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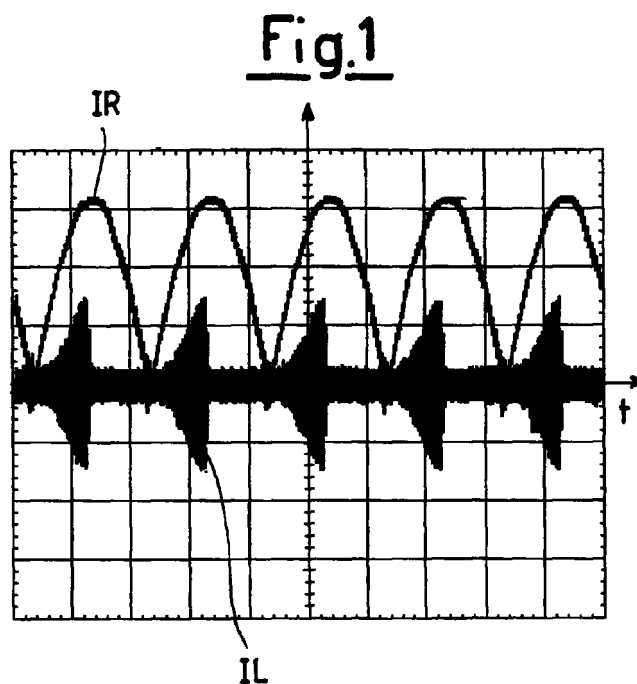
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(54) **Automatic lighting intensity regulating device**

(57) An automatic lighting intensity regulating device or "dimmer" (DM), utilizable in particular for electronic reactors of fluorescent tubes, controlled by an electronic circuit for the partial closing of the conduction angle, in order to supply a lamp current (IL), for each cycle of the rectified network signal (IR), only for a certain amount of time, so as to minimize the production and operating costs of the device (DM), with respect to those now offered on the market.



## Description

**[0001]** This invention refers to an automatic lighting intensity regulating device, in particular for electronic reactors of fluorescent tubes.

**[0002]** It is known that the fluorescent tubes have most of their emitted light produced by a fluorescent substance coating the tube.

**[0003]** Moreover, these tubes exhibit a typical negative voltage/current ratio and would therefore, in the absence of any other devices, increase their current flow after lighting, to a point leading to their destruction; it is therefore essential to provide a feeding device, which is normally constituted by an electronic reactor, capable of limiting the current and power of the lamp in accordance with the design data furnished by their manufacturers, of supplying the proper current intensity to preheat the cathodes of the tube and the proper voltage to prime the discharge.

**[0004]** The lighting intensity regulating devices for the reactor of the fluorescent tubes are controlled by electronic circuits, which carry a notoriously high cost, due the relative complexity of their components, the relative length of the wiring between feeder and lamp, and the need for observing the regulations bearing on their electromagnetic compatibility and current harmonics; moreover, the electronic reactors available on the market suffer from additional problems connected to high frequency dispersion currents.

**[0005]** The purpose of this invention is to produce an automatic lighting intensity regulating device, capable of implementing all the controlling functions of a regulator, by providing a rather essential architecture and aiming to minimize the circuits' costs and encumbrance with respect to those of the known art, based on the available advantages.

**[0006]** Another purpose of this invention is to offer an automatic lighting intensity regulating device of a particular efficiency, capable, in particular, of ensuring the observance of the current regulations in the matter.

**[0007]** These and other purposes are achieved by an automatic lighting intensity regulating device, in particular for the electronic reactors of fluorescent tubes, according to claim 1, which is being referred to for brevity.

**[0008]** In an advantageous manner, the plan is to produce a controlling circuit for the lighting intensity regulating device ("dimmer") for the electronic reactors ("ballast") of fluorescent tubes, based on a partial closing of the conduction angle; this means that within each cycle of the 50 Hz rectified current signal, the lamp current is supplied only for a certain amount of time.

**[0009]** The system is implemented by using a light detector ("phototransistor"), which takes care of monitoring the ambient light; after appropriate filtration, the signal is then sent to a circuit comparing it with a previously set-up value, which activates a synchronized timer, by using a tooth-shaped signal, with the 50 Hz

rectified network current signal.

**[0010]** The tube is switched on and off by varying the operating frequency of a half bridge circuit, from a low frequency value switching-on value of the tube to a high frequency switching off value; the action of the control circuit is therefore to activate or deactivate a capacitance element set in parallel with the outlet of the oscillator, and to divide the compensating reaction. This additional signal is conveyed to a controlling section of the oscillator, by slightly raising its frequency so as to inject a time lag in its priming process.

**[0011]** Further purposes and advantages of this invention will become clear from the following description and attached drawings, furnished for purely exemplifying and non limiting purposes, in which:

- Figure 1 represents a cartesian graph, which illustrates the time flow of a rectified feed current signal with an associated lamp current signal, according to the invention;
- Figure 2 illustrates a first section, relating to the detection of light, of an electronic control circuit of a lighting intensity regulating device, in particular for fluorescent tubes, according to the invention;
- Figure 3 illustrates a second section, relating to the generation and synchronization of the control signal, of the electronic control signal of the foregoing figure, according to the invention;
- Figure 4 depicts a cartesian graph showing the time flow of three outlet signals of the electronic circuit of Figure 2, according to this invention;
- Figure 5 outlines a cartesian graph showing the time flow of three additional outlet signals of the electronic circuit of Figure 2, according to this invention.

**[0012]** With reference to the mentioned figures, the electronic control circuit of the automatic lighting intensity regulator for the electronic reactors of fluorescent tubes, according to this invention and as illustrated in the Figures 2 and 3, is based on the partial closing of the conduction angle, so that within each cycle of the 50 Hz rectified feed current signal, generically identified by IR in Figure 1, the lamp current, indicated by IL in the same Figure 1, is only supplied for a certain amount of time.

**[0013]** This is achieved by using two sections of an electronic circuit, one relating to the detection of light, and the other to the generation and synchronization of a control signal.

**[0014]** In particular, Figure 2 shows the section of an electronic circuit referring to the detection of light based on an phototransistor FT.

**[0015]** In a preferred and exemplifying yet non-limiting embodiment, the phototransistor FT consists of the phototransistor NPN based on the Siemens SFH309 Silicon unit, which offers high efficiency at limited cost. In particular, this phototransistor FT offers an operating

temperature range from -55°C to + 100°C, a vacuum collector-emitter voltage of 35 volt, a collector current of 15 mA, a collector peak current of 75 mA, a power dissipation of 165 mW at a temperature of 25 degrees centigrade, and a thermal resistance of 450 K/W.

**[0016]** The wave length interval covered varies from 380 to 1,150 nm, on a radiation sensitive area of about 0.045 mm<sup>2</sup> and with respect to a subtended angle of ± 12 sexagesimal degrees.

**[0017]** The phototransistor FT is connected to a J4 terminal, with the emitter turned toward the resistor R51 and the collector connected to the diode D10, so as to be able to monitor the ambient light. In the presence of light the phototransistor FT generates a current signal IE causing the VE potential on the emitter outlet to rise up to a value equal to the product between the outlet current IE and the resistor R51.

**[0018]** The appropriately filtered signal is then conveyed to a circuit that compares it with a previously set-up value and activates a timer, by using a toothed signal, which is synchronized with the IR current signal.

**[0019]** In effect, whenever the outlet signal from the IC3A "buffer" is such as to commute the second IC3B comparator, the MOSFET Q17A transistor is activated; the IC3B comparator device is a hysteresis comparator, whose commuting thresholds are 3.2 and 2 volts, respectively, while the Q17A activates the voltage divider formed by the resistors R20 and R21, which have up to that point acted to keep the non-inverting inlet of the IC2B comparator at a high level.

**[0020]** The activation of the MOSFET Q17A brings the inlet of the IC2B comparator up to a pre-set value of about 4 volt (P-signal at the divider outlet of the resistors R20-R21), whose intercept with the toothed IS outlet signal from the circuit R25, C21 generates, at the outlet of the IC2B, a 100 Hz ID digital signal with a "duty cycle" of 70%.

**[0021]** Under these conditions, the consumption of the circuit passes, for a 100 Watt reactor, from 100 Watt to about 70 Watt.

**[0022]** The R25 resistor works as a current generator and charges the condenser C21, which is periodically discharged by the comparator device IC2A that behaves like a diode with an outlet when the collector is open. The outgoing signal from the electronic circuit section, which is shown in Figure 2 and constituted of the ID outlet of the comparator IC2B, is at a high level when the fluorescent tube lamp is switched on, but at a low level whenever the IS toothed signal exceeds the P signal value pre-set with the aid of the divider R20-R21, as clearly shown in Figure 4; this brings the operating frequency of the oscillator to such a high level as to switch off the lamp.

**[0023]** The operations of switching the fluorescent tube on and off are therefore performed by varying the operating frequency of the half bridge Q1, Q2. The action of the control circuit is to activate and deactivate the condenser C17 set in parallel to the oscillator

formed by the R1+P1 and C7 elements, and to divide the compensating reaction by using R61, R62 and Q7A.

**[0024]** The PR signal operating under continuous current, which pilots the MOSFET Q17A transistor, is in fact also conveyed to the control section of the Q7A oscillator, as shown in Figure 3, while slightly increasing its frequency to insert a time lag into the priming process. The PR signal is in effect used to control the MOSFET Q7A transistor, while dividing, by the R61 and R62, the reaction provided by the transistors Q14 and Q15, and while correcting, by the R3, the protective circuit depending on the operating conditions caused by the action of the lighting intensity regulator or dimmer DM.

**[0025]** The PR1 signal is introduced to cause the control circuit, as soon as switched on, to start and keep the tube lamp lit throughout the period, so as to allow a proper preheating and priming of the fluorescent tubes. About one second after the end of the preheating phase, when the PR1 signal is commuted toward a logic zero, the C37 is charged and the IC3B comparator's inverting inlet moves from a feeding value to a value depending on the resistors R55, R28, thus allowing the control circuit, if the lighting conditions are favorable, to jump into action.

**[0026]** In order to synchronize the outlet of the IC2B comparator with the signal relating to the 50 Hz network voltage, as indicated by the letters RT in Figure 5, a portion of an electronic circuit is set-up so as to detect the passing of the RT network voltage through the zero point; the diodes D13, D14, D3, D4 are in fact constituting a bridge, which is charged by the divider formed by the resistors R4+R5, R38. The resistor R38 controls the feed RT by using the diode 15, and serves the double function of feeding the IC1 switching-on process by using the resistors R4 and R5 and limiting the voltage on the R38 resistor to a value such as to match the feed current plus a D15 diode threshold value of about 0.7 volt.

**[0027]** The IC2A comparator device compares the signal which flows in the R38 resistor with a reference signal proportional to the divider of the resistors R34, R35, forcing its own outlet down to a low level whenever the signal on the R38 resistor drops below a preset value constituted by the passing of the RT feed signal through the zero point, as clearly illustrated in Figure 5.

**[0028]** The outlet of the IC2A comparator (configured as an "open collector") therefore starts to discharge the condenser C21, thus synchronizing the IS toothed signal with the 50 Hz RT network signal.

**[0029]** In conclusion, the switching off of the fluorescent tube is achieved by raising the operating frequency of the IC1 unit, with the aid of the MOSFET Q7A transistor, by using a continuous signal and causing a time lag in the priming process, by dividing the reaction network of the transistors Q14, Q15, and by using the MOSFET Q6A transistor with a 100 Hz signal and a pre-set duty cycle designed to switch the condenser C17 on and off.

**[0030]** Whenever the tube is switched on, the cathodes' preheating phase is implemented by keeping the Q6A transistor activated and inserting the C8 condenser in series with the C7 condenser; at the end of the preheating phase, the C8 condenser is short-circuited by the transistor Q12, which allows operating at a frequency value fairly close to a priming frequency, and therefore at a higher preheating value. The use of three different frequency levels allows in practice to attain a priming, preheating and switching off condition of the DM dimmer.

**[0031]** The above description clarifies the characteristics of the automatic lighting intensity regulating device, in particular for the electronic reactors of fluorescent tubes as an object of this invention, just as it clarifies its advantages, which consist in particular in a substantial reduction of the manufacturing and operating costs with respect to those of the known art, as a result of the advantages secured in this manner, combined with a reduction in the number of components used, and therefore in a lesser encumbrance with respect to that of the traditional regulating devices.

**[0032]** It is finally obvious that numerous other variants may be applied to the automatic lighting intensity regulating device for fluorescent tubes as an object of this invention, without thereby abandoning the principles of novelty inherent in the inventive idea, just as it is evident that in the practical implementation of the invention, the materials, shapes and sizes of the details shown may be of any kind, depending on the requirements, and that the same may be replaced by others of an equivalent type.

## Claims

1. An automatic lighting intensity regulating device, utilizable in particular for the electronic reactors of fluorescent tubes, characterized in that it is controlled by an electronic circuit, whose operation is based on at least one partial closing process of the conduction angle, so that within each IR feeding signal cycle, a current signal (IL) is supplied to said tube for a predetermined period of time, which is in any case at least half a period shorter than the wave shape of said IR feeding signal.
2. An automatic regulating device (DM) according to claim 1, characterized in that said (IR) feeding signal is constituted of a network frequency current signal having an essentially sinusoidal or rectified wave shape.
3. An automatic regulating device (DM) according to claim 2, characterized in that said electronic circuit comprises at least one light detecting or phototransistor device (FT) that monitors the ambient light and issues an outlet signal (VE, IE) which, after filtration, is conveyed to a portion of the circuit

designed to compare it with pre-set value P, so as to actuate a timing device synchronized with the (IR) current signal having a rectified wave form, by using a toothed signal (IS).

4. An automatic regulating device (DM) according to claim 1, characterized in that said fluorescent tube is switched on and off by varying at least one operating frequency of a half-bridge circuit, while activating and de-activating a capacitance element (C21) set in parallel with an oscillating circuit (R20, R21, C20), and by dividing a compensating reaction signal (PR), where said reaction signal (PR) is sent to a control section of said oscillator (R20, R21, C20) by slightly increasing its frequency in order to introduce a priming time lag.
5. An automatic regulating device (DM) according to claim 1, characterized in that said electronic control circuit comprises a section for the detection of light and a section for generating and synchronizing a control signal, capable of jumping into action under favorable lighting conditions.
6. An automatic regulating device (DM) according to claim 4, characterized in that it provides for a further signal (PR1), capable of keeping said lamp lit throughout the switched on period of said electronic control circuit, and of allowing some proper preheating and priming phases.
7. An automatic regulating device (DM) according to claim 6, characterized in that it provides for at least three different frequency values of at least one signal, corresponding to the priming, preheating and switching-off phases, respectively, of said regulating device (DM).

Fig.1

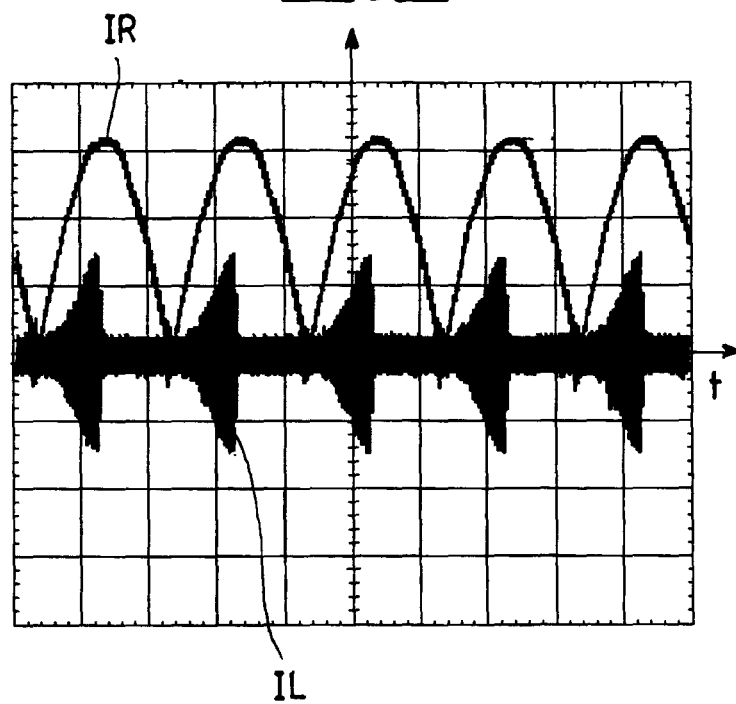
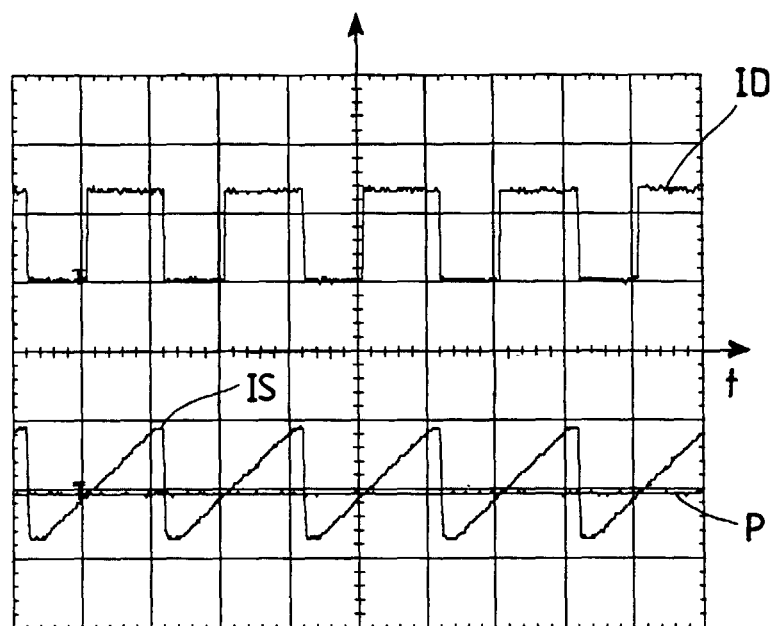


Fig.4



**Fig. 2**

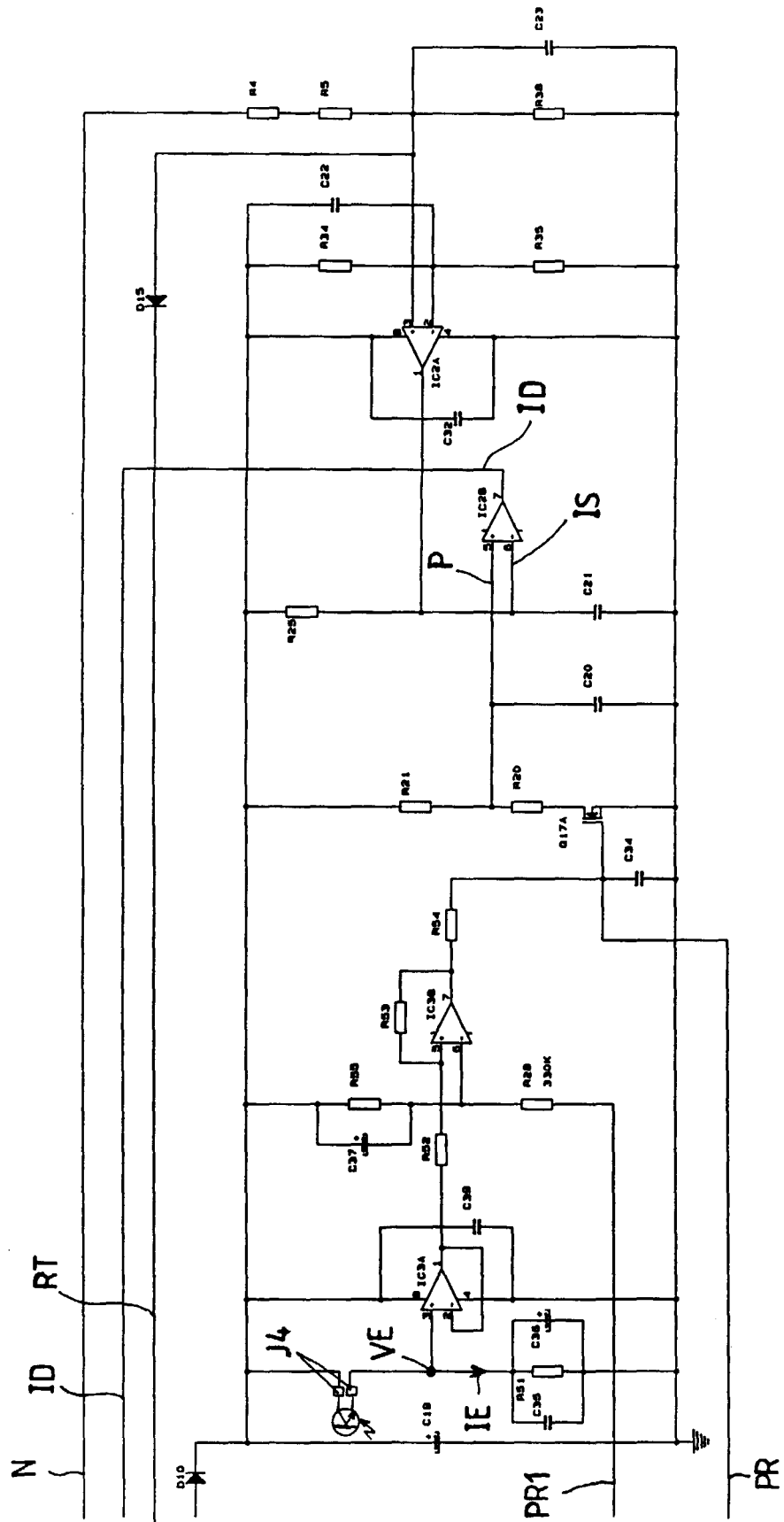


Fig. 3

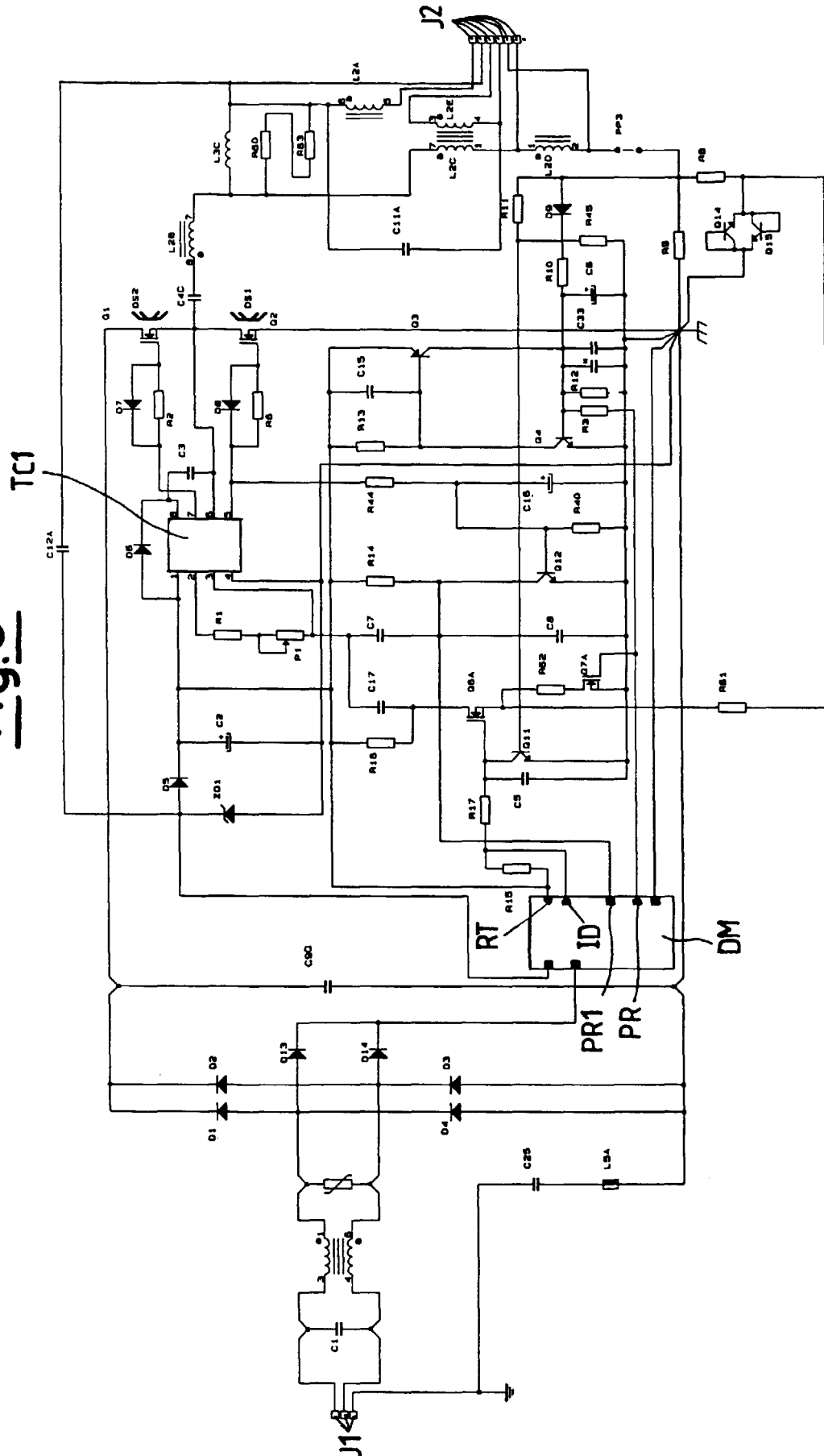


Fig.5

