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(54) Electronic ballast for gas discharge lamps and fluorescent lamps

(57) An electronic ballast for single or multi discharge or fluorescent lamps includes a AC to DC converter D_1-D_4 etc, high frequency oscillator IC_1 - Q_z, a switching resonant inverter Q_3 and a positive feedback circuit D_{12}, IC_2. The ballast can be dimmed by external auto or manual control which varies the oscillator duty cycle. The said ballast removes flicker by AC to DC converter. The said ballast can improve the power efficiency by the use of a switching resonant inverter 3. The said ballast is idealy suited to gas discharge lamp and fluorescent lamp applications, because it can accommodate a wide range of resistance loads at high efficiency.

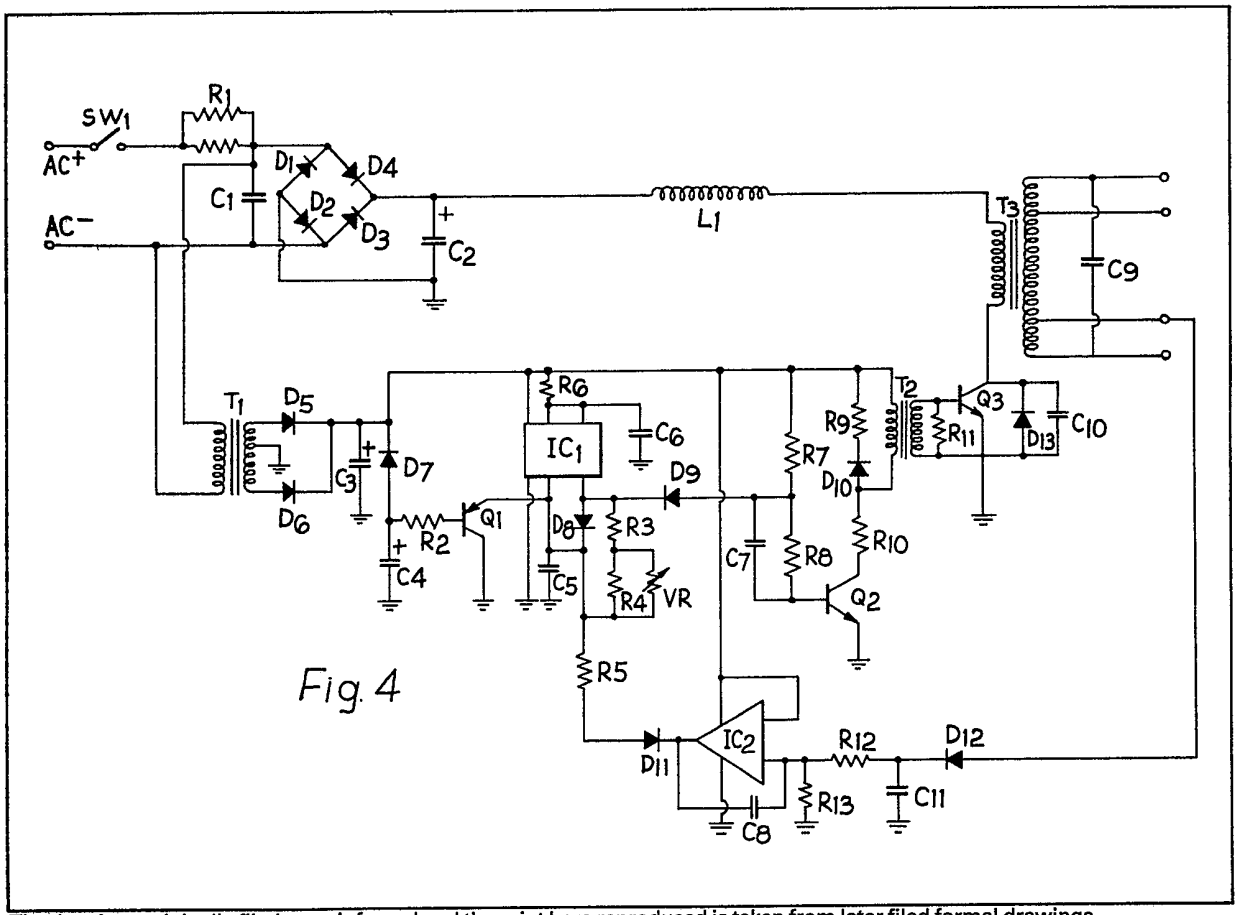

Fig. 4

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The drawings originally filed were informal and the print here reproduced is taken from later filed formal drawings.

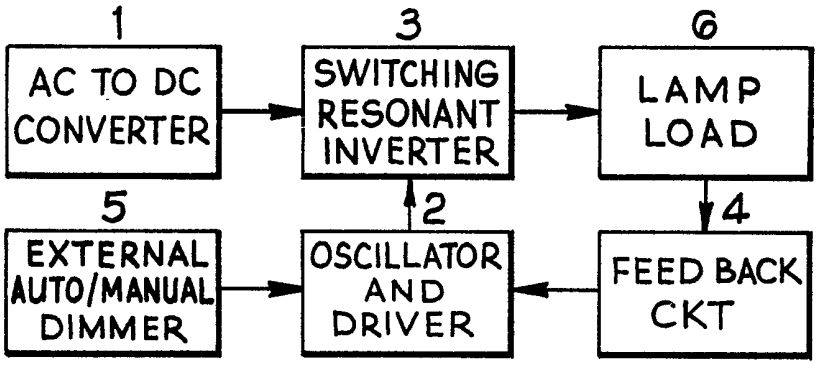

Fig. 1

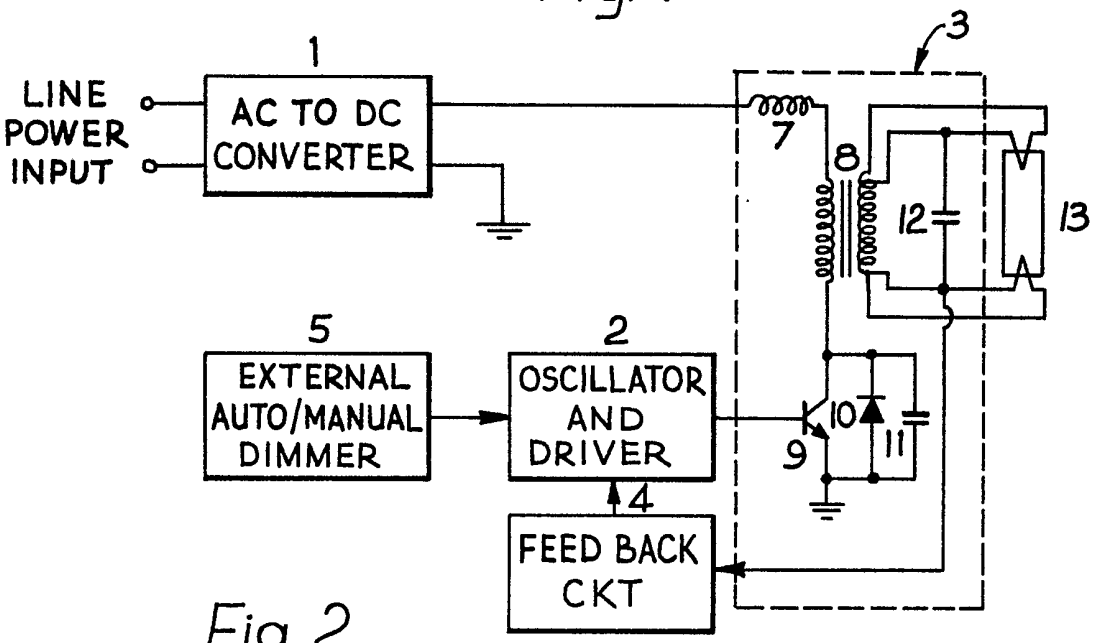

Fig. 2

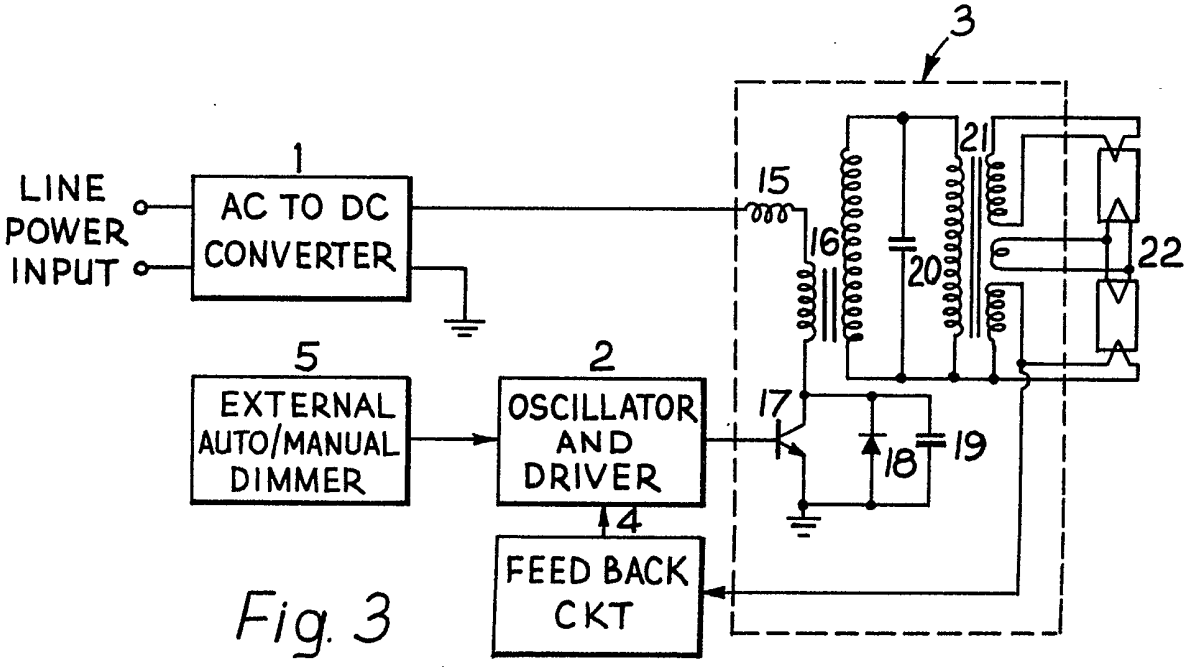

Fig. 3

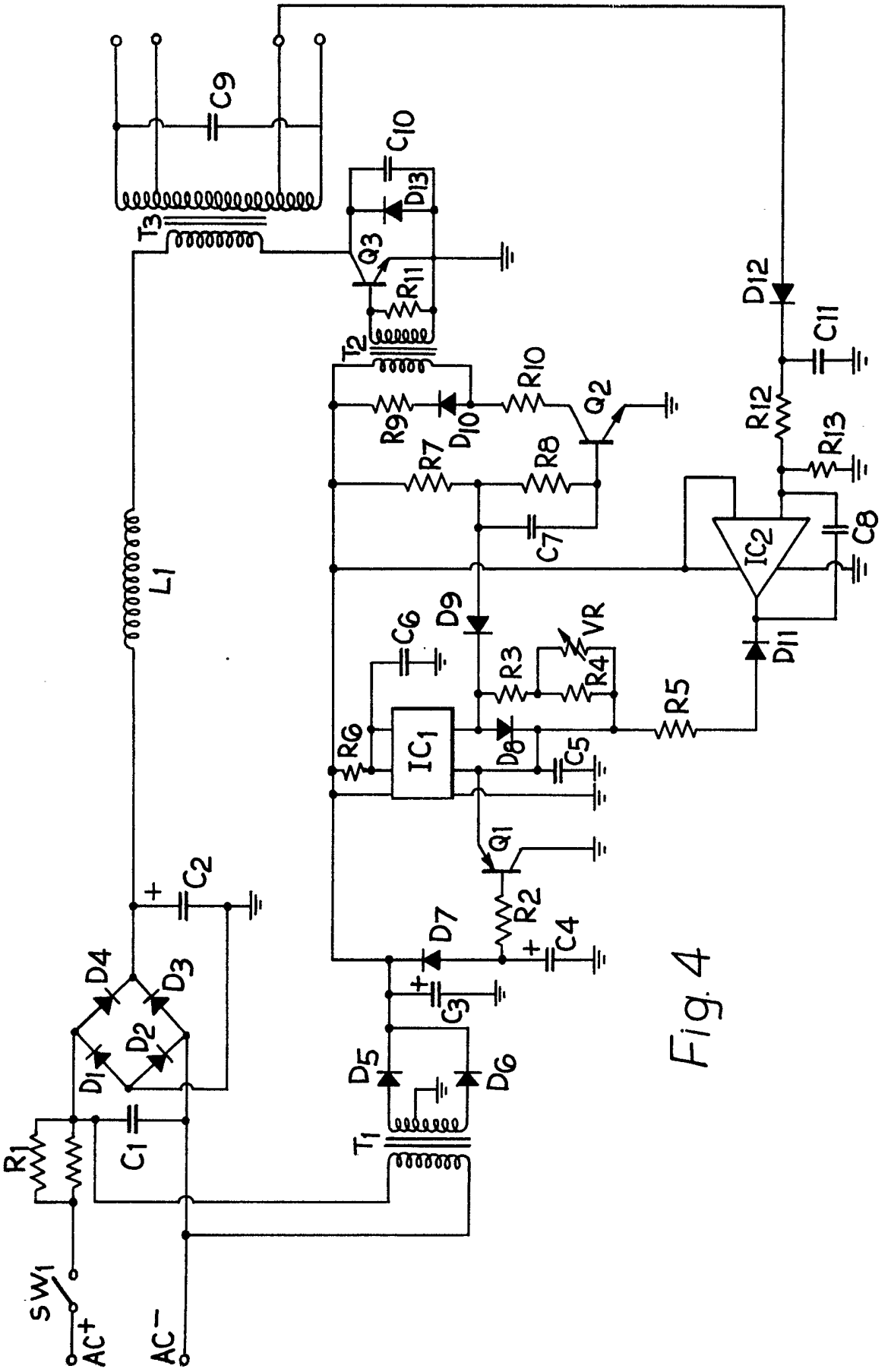
C9
C10
D13
T3
Q3
R11
T2
D12
C11
R10
Q2
R9
D10
R7
R8
R12
R13
C7
IC2
C8
L1
D9
C6
VR
R3
R4
R5
D11
R6
IC1
D8
C5
Q1
C2
R2
D7
C4
C3
D4
D3
D2
D1
D5
D6
T1
R1
C1
SW1
AC+
AC−

Fig. 4

SPECIFICATION

Electronic ballast for gas discharge lamps and fluorescent lamps

This invention concerns electronic ballast for gas discharge lamps and fluorescent lamps.

For many years, gas discharge fluorescent lamps have replaced conventional incandescent lamps in many applications. The gas discharge lamp and fluorescent lamp have a negative resistence characteristic once the lamp is ignited. This means the said lamps need a current limiting ballast. Conventional ballast used core coil inductor or transformer which is relatively heavy, and energy inefficient as compared with electronic ballast. Moreover conventional core coil type ballast operates in the audible frequency range, which is undesirable due to accompanying noise and disturbance annoying to the consumer.

Contrastly, electronic ballast normally operates at relatively high frequency, such as 20 KHZ to 50 KHZ for example, which is above the audible frequency range and relatively free from undesired noise. Also operating at such relatively high frequency may be constructed smaller, and energy efficient as compared with the conventional core coil type ballast. Moreover light flicker of no more than 2% is easily obtained by the present invention, as compared with 35% - 40% for the conventional core coil type ballast.

This invention provides an electronic ballast for a gas discharge lamp or fluorescent lamp, comprising a source of DC voltage.

a switching resonant inverter connected to receive DC voltage from said source, which comprises an inductor, a transformer, two capacitors, a transistor, a diode and inclusive the lamp load,

an oscillator and driver connected to switching resonant inverter which generates the operating frequency, and controls light output of the lamp load through varying the ON/OFF duty cycle of the said transistor,

a feed back circuit connected to oscillator and driver which senses the transformer output voltage and then varys the output duty cycle of the said oscillator and driver, and

an external Auto/manual dimmer added and connected to oscillator and driver and using manual control means or photo sensor type auto-control means to adjust the light lumen output

This invention provides an electronic solid-state ballast, which operates standend or energy efficient fluorescent lamp, which use 25% - 30% less power than the conventional core coil type ballast while providing the same visible light output. Moreover this electronic ballast provides a virtually flicker-free light output, audible noise-free, and can dim the lamp lumen output easily.

The invention will be described further, by way of example, with reference to the accompanying drawings in which:-

Figure 1 is an electrical block diagram of the inventive electronic ballase;

Figure 2 is an electrical block diagram with detail circuitry of switching resonant inverter for single lamp of Figure 1;

Figure 3 is an electrical block diagram with detail circuitry of switching resonant inverter for multi-lamp of Figure 1; and

Figure 4 is a detailed schematic diagram of this invention.

The AC to DC converter 1 converts the line input AC voltage to DC voltage. This DC voltage contains very small ripple voltage. This can provide virtually flicker-free light output. This converter also contains a fuse which can prevent catastrophe.

The oscillator and driver 2 provides a high frequency to drive the transistor 9 ON-OFF. Changing its ON-OFF duty cycle can do the dimming control.

The switching resonant inverter 3 includes lamp load 6 to be controlled by the said oscillator and driver 2, its function is inverting the DC voltage which from said AC to DC converter 1, to a constant amplitude high frequency current. The frequency is generated by the said oscillator and driver 2, to flow through the lamp load 6.

The feed back circuit 4 senses the transformer output voltage and then feeds back to the oscillator and driver 2 to vary the ON-OFF duty cycle. The main function of this ckt is to protect the transistor from being damaged if the switching resonant inverter is in wrong condition.

Refer to the Figure 2, an inductor 7, a transformer 8, a transistor 9, a diode 10, two capacitors 11, 12 and a lamp load 13(6), which are constructed as a switching resonant inverter. The advantages of this construction are getting relatively more sinusoidal-like output waveform, which will reduce third harmonic distortion and then reduce the radio frequency interference. Moreover the sinusoidal-like output can make the life of lamp bulb longer than the non-sinusoidal-like output of other types of electronic ballast.

Refer to the Figure 3, an inductor 15, two transformers 16, 21, a transistor 17, a diode 18, two capacitors 19, 20 and a lamp load 22(6). These parts are constructed as a switching resonant inverter. The advantages of this construction, First is getting relatively more sinusoidal-like output waveform which can reduce, third harmonic distortion and then reduce the radio frequency interference. Moreover the sinusoidal-like output can make the life of a lamp bulb longer than the non-sinusoidal-like output of the other electronic ballasts. Second is this construction can drive one or multi-fluorescent lamp if increases the numbers of secondary windings of transformer 18.

In Figure 4, R_1 can be used as a fuse or opens to prevent burning from over heat when Q_3 or rectifier circuit shorts. C_1 inhibits instantaneous pulse voltage of AC external power source. D_1, D2, D_3 and D_4 are bridge rectifier, and C_2, L_1 are designed for wave filtration. T_1 is input transformer, D_5, D_6, D_3 are designed for full wave rectification and provide oscillatory circuit with DC power source. IC_1 is square wave oscillatory circuit, R_6, C_6 may affect the time of square wave HIGH, D_8, C_5, R_3, R_4, and VR may adjust the time of square wave LOW. D_9 uses the square wave generated by IC_1 as the signal of Q_2 INPUT through R_8 limiting current, C_7 may accelerate the time of Q_2 OFF. R_7, R_8 provides Q_2 with bias. R_{10}

limits Q_2 Collector current 1_c to be not too large, T_2 primary coil PR1 per se will also be a coupling signal to push Q_3 when Q_2 is loaded. R_{11} controls Q_3 BASE 1_B at a suitable value, R_9, D_{10} inhibit the instantaneous pulse of T_2 PR1 TURN OFF. As a wave form shaping circuit, D_{13}, C_{10}, T_3 PR1 are in combination with Q_3 ON/OFF SWITCH to achieve an approximate half-sinusoidal wave at Q_3-C and to transmit the sinusoidal wave voltage to lamp tube load through T_3, C_9 coupling and shaping. IC_2 is an integrated circuit consisting of OP AMP and C_8 wherein the third terminal is connected to V_{cc} as a reference voltage, T_3 secondary coil output terminal is connected to D_{12}, C_{11} rectifying wave filter, and through R_{12}, R_{13} voltage divider, the said voltage is put in the INVERTER of OP AMP so as to change the output terminal voltage which decides the volume of IC_1 current divider R_5, D_{11} and therefore changes the time of LOW thereof. Q_1, R_2, C_4, D_7 are SOFT START circuit, take advantage of C_4 instantaneous short action to make instantaneous conductance volume large, affect the time of IC_1 LOW so as to achieve the delay of instantaneous output, and protect the life of lamp tube and Q_3 instantaneous impact.

CLAIMS

1. An electronic ballast for a gas discharge lamp of fluorescent lamp, comprising a source of DC voltage,

a switching resonant inverter connected to receive DC voltage from said source, which comprises an inductor, a transformer, two capacitors, a transistor, a diode and inclusive the lamp load,

an oscillator and driver connected to switching resonant inverter which generates the operating frequency, and controls light output of the lamp load through varying the ON/OFF duty cycle of the said transistor,

a feed back circuit connected to oscillator and driver which the transformer output voltage and then varys the output duty cycle of the said oscillator and driver, and

an external Auto/manual dimmer added and connected to oscillator and driver and using manual control means or photo sensor type auto-control means to adjust the light lumen output.

2. An electronic ballast for one or multi fluorescent lamp as claimed in claim 1, comprising a source of DC voltage,

a switching resonant inverter is connected to receive DC voltage from said source which inverter comprises an inductor, two transformers, two capacitors, a transistor, a diode and a lamp load;

an oscillator and driver connected to the said switching resonant inverter to generate operating frequency, and control light lumen output of the lamp load through varying the ON/OFF duty cycle of the said transistor;

a feed back ckt connected to the said oscillator and driver to sense the transformer output voltage and then vary the output duty cycle of the said oscillator and driver;

an external Auto/manual dimmer added and connected to the said oscillator and driver, which dimmer uses manual control means or photo-sensor type auto control means to adjust the light lumen output.

3. An electronic ballast for a gas discharge lamp or a fluorescent lamp substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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