to the opposite ends of the silicon body and a gate or control electrode **4** connected to the intermediate p or n zone. The electrical symbol for this rectifier is shown in Fig. 2.

The operating characteristics of gated silicon rectifiers are such that the rectifier may be rendered conductive solely by the application of sufficiently large potential across the emitter and collector electrodes **2** and **3** or by the combined effect of an emitter-collector potential which, in itself, is insufficient to cause conduction, and of a current of sufficient amplitude applied to the gate electrode **4**. The current applied to the electrode **4** must be in the forward conducting direction. The symbol shown in Fig. 2 is used in the circuit diagram of Fig. 3.

Referring now to Fig. 3, there is illustrated a control circuit according to my invention for selectively and variably controlling the application of alternating current, shown symbolically at **5**, to a load **6** comprising variable intensity lamps generally found in theaters.

The control circuit comprises generally a full-wave gate G enclosed by dash lines, which normally is closed to prevent the flow of power to the load. In the preferred embodiment, the full-wave gate comprises a pair of the gated rectifiers described in connection with Figs. 1 and 2. For Fig. 3, these rectifiers are shown at **7** and **8**. The input and output electrodes of one rectifier, e.g. **7**, are connected to opposite electrodes of rectifier **8** and both rectifiers are serially connected in a line joining the alternating current source **5** to the load **6**.

The gating function of the rectifiers is controlled by a selectively variable current source which preferably comprises a magnetic amplifier shown generally at **9**..

The magnetic amplifier comprises a pair of bias windings **10, 11**, control windings **12, 13** and output windings **14, 15**. The windings are preferably wound on the same core so that changes in flux produced by changes in the current flowing through one winding induces voltages in all of the other windings.

The output windings **14, 15**, are connected respectively in the gate-output electrode circuits of rectifiers **8** and **7**. Feed-back diodes **16** and **17** are serially connected in the circuits of the windings **14** and **15** respectively. The diodes **16** and **17** are conventional in magnetic amplifier circuits for providing rectifier feed-back currents for efficient operation. Capacitors **18** and **19** are connected across the diodes **16** and **17** and serve an important function which will be explained later.

The biasing current through the windings **10** and **11** is selected so that the induced voltage across the windings **14** and **15** produces a current in the reverse direction, thereby blocking the respective rectifiers **7, 8** and effectively opening the feed circuit to the load. In Fig. 4 the alternating current voltage is shown by the wave form **20** and the direct current biasing potential is shown in dotted line at **21**. As indicated by Fig. 4, the normal biasing potential maintains the rectifiers at cut-off so that the line to the load is effectively open.

The control windings **12, 13** are wound so as to counteract the effect of the biasing current through the windings **10** and **11**. By gradually increasing the flow of current through the control windings **12** and **13**, the resultant biasing potential is gradually decreased as shown in Fig. 4, at **22** and **23**. Although in Fig. 4 the biasing potential is shown at discrete levels, in practice the variation is gradual.

When the biasing potential is reduced to the level shown at **22**, the rectifier **7** is conducting at point **24**. Once the gated rectifier is opened or conducting, the voltage across it drops rapidly to a level **25** which represents the voltage drop across the diode. The rectifier continues to conduct current until the applied voltage drops below the level **25**. Thus, by increasing the current through the control windings to a still great extent to counteract the effect of the biasing current so that the resultant biasing potential is at a level **23**, the rectifier may be conducting at an earlier time in the cycle; for example, at point **26**. As can be readily appreciated, the time can be shortened considerably by producing a sharp current pulse at the inception of the voltage cycle. This is an advantage peculiar to this invention. The light intensity is a function, of course, of the amount of power applied to the lamps. Since the amplitude is varying constantly (A.-C.), the intensity of the lamps is varied by application of power to the load over varying periods of the cycle. Thus, application of the power at point **26**, Fig. 4, will increase the intensity of the lamps as compared to the application of power at point **24**.

The current applied to the bias and control windings is derived from the alternating current line over conductors **27, 28**. A capacitor **29** is provided for filtering and dropping the potential to a suitable value. The alternating current is rectified in the bridge **30** and applied to the several windings as follows: A resistor **31** and capacitor **32** serve to filter the voltage. The voltage across capacitor **32** is applied across the bias windings **10** and **11** and the resistor **33**; the resistor **33** being selected to provide a suitable time lag so as to prevent damage from a surge of current. The voltage across resistor **34** (coupled across the capacitor **32**) provides the voltage for the control windings **12** and **13**. An adjustable contact **35** taps off a desired voltage which is applied across the control windings after a suitable drop across resistor **36**. The resistor **34** may be called a fader or dimming resistor since variation of the tap **35** selectively varies the amount of current through the control windings. A further resistor **37** is provided across the control windings in order to limit the current through the windings.

Thus, gradual variation of light intensity is accomplished simply by moving the tap **35** from one end of the resistor **34** to the other end.

It is apparent that when the adjustable contact **35** is at the upper end of the resistor **34**, the control windings are coupled across the resistor **34** and maximum voltage is applied to the control windings. This voltage is reduced by moving the tap towards the lower end of the resistor **34**.

The capacitors **18** and **19** connected across the feedback diodes **16** and **17** respectively, provide an important function in linearizing the light intensity during variation of the voltage across the control windings. Apparently the capacitive reactance provided by the capacitors compensates the inductive reactance supplied by the windings of the magnetic amplifier. Since the dimensions of the magnetic amplifier core required by this invention are reduced to only a minor fraction of the cores heretofore required in magnetic amplifier control circuits, the hysteresis losses are correspondingly reduced and the magnetization curve is more linear. Of course, the valve of the capacitors **18** and **19** depends on the values of the other components in the circuit.

Resistors **38, 39**, are provided across the control-output electrodes of rectifiers **7, 8** respectively to limit the current in the electrode circuit. Fuses **40, 41** may also be provided to protect the rectifiers against damage from a surge in the line current.

Although the invention has been described in connection with lighting circuits, it is to be understood that the invention could also be utilized in motor control circuits. Further, by providing a plurality of magnetic amplifiers in combination with gated rectifiers, three-phase control may be obtained.

While the foregoing description sets forth the principles of the invention in connection with specific circuits, it is to be clearly understood that this description is made only by way of example and not as a limitation of the scope of the invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. A control circuit for selectively and variably controlling variable intensity electric lights energized with alternating current, which control circuit comprises a