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FLUORESCENT LIGHT DIMMING SYSTEM

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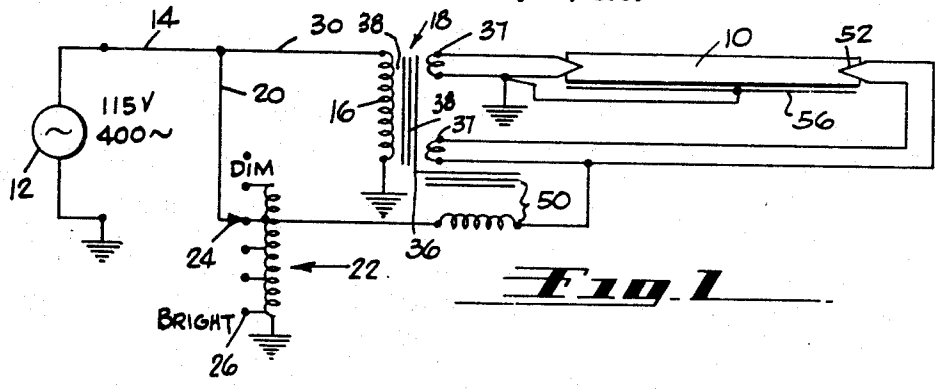

Fig. 1

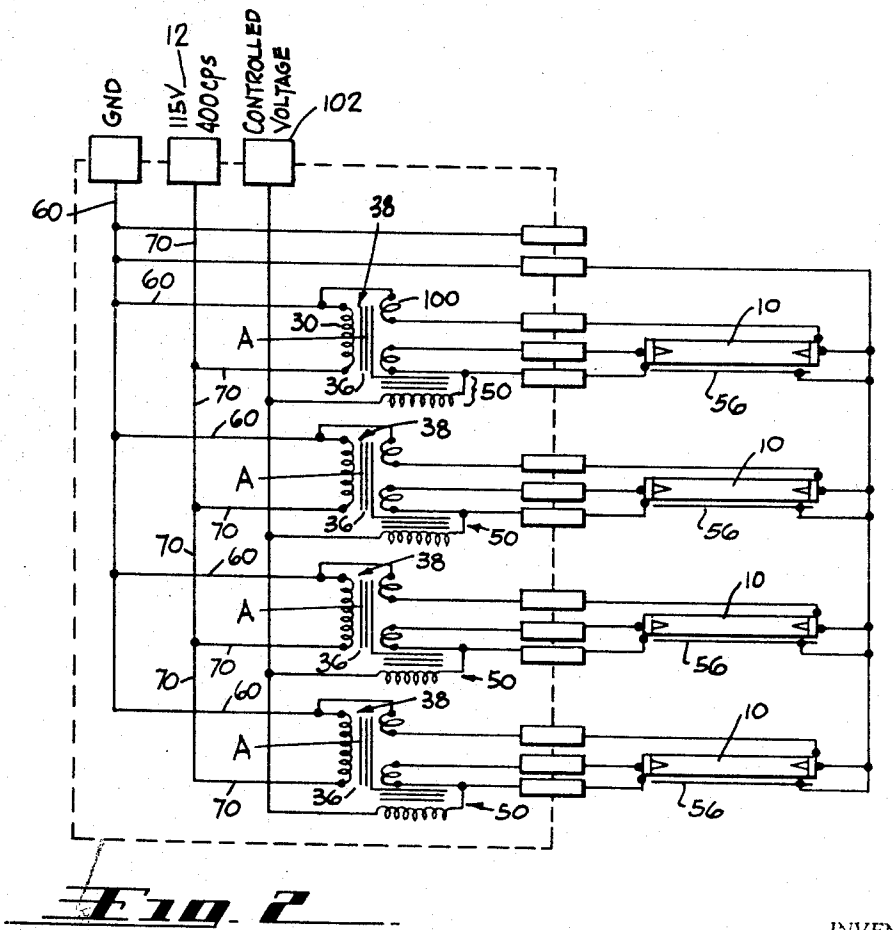

Fig. 2

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FLUORESCENT LIGHT DIMMING SYSTEM

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This invention relates to fluorescent lamps and systems, particularly those in aircraft.

More especially, it deals with fluorescent lighting in aircraft propelled by jet engines, in which A.C. generating systems are normally available.

Still more particularly, this invention is concerned with jet-aircraft fluorescent lighting systems employing 13-watt "T–5" lamps therein. T–5 lamps, although unstable, particularly when the lights are dimmed, as to obviate reflections from the pilots's windscreens, or to enable passengers to sleep, are, for many well known reasons, currently the preferred type of fluorescent lamp. Among these reasons is the fact that the T–5 exhibits the highest ratio of light output and intensity to its weight of all ratings of fluorescent lamps.

The conventional T–5 or other such lamp will either go out, flicker, jitter, oscillate or exhibit striations of light and opacity upon being dimmed, as for the present purposes.

This invention is predicated upon, among other considerations, the discovery that rapid-start and consistent lamp "re-ignition" at each semi-cycle of the A.C. supply voltage are essential in order to obviate most of the aforestated defects and to assist in alternate and rapidly occurring dimming followed by full lighting.

Broadly to achieve these particular functions (rapid-start and consistent lamp re-ignition), the lamp filaments are continuously energized, even during the dimming phase, thereby to make available at all times at the lamp filaments an abundance of electrons, to always enable establishment of an arc thru the inert gas from filament to filament.

Further to these and other ends, means are provided for suddenly peaking the voltage at the end of each half-cycle of the A.C. voltage (whether the lamp is dimmed or not), the peak being of unusually low total energy but of high—or sufficiently high—amplitude. The latter means, in one embodiment, may take the form of one or more saturable, voltage peaking transformers in the basal circuits. Generalized, the invention thus provides a steep lamp voltage wavefront, having a sufficient amplitude to effect infallible re-ignition of the lamp at the same phase angle of each A.C. semi-cycle. The peaking-transformer arrangement acts herein as a filament transformer and also cooperates with the lamp ballasting means.

Objectionable striations are minimized by means which overcome the detrimental effects of impurities in the inert gas of the lamp and the fluorescible coating on the inside of the tube wall. These effects operationally combine with the effects of gas pressure, temperature and fragile or improper electrode configuration to cause this highly objectionable striating. One form of means contemplated to achieve this end includes unusually heavy electrical ballasting of the lamp, as detailed hereinafter. Preferably, an inductive impedance ballast is employed. Also, at low and medium lamp-current operation, a high series impedance arrangement is rendered effective hereby. One form of means contemplates the use of a secondary-ballast arrangement for the peaking transformer.

To obviate discontinuities throughout the dimming range, a proper lamp voltage wave shape is provided and smooth transition of voltage waveshape in the lamp during change in current in the lamp is produced with the peaking transformer arrangement.

Further, the light-output level of the lamp is controlled in a novel manner, as by varying the voltage across the lamp-ballast series circuit, and a relatively high supply voltage is employed, up to 115 volts A.C. It may be obtained from an auto transformer in the circuitary, with a tapped primary or secondary winding.

Several of the presently preferred embodiments of these, and other concepts are diagrammatically and representationally illustrated, by way of example only, in the accompanying drawings. The embodiments will be described more in detail hereinafter with reference to these drawings.

In these drawings:

FIGURE 1 is a circuit diagram, embodying the present invention, for a lighted locus that employs but a single lamp; and

FIGURE 2 diagrammatically illustrates a substantially complete system, according to this invention, for the crew-compartment or one bay, or other large segment, of the cabin of a jet transport aircraft.

In the arrangement shown in FIGURE 1, for a T–5, 13-watt fluorescent lamp **10**, there is provided a source **12** of 115 volts, 400 c.p.s. of A.C. energy for the lamp. A conductor path **14** leads from **12** toward the grounded primary winding **16** of a filament transformer **18**, this conductor path dividing as shown at a conductor path **20** which leads to a brightness control unit **22**. Conductor **20** terminates in a sliding contact, or the like, **24**. Sliding contact **24** is adapted to make contact with any one of a plurality of tap-points **26** on a ground voltage auto-transformer **22** to thereby vary the voltage fed from **22** toward the lamp filaments, thus to vary the brightness of the lamp as desired. The fed-out voltage may vary from 0 to 425 volts, from the 115 volts A.C. source **12**.

The other path, **30**, extending onwardly from the junction of **14** and **20**, terminates in the grounded primary winding **16** of a filament transformer, **18**.

Interposed between the primary and two secondary windings **37** of **18** is a dual-function, angled and saturable core **36**. One leg **38** of core **36** serves the secondaries **37** of the respective lamp filaments and the other leg serves a ballast **50**. The ballast **50** is a heavy-duty, inductive impedance ballast and is connected to the auto-transformer, **22**, at its input end, the output end of the ballast unit being tied into one of the electrodes or filaments **52** of the lamp, **10**, via the conductor path, shown, from one of the secondaries **37**. The combination of transformer **18**, core **36** and ballast **50** comprises a peaking transformer having a primary winding **16** and a secondary ballast **50** winding. The conductor path provided by the other secondary **37** ties into the other filament **54** of the lamp. Intermediate its ends this other secondary segment is grounded and also connected to a ground-plane plate **56**. Ground-plane **56** physically parallels the lamp at a distance not over 1/16 inch therefrom and serves to enhance ionization in the gases, among other functions.

In FIGURE 3 a more or less complete lighting system for the crew's compartment of a jet engine transport aircraft is shown diagrammatically. Here, the same fundamental concepts and principles that are set forth hereinabove are employed; however, four T–5, 13-watt lamps **10** are arranged in electrical parallel, being energized by a 115 volts, 400 c.p.s. source **12**, as before. More specifically, energy is fed in parallel to the primaries of four filament transformers essentially the same as **38**, from a source **12** by means of a conductor network **70**.

A common ground is provided for the primary winding of each of the four filament transformers, the windings being connected in parallel by means of a conductor path network **60**.

Each filament transformer has, as before, an angled,

dual-function, saturable core **36**, interposed between the primary winding and the secondaries. Here, however, the conductor **60** is shunted across to the upper one **100** of the secondary coils in order to provide community of grounding of one end of one of the secondary coils. The distal and electrodes or filaments and the ground-plane plates of all four lamps are grounded by **60**.

Each secondary winding is connected to a respective filament. Secondaries **100** are connected to the distal filament, whereas the lower secondaries are connected to the proximal electrodes.

The upper leg A of core **36** serves the secondaries of the respective lamp filaments, and the lower leg of the angled core serves the ballast means **50** as before, the ballast **50** being connected, as before to a brightness control unit, not shown, but indicated at **102** and constituted in the same manner as the voltage autotransformer **22** set forth in describing FIGURE 1.

As before, the combination of filament transformer, core and ballast comprises a peaking transformer, and a ground-plane plate **56**, as, and for the purposes previously described, is provided for each lamp.

By means of the concepts and arrangements set forth herein above, a system designed for a nominal lamp current value of 100 milliamperes per lamp will give a dimming ratio of 100:1. With a system designed for a nominal lamp current of 150 milliamperes, a dimming ratio of 1000:1 will be obtained.

It is now perceivable that employing the foregoing concepts, dimming can also be achieved by utilizing a very high frequency power supply, greater than 400 c.p.s., giving rise to even greater lamp efficiency and diminishing the number, size and weight of the adjunctive means. Also, substantially the same objectives could be attained, utilizing the aforedisclosed principles, except that control is accomplished by saturating the series impedance ballast, thus decreasing the weight, size and volt-ampere capacity of the control-unit for the dimming means.

Although certain arithmetic parameters, geometrical shapes and compositions have been hereinabove employed, for the sake of concreteness, it is to be understood that, notwithstanding, the scope of the invention is not limited thereby and is of the breadth defined by the sub-joined claims.

I claim:

A fluorescent lamp lighting and dimming system, comprising:

a source of A.C. energy providing alternating voltage of a relatively high predetermined frequency;

an autotransformer including an input and an output, said input being connected to said source and adjustable to vary an output voltage from said output;

a substantially independent filament transformer including a primary winding connected to said source, and first and second secondary windings;

a substantially independent ballast providing a high series impedance at low and medium lamp current operation, and including an inductive winding having one end connected to one side of said autotransformer output;

a saturable core connecting said filament transformer and said ballast in a peaking transformer arrangement wherein said filament transformer primary winding serves as a primary winding for said peaking transformer and said ballast winding serves as a secondary winding for said peaking transformer; and

a fluorescent lamp including first and second filaments connected respectively to said first and second secondary windings of said filament transformer, and a ground-plane plate connected to ground, said ground-plane plate and the other side of said autotransformer output connecting with said first filament, and the other end of said ballast winding connecting with said second filament so that said autotransformer output voltage is applied to a series combination of said ballast winding and said fluorescent lamp,

said filament transformer providing continuous energization of said first and second filaments, said autotransformer providing an adjustable output voltage to said ballast and series connected fluorescent lamp for varying light output of said lamp, said high series impedance ballast producing re-ignition of said lamp at a substantially constant phase angle each half-cycle at low and medium lamp current operation to minimize striations, and said relatively high frequency of said source, said high series impedance of said ballast and said peaking transformer arrangement providing, when finite current flows through said lamp, a sharp, steep wavefront lamp re-ignition peak at the beginning of each half-cycle of that portion of voltage impressed across said fluorescent lamp which is due to said autotransformer output voltage applied to said series combination of said ballast winding and said fluorescent lamp, whereby stable operation of said lamp over a wide light output dimming range is obtained.

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