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B. K. NASTER

2,305,487

LIGHTING DEVICE

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Fig. 1

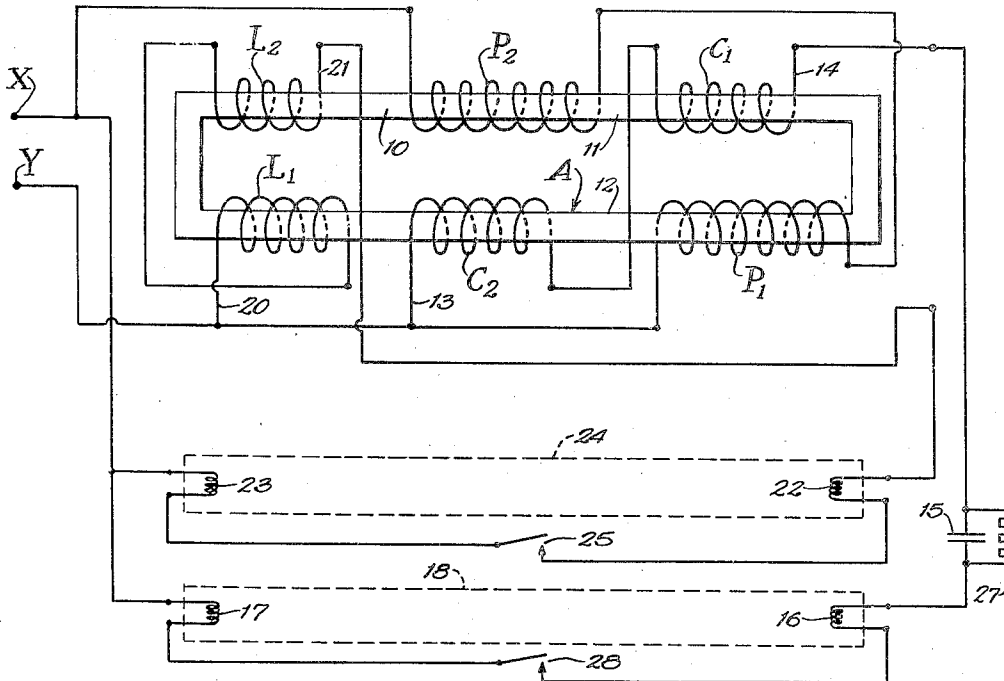


Fig. 2

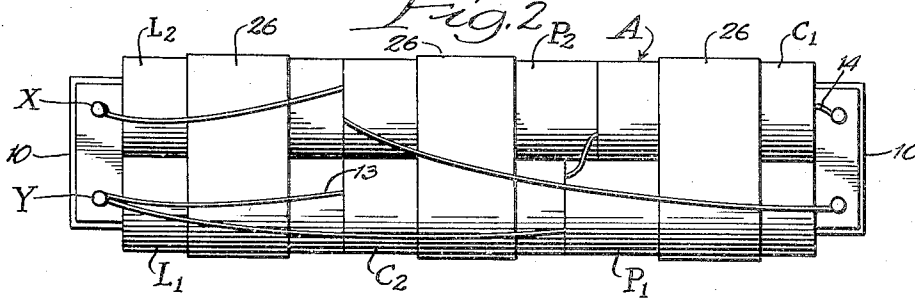


Fig. 3

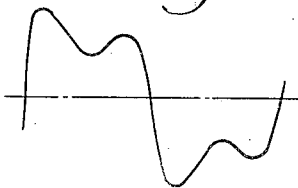


Fig. 4



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LIGHTING DEVICE

Bert K. Naster, Chicago, Ill.

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8 Claims. (Cl. 176-124)

This invention relates to a lighting device, and more particularly to a device in which at least two fluorescent lamps are employed, and in which the current in each lamp is in different phase.

Since the light output of a fluorescent lamp is diminished as the magnitude of the alternating current energizing it diminishes and is zero when the current is zero, a single lamp will have a pulsating light emission which corresponds to twice the frequency of the source of electrical energy, there being 120 pulsations of light on a 60 cycle per second power supply. This creates a noticeable stroboscopic effect. However, it has been common in the past to use a pair of lamps in one unit, one of the lamps being in a circuit in which the current is in leading phase relationship to the current in the circuit of the other lamp. In this way one of the lamps is caused to have strong light emission at the instant the current is changing direction in the other. In this way the stroboscopic effect is minimized.

However, in the arrangements previously proposed, several difficulties have been encountered. In order to cause the current in one circuit to be leading a condenser has been employed in this circuit, and in operation a high voltage is built up across this condenser requiring that it be constructed for such high voltages. A more serious objection is that the wave form of the voltage developed across the lamp in the leading circuit has been irregular, having a depression near the middle of the half cycle, and so causing a loss of power resulting in substantially decreased brilliancy in this lamp. The disadvantage of having one lamp of lesser brilliancy in a device of this character is self-evident.

An object of the present invention is to provide a device in which the lamps will be of substantially equal brilliancy and will deliver a maximum of light output for the energy supplied and with relatively equal current in each lamp. A further object is to provide a device of this nature which is economical of construction and conservative of space and materials. Another object is to provide a device in which the leading circuit will not require a condenser adapted for such high voltage. Still other objects will appear as the specification proceeds.

An embodiment of the invention is illustrated by the accompanying drawing in which:

Figure 1 is a wiring diagram of the device; Figure 2, a plan view of the transformer here employed, showing the specific arrangement of the coils; Figure 3, a diagram showing the form of the voltage across the lamp in the leading cir-

cuit when another type of transformer is employed; and Figure 4, a diagram showing the wave form of the voltage across the lamp in the leading circuit when the transformer illustrated in Figure 2 is employed.

As illustrated, the device includes an autotransformer A of elongated high reactive design. Figure 2 shows the physical aspects of the transformer and Figure 1 shows schematically the electrical connections and arrangement. The core 10 may be laminated and is of generally rectangular cross section, and has coils about each of its sides or legs 11 and 12.

The two primary coils P₁ and P₂ extend about different legs of transformer A and are connected in series with the terminals X and Y which constitute a source of alternating current. The windings of coils P₁ and P₂ are in such direction as to aid each other in building a magnetic field within the transformer core.

It will be observed that the coils P₁ and P₂ are in staggered relation, and directly opposite these coils are the secondary coils C₁ and C₂. Thus the coils P₁ and C₁ are opposite each other on different legs and at the extreme end of the core. Just adjacent these coils are the coils P₂ and C₂ also opposite each other. The end 13 of coil C₂ is connected to the terminal Y of the alternating current source. The other end of this coil is connected with one end of the winding of coil C₁. The direction of the windings in coils C₁ and C₂ are such as to build a magnetic field opposing the field provided by the primary windings. The end 14 of coil C₁ is connected in series with the capacitor 15, which in turn is connected through filaments 16 and 17 of the fluorescent lamp 18, to the terminal X of the alternating current source. A resistor 19 is connected across the capacitor 15 to discharge any residual charges left on the condenser. A switch 20 of the usual type is placed in connection between filaments of the lamp which is designed to open after the lamp has started to operate.

Toward the other end of the transformer A are the secondary coils L₁ and L₂. These coils are adjacent the coils P₂ and C₂ and are disposed opposite each other on different legs of the transformer core. Like the first-mentioned secondary coils, these coils are connected in series, the end 20 of coil L₁ being connected to terminal Y of the source of alternating current, their windings being in such direction that each builds a magnetic field opposed to the field of the primary windings. The end 21 of coil L₂ is connected through filaments 22 and 23 of the lamp 24 to the terminal X

of the alternating current source. The usual switch 25 is provided to open the connection between the lamp filaments after it has lighted.

The preferred physical arrangement of the coils on the transformer core is shown in Fig. 2. The paper straps 26 are here used to securely bind the coils to form a strong structure and to further insulate the coils from the grounded case. In the embodiment illustrated, the primary coils P_1 and P_2 are composed of 1090 turns each, the secondary coils C_1 and C_2 of 1145 turns each, and the secondary coils L_1 and L_2 of 915 turns each. The source of alternating current may be of the ordinary 110-115 volt A. C. source, and the lamps each may be, for example, a standard 40 watt fluorescent lamp. It is expected, of course, that these factors, such as the number of turns on the different windings, the voltages employed and the size of the lamps, condensers, etc., may be varied to suit the particular situation while still obtaining the advantages of this invention.

The lamp 24 is served by a circuit including terminal X, coils L_1 and L_2 and terminal Y; and the lamp 18 is served by a circuit including terminal X, coils C_1 and C_2 , capacitor 15, and terminal Y. Thus, both lamp circuits are provided with inductors which serve to check the current. However, only the circuit serving the lamp 18 has a capacitor, and the effect of this capacitor is to change the phase in this circuit, making the current in this circuit lead the current in the circuit of the other lamp. In this way each of the lamps is caused to be at substantially full intensity at the instant the current at the other is changing direction and is at a minimum.

In operation of the device, I find that each of the lamps 18 and 24 burn with substantially the same brilliancy, and that the voltage across the capacitor 15 is much lower than would be expected from experience with prior devices of this nature.

The improved operation is attributed to the novel arrangement of the coils. With the interrelationship of the coils here provided, the circuit characteristics in each circuit are made more suitable and result in the improvements here made possible. It may be noted that the magnetic coupling between the primary coils and the secondary coils C_1 and C_2 is substantially closer than the coupling between the primary coils and the secondary coils L_1 and L_2 .

An improved effect is also obtained by other coil arrangements than those herein specifically described and where the coupling of a winding or windings corresponding with coils L_1 and L_2 are less closely coupled with a primary winding than is a winding or windings corresponding with coils C_1 and C_2 , as, for example, an arrangement where coils corresponding with L_1 and L_2 are on one side of the primary and coils corresponding with C_1 and C_2 are on the other side, the coils corresponding with L_1 and L_2 being spaced a greater distance along the core from the primary coils and so more loosely coupled.

It is my belief that the improvement in the wave form is due to a shift in the prominence of the individual harmonics, such as the 3rd, 5th, and higher harmonics, which is produced by the change in the coupling between the secondary coils of the lamp circuits and the transformer primary coils, but it is not intended to disclaim any part of my invention should the advantages obtained be better explained on some other theory.

To demonstrate the improvement of the present arrangement, the voltage wave form across

the lamp in the circuit including the capacitor was compared by oscillograph with the wave form of the voltage across a lamp in a corresponding circuit where the coils P_1 and C_2 were interchanged. In this other arrangement a pair of secondary coils were on each end of the transformer, the primary coils being in the center and equally spaced from each secondary, and the resulting wave form of the voltage across the lamp in the leading circuit is shown in Figure 3 of the drawing. Note that the wave contains a serious depression near the center of the half cycle. This depression represents a considerable loss of power, and this results in substantially decreased brilliancy of the lamp in this leading circuit.

In the arrangement as herein set out in the present invention, the wave form of the voltage across the lamp in the leading circuit is shown in Figure 4. Note that the depression characteristic of the wave form in Figure 3 does not appear in Figure 4. This improved wave form is substantially the same as the wave form of the voltage across the lamp in the other or lagging circuit. Thus with the improved voltage wave the lamps give equally good performance and will balance each other to good effect.

Also the improved arrangement permits the use of a smaller capacitor in the leading circuit. In comparing the voltage across the capacitor at the same times as the wave forms in Figures 3 and 4 were taken, it was found that with the condition represented by Figure 3 where the primary windings were in the center with the secondaries on each side, the voltage across the capacitor was 330 volts; whereas with the condition represented by Figure 4, with the coil arrangement shown in Figure 1, the voltage across the condenser was only 230 volts. This difference in voltage requirement enables a very considerable saving in material and expense in the construction of the device.

While I have shown and described in detail a specific embodiment of my invention, it is to be understood that many changes and shifts may be made and the construction may take various forms, yet obtaining the improvements herein set forth and all within the spirit of the invention. Though the invention has been described only in connection with fluorescent lamps, it is also applicable in the same manner when neon, argon, or like gaseous lamps are employed.

What I claim is:

1. A fluorescent lighting device comprising a source of electrical energy, an elongated magnetic circuit, a primary coil on one leg of said circuit and connected to said source, a secondary coil on the other leg of said circuit and disposed opposite said primary coil, a fluorescent lamp and a capacitance connected in series with said secondary coil and said source, another secondary coil on said magnetic circuit and disposed endwise of said coils, and a second fluorescent lamp connected in series with said last-mentioned coil and said source, said last-mentioned secondary coil being less closely coupled magnetically with said primary coil than is said first-mentioned secondary coil.

2. A fluorescent lighting device comprising a source of electrical energy, an elongated magnetic circuit, a pair of primary coils on different legs of said circuit and connected with said source, a pair of secondary coils on different legs of said circuit and disposed opposite said primary coils, a fluorescent lamp and a capacitance connected in series with said secondary coils and

said source, a second pair of secondary coils on said magnetic circuit and disposed endwise of said primary and secondary coils, and a second fluorescent lamp connected in series with said second pair of coils and said source, said second pair of secondary coils being less closely coupled magnetically with said primary coils than is said first-mentioned secondary coils.

3. A fluorescent lighting device comprising a source of electrical energy, a primary coil connected with said source, a circuit containing a fluorescent lamp a capacitance and a secondary coil in series connection, said circuit being connected to said source, said secondary coil being magnetically coupled with said primary coil, and a second circuit containing a fluorescent lamp and a secondary coil, said second circuit being connected to said source, and said last-mentioned secondary coil being magnetically coupled with said primary coil to a lesser extent than said first-mentioned secondary coil.

4. A fluorescent lighting device comprising a source of electrical energy, a primary coil connected with said source, a circuit containing a fluorescent lamp a capacitance and a secondary coil in series connection, said circuit being connected to said source, said secondary coil being magnetically coupled with said primary coil, and a second circuit containing a fluorescent lamp and a secondary coil, said second circuit being connected to said source, said last-mentioned secondary coil being magnetically coupled with said first-mentioned secondary coil and with said primary coil but being coupled to said primary coil less closely than said first-mentioned secondary coil.

5. A fluorescent lighting device comprising a source of electrical energy, a primary coil connected to said source, a circuit containing a fluorescent lamp a capacitance and a secondary coil in series connection, said circuit being connected to said source, said secondary coil being magnetically coupled with said primary coil, and a second circuit containing a fluorescent lamp

and a secondary coil, said second circuit being connected to said source, said last-mentioned secondary coil being magnetically coupled with said primary coil but being farther removed from said primary coil than is said first-mentioned secondary coil.

6. A fluorescent lighting device comprising a source of electrical energy, an elongated magnetic circuit, a primary coil embracing said circuit at its one end portion, said coil being connected with said source, a fluorescent lamp a capacitance and a secondary coil connected in series with said source, said secondary coil engaging said magnetic circuit at said one end portion near said primary coil, a second fluorescent lamp and a second secondary coil connected in series with said source, said second secondary coil engaging said magnetic circuit at its other end portion removed from said primary coil, and being less closely coupled magnetically with said primary coil than is said first-mentioned secondary coil.

7. In a lighting device, an electrical autotransformer comprising a primary winding, a secondary winding magnetically coupled with said primary winding, and another secondary winding magnetically coupled with said primary winding and also with said first-mentioned secondary winding, each of said windings being connected electrically for energization from the same source of electrical energy, said last-mentioned secondary winding being less closely coupled magnetically with said primary winding than is said first-mentioned secondary winding.

8. In a lighting device, an autotransformer having a primary and two secondary windings, an electrical circuit including a lamp, a capacitance, and one of said secondary windings, and a second electrical circuit including a lamp and the second of said secondary windings, said second winding being linked by fewer magnetic lines of force developed by said primary winding than is said first-mentioned secondary winding.

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