatus substantially without including the circuit starting components in the operating path.

It is another object of the invention to provide a circuit arrangement of the character thus far described which is adaptable for operation at an elevated frequency to enable the circuit components to be constructed economically.

It is yet another object of the invention to provide a circuit arrangement for energizing load apparatus which includes inductive means for starting the apparatus and impedance means for preventing the transmittal of operational current through the inductive means to the apparatus.

Another object of the invention is to provide a circuit arrangement, of the character described in the preceding object, which includes means for limiting the operational current and for isolating any elevated potential of the load apparatus from the input of the circuit arrangement, particularly during the start-up period.

These and other objects of the invention will become more apparent upon consideration of the following detailed description of an illustrative embodiment of the invention as related to the attached drawing, in which:

The single FIGURE is a schematic diagram of a circuit arrangement formed in accordance with the principles of the invention for energizing electric discharge devices.

With regard to the broad precepts of the invention, means are provided for transforming or amplifying the voltage of a given source to a voltage having sufficient magnitude for initiating a discharge in load apparatus or a discharge device, and means, including for example an impedance element, are provided for restricting any subsequent current associated with the starting voltage to an acceptable value. The voltage source then energizes the load apparatus through impedance or ballasting means with substantially no load current being supplied by the transforming means as a result of an impeding effect produced by the exemplified impedance element. The ballasting means can also be employed to prevent the starting voltage from being imposed upon the input of the circuit arrangement. To illustrate more clearly but not to limit these broad principles of the invention, the detailed description will now be set forth.

With reference to the figure, a circuit arrangement 10 is provided for energizing load apparatus, such as a fluorescent lamp 12. Energy can be derived from any suitable source such as the exemplified generator 14, here having a square wave output. The exemplified lamp 12 is shown to be in the form of the aforementioned "rapid start" type so that heating filaments 16 and 18 are included therewith to facilitate the establishment of a discharge.

To provide a starting voltage for the lamp 12, and, if desired, to enable the filaments 16 and 18 to be heated, inductive means 20 are included in the circuit arrangement 10. The inductive means 20 include a core 22, which can be formed of any suitable magnetic material, such as silicon steel, and which can be formed in any suitable manner, such as with laminations. About the core 22 is wound a primary or magnetizing winding 24. A secondary winding 26 is also wound upon or about the core 22 to contribute substantially in the establishment of the noted starting or elevated voltage. If desired, auxiliary windings 28 and 30 can also be wound upon the core 22 to energize the lamp filaments 16 and 18, respectively. In this instance, the auxiliary windings 28 and 30 are provided with a sufficient number of turns

to enable the intended heating function to be accomplished.

Impedance means, here in the form of a capacitor 32, are connected serially with the secondary winding 26 to limit the lamp starting current and to preclude the inductive means 20 from transmitting any substantial portion of the normal operating lamp current for reasons subsequently to be noted. Thus, the capacitor 32 and the secondary winding 26 form a circuit branch which is connected in parallel with the lamp 12, thereby enabling any induced voltage across the winding 26 to be applied substantially across the lamp 12, particularly during the time period prior to the flow of lamp current. By providing the inductive means 20 with suitable design parameters, it follows that any reasonable voltage required to start the lamp 12 can be obtained.

Accepting, for the present, the premise that the inductive means 20 transmit negligibly little energy to the lamp 12 during normal operation of the circuit arrangement 10, it is clear that normal operating current for the lamp 12 can flow serially from the source 14, through ballasting means 34 which are included for purposes already described, and through the lamp 12 to return to the source 14 through conductor 35. The ballasting means 34, for example, can be provided in the form of an ordinary inductor which can be constructed with design parameters enabling its intended functions, which will be described more fully hereinafter, to be fulfilled. Although not shown here, means for correcting the circuit power factor or phase difference between at least the basic components of the input current and voltage of the circuit arrangement 10 can be employed with the arrangement 10. As an example, capacitive means (not shown) can be shunted between circuit input terminals 36 and 38 to compensate for a current lagging effect in the circuit arrangement 10.

With the general purpose of each of the described circuit components being established, the operation of the circuit arrangement 10 can now be clearly set forth. When the arrangement 10 is first activated by the source 14, an induced and elevated voltage appears across the secondary winding 26 as a result of electromagnetic induction initiated by the flow of a magnetizing current through the primary winding 24. In addition, a voltage is induced across the auxiliary windings 28 and 30 to initiate heating of the lamp filaments 16 and 18. When the filaments 16 and 18 are sufficiently heated, the induced voltage across the secondary winding 26, having resulted in a potential gradient across the lamp 12, causes a discharge to occur through a path, ionized by the noted gradient, in the lamp 12.

The voltage required across the lamp 12 for sustaining a discharge is usually lower than that required for initiating the discharge. Thus, the character of the circuit arrangement 10 when normally operating is such as to preclude substantially the imposition of any elevated potential of the secondary winding 26 upon the lamp 12. Moreover, any tendency of the inductive means 20 to transmit substantial current to the lamp 12 once a discharge has been initiated is precluded through the impeding effect of the capacitor 32. The current impeding effect and the potential isolating effects are particularly enhanced in the instance in which the voltage source 14 is provided with a voltage wave form having harmonic components, such as the one employed here which is substantially square in form. As such, the capacitor 32 can be designed economically to impede all but higher harmonic current components. As observable on a suitable electronic instrument, such as an oscilloscope, the only current through the capacitor 32 and the secondary winding 26 during normal operation of the lamp 12 is therefore what is termed a "spike" of current each time the source voltage, if selected to be of the exemplified square wave form, is switched or alternated.

As a corollary, the ballasting means 34 desirably are

accorded design parameters resulting in an impeding effect against all higher harmonic current components, such as those above the seventh or ninth harmonic, relative to the source fundamental component, so that the elevated voltage of the secondary winding 26 prior to the initiation of a discharge through the lamp 12 cannot appear across the input terminals 36 and 38. As another effect, the ballasting means 34 therefore deliver an operational current to the lamp 12 from the source 14 which is less square in form than it might otherwise be.

However, it is necessary that the ballasting means 34 be not operative to drop the voltage of the source 14 below that which is prescribed or required for sustaining the discharge when once initiated through the lamp 12. Clearly, since operative current is substantially precluded from being supplied by the secondary winding 26 for reasons already presented, the operative current for sustaining a discharge through the lamp 12 is, with favorable voltage conditions, obtained serially through the ballasting means 34 from the source 14. An immediate benefit to be derived from this unique operation is the fact that the inductive means 20 need not be provided with an elevated power rating to handle all or even any significant portion of the normal load current, but, on the contrary, need be provided only with a substantially reduced power rating for handling substantially only the energy required for starting the lamp 12 and, of course, for heating the filaments 16 and 18, when employed.

Once the circuit arrangement 10 is primed to operate normally, a sufficient voltage can, if the circuit components are suitably designed and particularly if the source 14 is provided with an elevated frequency, be maintained across the lamp 12 to sustain a lamp discharge supplied from the source 14 through the ballasting means 34. Thus, substantially the only energy transmitted losses appear in the ballasting means 34 with only a nominal amount of energy being expended to sustain magnetization of the core 22. In the interest of completing the operational analysis of the circuit arrangement 10, it is to be noted that during normal operation the elevated voltage of the secondary winding 26 is offset by a voltage drop across the capacitor 32 to equal the operating voltage across the lamp 12.

The operational character of the described illustrative embodiment of the invention has been verified experimentally. For example, it has been found that if the source 14 is provided with a voltage of square wave form that reverses or switches at the rate of about 1500 cycles per second, and if an ordinary filament transformer, supplemented with an additional winding to provide the illustrated secondary winding 26 and having conventional audio transforming fidelity, is employed, the lamp 12 can be started successfully with subsequent flow of lamp current through the ballasting means 34 in the manner already described. The ballasting means 34 can be provided in the form of a linear inductance but, in general usage, it can just as well be provided, for example, in the form of a tuned combination of circuit elements.

In the foregoing description, the mode of operation of an arrangement of specific circuit elements has been related to point out the principles of the invention. The description, therefore, has only been illustrative of the invention, and, accordingly, it is desired that the invention be not limited by the arrangement or embodiment described here but, rather, that it be accorded an interpretation consistent with the scope and spirit of its broad principles.

What is claimed is:

1. A circuit arrangement for energizing at least one discharge device or the like, said circuit arrangement comprising an input connected to a source of fluctuating voltage, inductive means for amplifying said fluctuating voltage, the output of said inductive means providing starting energy for said discharge device, impedance means being connected between the inductive means output and

said discharge device for substantially precluding the flow of operating current to said discharge device from said inductive means, and impedance means connected between said input and said discharge device for ballasting said discharge device and for substantially precluding any elevated starting potential from being imposed upon said source.

2. A circuit arrangement for energizing at least one discharge device or the like, said circuit arrangement comprising an input connected to a source of fluctuating voltage having a substantially regularly formed wave including harmonic components, means for transforming to an elevated value the fluctuating voltage of said source, said transforming means being coupled with said discharge device to provide starting energy therefor, capacitance means for substantially impeding any flow from the output of said transforming means of at least a major portion of current components in the frequency spectrum extending from and including the fundamental frequency, and means for normally energizing said discharge device directly from said source including impedance means for ballasting said discharge device and for blocking a substantial portion of the harmonic voltage components of the output of said transforming means from being imposed upon said source.

3. A circuit arrangement for energizing at least one discharge device or the like having filaments to be heated, said circuit arrangement comprising an input connected to a source of fluctuating voltage having a substantially regularly formed wave including harmonic components, means for transforming to an elevated value the fluctuating voltage of said source, said transforming means being coupled to said discharge device to provide starting energy therefor, capacitance means for substantially impeding any flow from the output of said transforming means of at least a major portion of current components in the frequency spectrum extending from and including the fundamental frequency, and means for normally energizing said discharge device directly from said source including impedance means for ballasting said discharge device and for blocking a substantial portion of the harmonic voltage components across the output of said transforming means from being imposed upon said source, said transforming means including output windings for heating said filaments in said discharge device.

4. A circuit arrangement for energizing at least one discharge device or the like having filaments to be heated, said circuit arrangement comprising an input connected to a source of fluctuating voltage having a substantially regularly formed wave including harmonic components, means for transforming to an elevated value the fluctuating voltage of said source, said transforming means being coupled with said discharge device to provide starting energy therefor, capacitance means for substantially impeding any flow from the output of said transforming means of at least a major portion of current components in the frequency spectrum extending from and including the fundamental frequency, and means for normally ener-

gizing said discharge device directly from said source including impedance means for ballasting said discharge device and for blocking a substantial portion of the harmonic voltage components across the output of said transforming means from being imposed upon said source, said transforming means including output windings for heating said filaments in said discharge device, and means for correcting the power factor of said circuit arrangement.

5. A circuit arrangement for energizing at least one discharge device or the like, said circuit arrangement comprising an input connected to a source of fluctuating voltage having a substantially regularly formed wave including harmonic components, a transformer having a primary winding and a first secondary winding for amplifying the fluctuating voltage of said source, a capacitor being serially connected with said secondary winding with the serial combination just described being connected across said discharge device, said secondary winding providing a starting voltage for said discharge device and said capacitor substantially impeding any flow from said secondary winding of at least a major portion of current components in the frequency spectrum extending from and including the fundamental frequency, and a circuit loop for energizing said discharge device during normal operation, said circuit loop including impedance means for ballasting said discharge device and for blocking a substantial portion of the harmonic voltage components across the aforementioned serial combination from being imposed upon said source.

6. A circuit arrangement for energizing at least one discharge device or the like having filaments to be heated, said circuit arrangement comprising an input connected to a source of fluctuating voltage having a substantially regularly formed wave including harmonic components, a transformer having a primary winding and a first secondary winding for amplifying the fluctuating voltage of said source, a capacitor being serially connected with said secondary winding with the serial combination just described being connected across said discharge device, said secondary winding providing a starting voltage for said discharge device and said capacitor substantially impeding any flow from said secondary winding of at least a major portion of current components in the frequency spectrum extending from and including the fundamental frequency, and a circuit loop for energizing said discharge device during normal operation, said circuit loop including impedance means for ballasting said discharge device and for blocking a substantial portion of the harmonic voltage components across the aforementioned serial combination from being imposed upon said source, and means for heating said filaments in said discharge device and for correcting the power factor of said circuit arrangement.

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