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THEATER LIGHTING CONTROL SYSTEM

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This invention relates to theater lighting control systems, and more particularly to a unique power and dimmer control for such systems.

Theater lighting control systems are now well known. There are commonly two types of control circuits, one utilizing the thyratron with grid control for regulating light intensity and the other utilizing saturable core reactors or magnetic amplifiers for controlling the quantity of current applied to the lighting circuits.

In the typical control circuits, the load or lighting circuit is connected to the source of power, usually alternating current, through the control element. In the thyratron circuit the power source may be coupled to the cathode and the lighting circuits to the anode. The grid circuit is utilized to control the flow of power through the tube. Conventionally, power control is achieved by applying an alternating voltage to the grid circuit, and by suitably phasing the grid voltage with the anode voltage, a desired power output is obtained. Since theater lighting circuits consume power usually in the order of hundreds of kilowatts and occasionally megawatts, it is apparent that the thyratrons required are bulky and inefficient. Moreover, as a result of the high current passing through the thyratrons, considerable heat is generated. Dissipation of this heat requires additional equipment which adds to the bulk and cost of the system. These are but a few disadvantages of the thyratron control system.

In the saturable reactor or magnetic amplifier control circuit, the load and power source are usually in series with the output winding of the inductor. The amplifier is usually equipped with two primary windings; one for providing a biasing current to increase the reactance sufficiently so as to prevent the flow of current through the secondary, and the other a control winding to counteract the effect of the biasing current and permit the secondary to conduct current.

The magnetic amplifier is generally preferred to the thyratron because of its high efficiency, stability, reliability and flexibility. It is also capable of handling large amounts of power; however, with increase in power capabilities the weight and size of the core becomes undesirably large.

Another disadvantage suffered by the magnetic amplifier is the non-linear variations of light intensity with increasing and decreasing voltages across the secondary. This is probably a result of losses in the core, particularly hysteresis, whereby the magnetization curve is asymmetrical for rising and decreasing voltages. This lack of linearity makes it difficult for the operator to predict the amount of dial rotation for a desired light intensity.

Accordingly, it is a primary object of this invention to provide a lighting control system which possesses all of the advantages of the magnetic amplifier and which is only a small fraction of the size and weight of a magnetic amplifier performing comparable functions.

It is a further object of this invention to provide a miniaturized control circuit comprising a solid state switching element controlled by a magnetic amplifier of greatly reduced proportions.

It is still a further object of this invention to provide a control circuit which has an approximately linear characteristic for increasing and decreasing light intensity.

In accordance with an aspect of the invention there is provided a lighting control circuit for selectively and continuously variably controlling the application of alternating current to variable intensity lamps. The circuit comprises a pair of normally blocked unidirectional gates, each having input, output and control electrodes. The input and output electrodes of one gate are connected to the opposite electrodes of the other gate and both gates are serially connected in a line connecting the lamps to the alternating current. The gates are of a type capable of being opened by the application of current of given amplitude and direction to the control electrodes. Current is applied to the control electrodes from a variable current source capable of producing current of sufficient amplitude to open the gates.

The control circuit is characterized by its miniature proportions and its ability to control large amounts of power. These features are partly a result of a newly-developed gated silicon rectifier and a unique control circuit for the rectifier. Since the gating function is performed by a gating switching element which is either "open" or "closed," there is relatively little loss of power in the element. Further, it is a characteristic of the gated silicon rectifier to be rendered conducting by a relatively small amplitude of current. This also improves the efficiency of the overall circuit.

Another important feature of the invention which derives from the use of a gating element requiring only relatively small amplitudes of current for operation is that the current source need only be large enough to produce the required current. Since the required current is small, the current source may be correspondingly small.

One of the most significant advantages of this invention resides in its simplicity. The invention actually comprises relatively few "building blocks" of miniature proportions for power control applications. For example, the apparatus represented schematically in Fig. 3 excluding the load, may weigh less than one pound per kilowatt of controlled power. In lighting control systems employing magnetic amplifiers, the functionally equivalent apparatus weighs approximately 100 times more than apparatus constructed in accordance with this invention. Furthermore, the apparatus represented in Fig. 3 may be made to occupy less than 27 cubic inches whereas a functionally comparable magnetic amplifier occupies approximately 1500 cubic inches.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing, wherein;

Fig. 1 is a diagrammatic illustration of a gated rectifier;

Fig. 2 is the electrical symbol for the rectifier shown in Fig. 1;

Fig. 3 is a schematic diagram of a preferred lighting control circuit; and,

Fig. 4 is a voltage curve showing the relationship between the line voltage and the bias voltage induced by current flowing in a winding of a magnetic amplifier.

My invention makes use of a recently introduced gated silicon rectifier, illustrated in Figs. 1 and 2, which comprises three p-n junctions, or four zones of p-n-p-n conductivities or vice versa. The rectifier shown generally at **1** comprises an input electrode or emitter electrode **2**, an output or collector electrode **3**, connected respectively