(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 December 2012 (06.12.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/164588 A1

(51) International Patent Classification:
H05B 41/18 (2006.01) *H05B 41/04* (2006.01)

(21) International Application Number:
PCT/IT2011/000182

(22) International Filing Date:
31 May 2011 (31.05.2011)

(25) Filing Language: Italian

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **GIACOMO SRL** [IT/IT]; Via Lorenzo il Magnifico, 35, I-00162 - ROMA (RM) (IT).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **CARLUCCI, Giacomo** [IT/IT]; Via S. Francesco, 41, I-85024 LAVELLO (PZ) (IT).

(74) Agent: **SARPI, Maurizio and FEZZARDI, Antonio**; STUDIO FERRARIO, Via Collina, 36, I-00187 - Rome (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

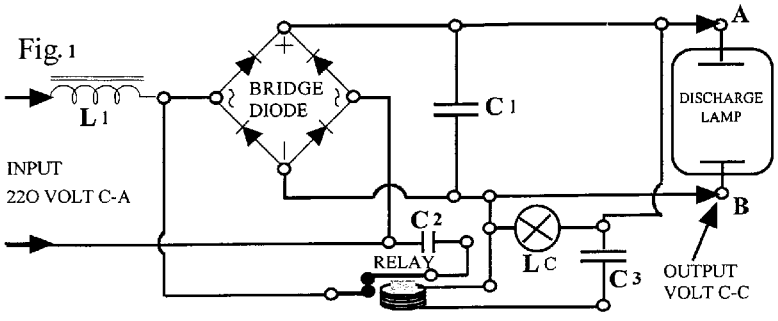
Published:

— *with international search report (Art. 21(3))*

WO 2012/164588 A1

(54) Title: HIGH-EFFICIENCY ELECTRONIC DEVICE FOR TURNING ON AND POWER SUPPLYING OF LAMPS

Fig. 1



(57) Abstract: An high-efficiency electronic device for turning on and power supplying of lamps, is provided with a circuit comprising a diode bridge rectifier, or Graetz bridge, AC powered preferably by stabilizing inductor (LI), wherein at DC output poles of said rectifier bridge are connected in parallel, respectively: a first capacitor (CI), a load constituted by one or more DC powerable lamps connected to the output pole (A, B) of the circuit, in turn connected together in series and/or in parallel, a second capacitor (C2) placed in series with a relay switch, which, in their entirety, are connected in parallel to the bridge rectifier input, wherein the winding of said relay is connected in series to a third capacitor (C3); said winding and said third capacitor (C3) being connected in parallel, in their entirety, to the bridge rectifier output.

HIGH-EFFICIENCY ELECTRONIC DEVICE FOR TURNING ON AND POWER SUPPLYING OF LAMPS

*****

The present invention relates to the lighting industry, and in particular to an novel turning on and power supplying device for fluorescent lamps, to be used as a replacement of the current starter and reactor used for such lamps.

The neon lamp is a type of discharge lamp constituted by a transparent glass bulb containing neon gas at low pressure.

Generally speaking, the fluorescent lamps, used for lighting homes and offices, are erroneously referred to as "fluorescent lights". Unlike the former, however, the properly called neon lamps emit a low intensity orange light and are used more for signaling than lighting purposes.

The fluorescent lamp is a particular type of discharge lamp in which the visible light emission is indirect, i.e. it's not directly emitted by the ionized gas, but from a fluorescent material (hence the name).

As mentioned above, this type of lamps are erroneously called neon lamps or neon tubes, but they do not always contain neon and in fact their functioning is mainly due to the presence of mercury vapor and fluorescent materials, and not to neon.

A fluorescent lamp is constituted by a glass tube, which can be linear, circular or variously shaped (in particular CFL lamps, Compact Fluorescent Lamp, which have the tube shaped so as to have a reduced size and typically they integrate the power supply electronics

and are equipped with E27 base) inside which the vacuum is first applied, then a noble gas (argon, xenon, neon, or krypton) at a low pressure and a small amount of liquid mercury, which evaporates in part mixing itself with the noble gas, are introduced. The inner surface of the tube is coated with a fluorescent material, which has the appearance of a white powder. At the two ends of the tube, there are two electrodes.

The electrons moving between the two electrodes excite the mercury atoms comprised in the gas, energizing them so that they emit an ultraviolet radiation. The fluorescent material with which the tube is covered, hit by such radiation, in turn emits visible light. Since visible light has a frequency and therefore an energy lower than the ultraviolet light, the transformation produced by the fluorescent material results in an inevitable energy loss, in the form of heat, which causes the heating of the tube. A different composition of the fluorescent material allows to produce a warmer or colder light.

The electrodes of a fluorescent tube, as opposed to an incandescent lamp cannot be directly connected to the mains because, due to its typical power-current, the lamp must be powered in current limitation. For this reason, the lamp is placed in series with a device capable of limiting the current, usually an inductor, commonly referred to as reactor, which in addition allows to generate an overvoltage that facilitates the triggering, or in very rare cases a resistor is used. There are two categories of power supplies: electromagnetic, which require the use of the so-called

starter, and electronic, which make the starter unnecessary.

Fluorescent lamps have a life expectancy greater than incandescent lamps, but their duration may be strongly affected by the number of turning on and off, unless you use an electronic drive: each of these operations, indeed, reduces the lamp life, due to the wear experienced by the electrodes. The value provided by the manufacturers is generally calculated with turning on cycles of 8 hours, ranging from 12-15000 hours of tube lamps to 5-6000 hours of compact lamps.

The electronic drive, however, due to cathodes (electrodes) preheating, prevents them from damage allowing a virtually infinite number of starts (over 60000) and the precision of the control extends their lives of at least 10000 hours. Unlike incandescent lamps, these lamps have a slight loss in the amount of light flow emitted over time, furthermore the older models (usually without preheating) of compact lamps usually take a few minutes to reach the maximum possible emission after the turning on.

The so-called starter or igniter in the lighting technology field is a device typically used in discharge lamps in order to start the operation.

This device causes the heating of the lamp electrodes to a temperature of about 1200-1300° K, thus initiating the process of gas ionization. Therefore, this results in the discharge which then allows the complete ionization of the gas and the steady operation of the lamp.

The starter must be properly calibrated to achieve

a quicker and stronger turning on. This component, even though within certain limits, however, has the ability to adapt to discharge lamps of different power.

It must be underlined that the currently known starters are not able to ensure a rapid turning on of the fluorescent lamp over time, and with the passing of time, their operating characteristics deteriorate, until the lamp fails to start and it is necessary to replace them.

In addition, with current starters the turning on of the lamp is not as immediate as that of incandescent lamps, and in many cases it is necessary to wait a few minutes to have the maximum brightness from the lamp.

Also, when a fluorescent lamp begins to "run out", i.e., when its operating characteristics deteriorate, it must be replaced because the currently known starters are not able to switch it on.

Considering the above mentioned, it is clear that now there is a need to contemplate, for each fluorescent lamp, a respective starter and a respective "reactor".

A first object of the present invention is to provide a single electronic device for turning on and power supplying for both traditional fluorescent (T8/T5) and cold cathode (ANTROX or similar) lamps, which achieves the integrated dual function of igniter and power supply, without the need of involving the use of starters and/or reactors.

A second object of the invention is to provide an electronic device which achieves an immediate turning on of the lamp without any latency period.

A third object is to provide an electronic device which acts as an igniter and power supply, which is installable also at a great distance from the lamp (100 meters) to be turned on/powered.

A fourth object is to provide an electronic device which allows a reduction of the electromagnetic emissions even higher than 90%.

A fifth object is to provide an electronic device which guarantees the absence of "flickering", i.e. the flicker or shimmer of the light emitted from the lamp.

A sixth object is to provide an electronic device which, with the same light output, is able to reduce the energy consumption by 40% or more.

A seventh object is to provide an electronic device which allows to have low replacement and/or installation costs.

An eighth object is to provide an electronic device which is installable on all types of fluorescent lamps on the market.

A ninth object is to provide an electronic device capable of simultaneously power supplying more lamps, even of different types.

A tenth object is to provide an electronic device capable of adjusting, in direct current, the intensity of the light emitted by the lamps to which it is connected.

These and other objects have been achieved, according to the invention, by providing an electronic device with a circuit comprising a diode bridge rectifier (Graetz bridge) powered in A.C., for example at 220 volts, preferably through a stabilizing

inductor, wherein at DC output poles of said rectifier bridge are respectively connected in parallel: a first capacitor, an optional bulb control, a load constituted by one or more lamps of any type powerable in D.C., in their turn connected in series or in parallel, a second capacitor place in series with a relay switch, which, in their entirety, are connected in parallel to the bridge rectifier, wherein the winding of that relay is connected in series with a third capacitor, which, in their entirety, are parallel to the bridge rectifier output.

A better understanding of the invention will be possible with the following description and with reference to the attached figures, which illustrate, by way of example and not limitation, some preferred embodiments of the invention.

In the drawings:

Fig. 1 schematically shows a first embodiment of the invention;

Figs. 2, 3 and 4 are circuit diagrams related to a second, third and fourth embodiment of the invention, respectively;

Figs. from 5 to 8, similar to Figs. 1-4 respectively, are related to variations for powering the lamps with or without liquid mercury;

Figs from 9 to13 are circuit diagrams of further variations of the second, third and fourth embodiment, provided with means of adjusting the light intensity;

Figs from 14 to19, similar to the previous Figs. 9-13, show said variations with brightness adjustment applied to cold cathode lamps.

Figs 20-21, relate to a fifth simplified embodiment and a variant thereof, particularly suitable for powering one or more lamps each of which has limited power, respectively.

With reference to Fig. 1, according to a first embodiment of the present invention an electronic igniter constituted essentially of a circuit capable of being connected in parallel to one or more lighting lamp, connectable in series and/or in parallel, is contemplated comprising, in combination:

- a bridge diode rectifier (Graetz bridge) adapted to be connected to an alternating current power supply (AC);
- at least one capacitor C1 connected in parallel to the direct current (DC) output of the bridge rectifier;
- a second capacitor C2 placed in series with a relay switch, which are then connected, in their entirety, in parallel to the AC input of the rectifier bridge;
- the winding of said relay is connected in series with a third capacitor C3 and together are placed in parallel to DC output of the rectifier bridge;
- at least an inductor L1 placed at a first AC input pole of the bridge or the positive branch of DC output of the bridge rectifier output DC, having also the purpose of reducing energy consumption;
- an optional LC control light bulb, adapted to discharge the capacitor C3 when the power is

off, as well as to ensure that there is a DC voltage output of the rectifier bridge.

According to a distinctive feature of the invention, said second capacitor C2 in series with said relay serves to give the initial discharge that turns the lamp on without the use of a starter or reactor.

A further distinctive feature of the invention, consist in the fact that by varying the values of C1 and L1 it is possible to vary the value of the brightness emitted by the lamp.

It is worth noting that, according to the invention, it is possible to turn on and power lamps of any kind: neon, fluorescent, incandescent, arc, etc..

A second embodiment of the invention, shown in Fig. 2, involves the replacement of the first capacitor C1 with two in-series capacitors C1a and C1b where the part of the circuit between them is connected to the second pole of the rectifier bridge AC input.

A third embodiment of the invention, shown in Fig. 3, involves the in series addition on the DC output positive branch of the bridge rectifier, downstream of the capacitor C1 or the pair C1a-C1b, of a second inductor L2.

A fourth embodiment of the invention, shown in Fig. 4, involves the in series addition on the DC output negative branch of the rectifier bridge, downstream of the capacitor C1b, of a third inductor L3 coupled to said second inductor L2 via a common gap; as well as the replacement of this LC control light bulb with a resistor R1, which is also intended to discharge the capacitor C3 when the device is turned off (i.e.

the power is off).

As already mentioned, the above-mentioned embodiments of the invention, can be used to light lamps of various types. In order to turn on and power lamps with or without liquid mercury, it is advisable to place between these lamps and the A and B output DC poles of the device described so far a CP polarity switch. In Figs from 5 to8 some variants of the four embodiments described above provided with said polarity switch and usable with said fluorescent lamps with or without liquid mercury, are shown. The polarity switch is also adapted to cause the lamp to warm uniformly.

Another distinctive feature of the present invention, consists in the fact that it provides the ability to adjust the brightness of the lamp(s) powered by the device itself.

For this purpose, between the two positive and negative output branches of the rectifier bridge, downstream of the capacitor C1b or of the pair of capacitors C1a, C1b, a transistor Tr1 is provided in series with a capacitor C4, the base of which is connected with a cursor to a resistor R2 connected in parallel with said transistors Tr1 and its capacitor C4 (Fig. 8).

Figs from 9 to 13 relate to other variants of the embodiments already described above with reference to Figs. from 2 to 4, but provided with said light intensity adjustment means now described.

Figs from 14 to 19, similar to the previous Figs 9-13, show said variations with brightness adjustment applied to cold cathode lamps, connected in series

between them.

Figs 20-21 relate to a fifth embodiment and a variant thereof, simplified compared to the previous ones, which is particularly suitable for powering one or more lamps each of which has limited power: For example, no more than 25W. Said variant of the fifth embodiment is characterized by the presence of the polarity switch.

As seen from the figures now mentioned, in this embodiment the relay switch is absent and the capacitor C2 is connected between the AC input of the rectifier bridge and the DC positive or negative output of the same.

In Figs 20 and 21 a normal switch for turning the device on and off is also shown.

It should be noted that, in this fifth embodiment, the capacitor C3 and its LC lamp or resistor R1 are entirely absent.

In all embodiments of the invention so far described, the presence of one or more reactors is also used to reduce energy consumption and to make the light output steadier.

It is interesting to note that the experimental tests have highlighted the potentiality and flexibility of the turning on and power supplying device of the lamps according to the invention described so far.

During such tests two systems of turning on and power supplying were compared on three types of lamps: 23 watt Edison base energy-saving fluorescent lamp; 18 watt T8 fluorescent lamp; and 18 watt ANTROX cold cathode fluorescent lamp.

Some of test results are reported below.

18 watt T8 fluorescent lamp power:

CONVENTIONAL SYSTEM		
TURNING ON	CONSUMPTION	ILLUMINANCE
3.5 sec.	300 mA x 62 V = 18.6 W.	23000 LUX at turning on 25000 LUX after 1 min.
NOVEL SYSTEM ACCORDING TO THE INVENTION		
TURNING ON	CONSUMPTION	ILLUMINANCE
almost instantaneous	190 mA x 56 V = 10.64 W.	26400 LUX

A subsequent test allowed to verify the possibility to turn on and power two T8 lamps in series, with a reduction in consumption.

An incendive test was performed also by connecting the novel turning on device with a 1x1,5 mm^2, 50 meters long cable with two lamps in series:

NOVEL SYSTEM ACCORDING TO THE INVENTION + 1X1,5 mm^2, 50 mt LONG CABLE 2 18 W T8 FLUORESCENT LAMPS CONNECTED IN SERIES		
TURNING ON	CONSUMPTION	ILLUMINANCE
almost instantaneous	110 mA x 139 V = 15.07 W.	33400 LUX

It should be noted that this result demonstrate the possibility of using the turning on and power supply devices according to the present invention to manage one or more lamps, even of different type and connected in series and/or in parallel, not installing them in the immediate vicinity of the lamps (i.e., for example, in the ceiling lights or pendants, as used nowadays) but at a distance, even a remarkable one.

This suggests the possibility of changes to existing installations and of revolutionizing the

current installation design. For example, with the invention it would be possible to install the device in a junction box to power more lights, even different from each other, and also change over time the number and/or the type of lamps without having to intervene on the device itself, which automatically adapts to the new power supply needs.

In light of this, it is reasonable to assume that the field of application of the invention may be the market for fluorescent lighting systems which is undoubtedly the one mostly spread worldwide. Industrial applications with T8 or T5 systems account for billion units installed worldwide: supermarkets, shopping malls, industries or areas covered by public services (airports, railway stations, subways). An installed base of hundreds of millions of pieces can be estimated only nationwide. In addition, energy-saving fluorescent lamps are replacing in domestic environment lighting any type of light source worldwide.

The target market of the system is divided into two distinct sections: the retrofitting of existing installations, and that of new installations.

The market for retrofitting or replacement of traditional systems of power supplying and turning on of existing lamps, for example in the case of T8 lamps, can generate substantial gains in the case of projects for Power Management.

The market for new installations allows to revolutionize installation design, allowing to mount the control systems of the lamps no longer on the ceiling lamps, but in a framework plan, which can be

managed easily and cost effectively.

The analysis of market penetration is extremely interesting, because of the easiness of the replacement on one hand and of the installation on the other, and of the low cost of both.

By way of example but not limited to, here below we indicate some possible values for the capacitors:

C1= from 0.20 µF up to 1-2 µF and more

C1a = C1 b= from 0.20 µF up to 1-2 µF

L1 = less than or equal to the power of the lamps to be powered

C3 = 0.33 µF

C4 = from 0.5-1 µF up to 2-3 µF and more

The larger the sizes of electrical components used, the greater the power output from the circuit according to the present invention.

CLAIMS:

1. An high-efficiency electronic device for turning on and power supplying of lamps, characterized by the fact that it is provided with a circuit comprising a diode bridge rectifier, or Graetz bridge, AC powered preferably by stabilizing inductor (L1), wherein at DC output poles of said rectifier bridge are connected in parallel respectively: a first capacitor (C1), a load constituted by one or more DC powerable lamps connected to the output pole (A, B) of the circuit, in their turn connected together in series and/or in parallel, a second capacitor (C2) placed in series with a relay switch, which, in their entirety, are connected in parallel to the bridge rectifier input, wherein the winding of said relay is connected in series to a third capacitor (C3); said winding and said third capacitor (C3) being connected in parallel, in their entirety, to the bridge rectifier output.

2. The electronic device according to the preceding claim, characterized by the fact that said circuit is adapted to be connected in parallel with one or more lighting lamps, connected in series and/or in parallel, and comprises, in combination:

- a diode bridge rectifier, or Graetz bridge, adapted to be connected to an alternating current power supply (AC);
- at least one first capacitor (C1) connected in parallel to the direct current (DC) output of the bridge rectifier;
- a second capacitor C2 placed in series with a relay switch, which are then connected in

parallel, in their entirety, to the rectifier bridge AC input;

- a winding of said relay which is connected in series to a third capacitor C3 and together are placed in parallel with DC output of the rectifier bridge;
- at least a first inductor (L1) placed at a first AC input pole of the bridge or on the positive branch of the bridge rectifier DC output, having also the purpose of reducing energy consumption;

wherein said second capacitor (C2) in series to said relay serves to give the initial discharge, which turn said lamp(s) on without the use of starter or reactor.

3. The electronic device according to the preceding claim, characterized by the fact that it includes a control lamp (LC) or a resistance (R1), adapted to discharge the capacitor (C3) when the power is off, as well as to ensure that there is DC voltage at rectifier bridge output.

4. The electronic device according to claim 2, characterized by the fact that the capacitance values of the of the first capacitor (C1) and the inductance values of said first inductor (L1) are adjustable in order to change the value of the brightness emitted by each lamp.

5. The electronic device according to claim 2, characterized by the fact that said the first capacitor (C1) can be replaced with two capacitors in series (C1a and C1b), where the part of circuit placed between them is connected to the second pole of the rectifier bridge AC input.

6. The electronic device according to the preceding claim, characterized by the fact that it provides a second inductor (L2) connected in series on the positive branch of the bridge rectifier DC output, downstream of the capacitor C1 or the pair of capacitors (C1a, C1b).

7. The electronic device according to the preceding claim, characterized by the fact that it provides a third inductor (L3) coupled to said second inductor (L2) by means of a gap connected in series on the negative branch of the rectifier bridge DC output, downstream of the capacitor (C1 or C1b).

8. The electronic device according to one of claims 2 onwards, characterized by the fact that in order to switch on and power the lamps with or without liquid mercury, it is envisaged to interpose between such lamps and output poles (A, B) DC of the device, a polarity switch (CP); said polarity switch being also adapted to cause the lamp to warm uniformly.

9. The electronic device according to claim 2, characterized by the fact that in order to adjust the brightness of the lamp(s) powered by the device itself, between the two positive and negative branches exiting from the rectifier bridge, downstream of the condenser (C1) or a pair of capacitors in series (C1a and C1b), wherein the part of circuit placed between them is connected to the second pole of the rectifier bridge AC input, a transistor (Tr1) in series with a capacitor (C4), the base of which is connected with a cursor to a resistance (R2) connected in parallel to said transistor (Tr1) and the relative capacitor (C4), is

provided.

10. The electronic device according to claim 1, characterized by the fact that in order to power one or more lamps each of which has a limited power, e.g. no more than 25W, connected together in series and/or in parallel, it comprises, in combination:

- a diode bridge rectifier, or Graetz bridge, adapted to be connected to an alternating current power supply (AC);
- at least a first capacitor (C1) connected in parallel to the direct current (DC) output of the bridge rectifier;
- a second capacitor (C2) connected between the rectifier bridge AC input and its positive or negative DC output;
- at least a first inductor (L1) placed at a first AC input pole of the bridge or on the positive branch of the bridge rectifier DC output, having also the purpose of reducing energy consumption;

wherein said second capacitor (C2) in series to said relay serves to give the initial discharge, which turn said lamp(s) on without the use of starter or reactor.

11. An electronic device according to the preceding claim, characterized by the fact that it provides a normal switch for switching on and off the device.

Fig. 1

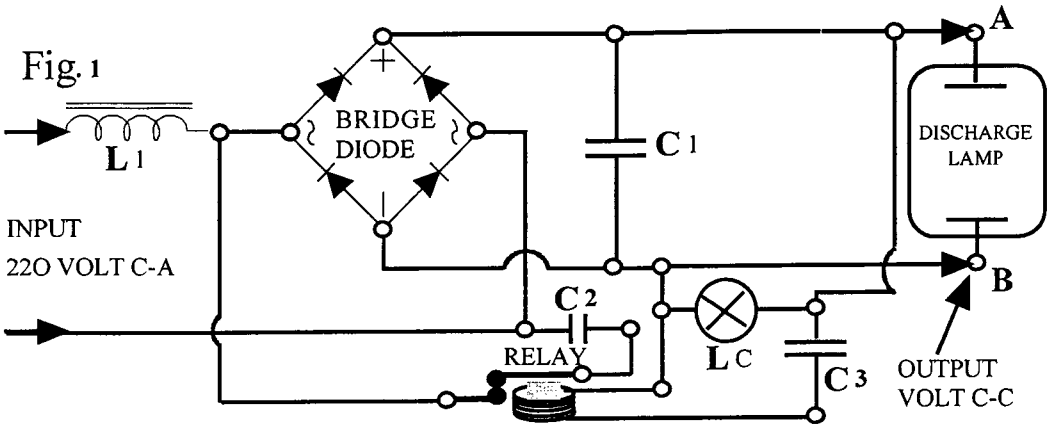


Fig. 2

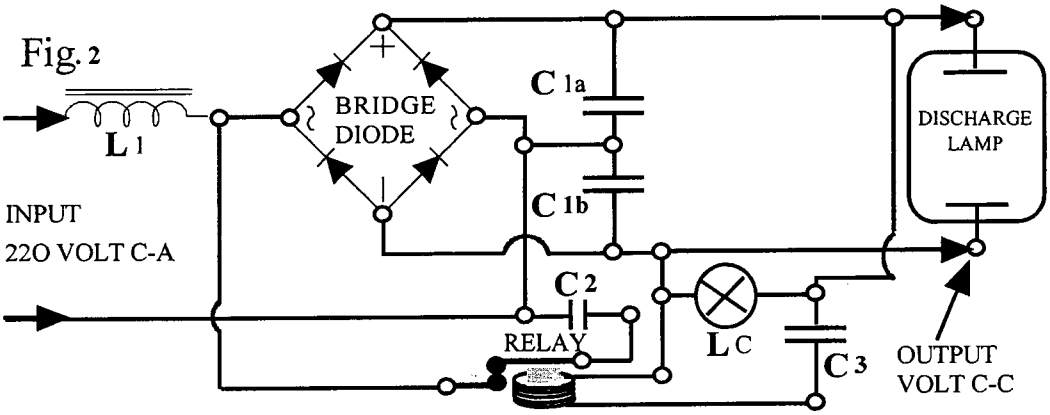


Fig. 3

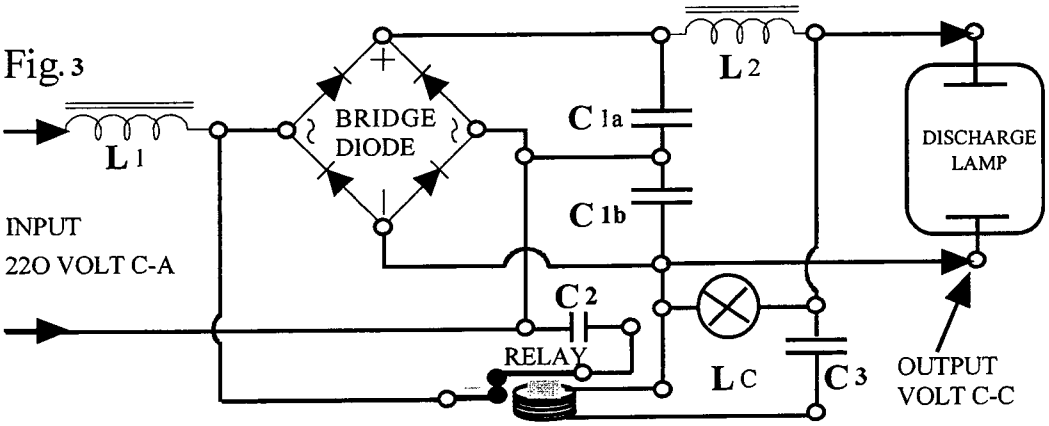


Fig. 4

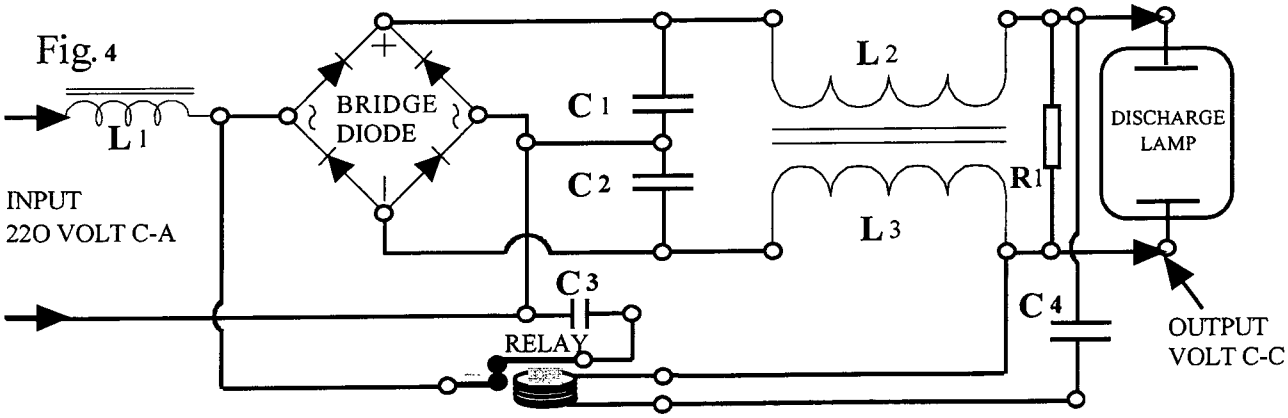


Fig. 5

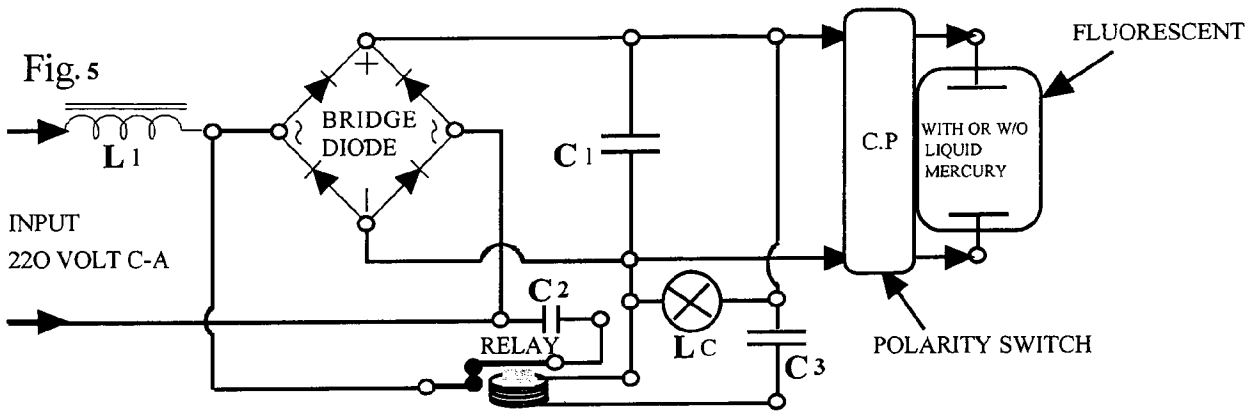


Fig. 6

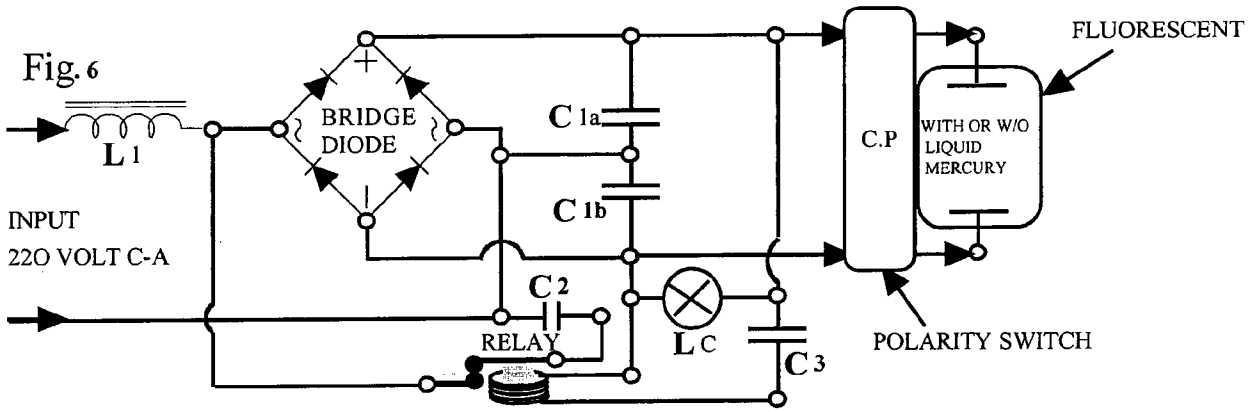


Fig. 7

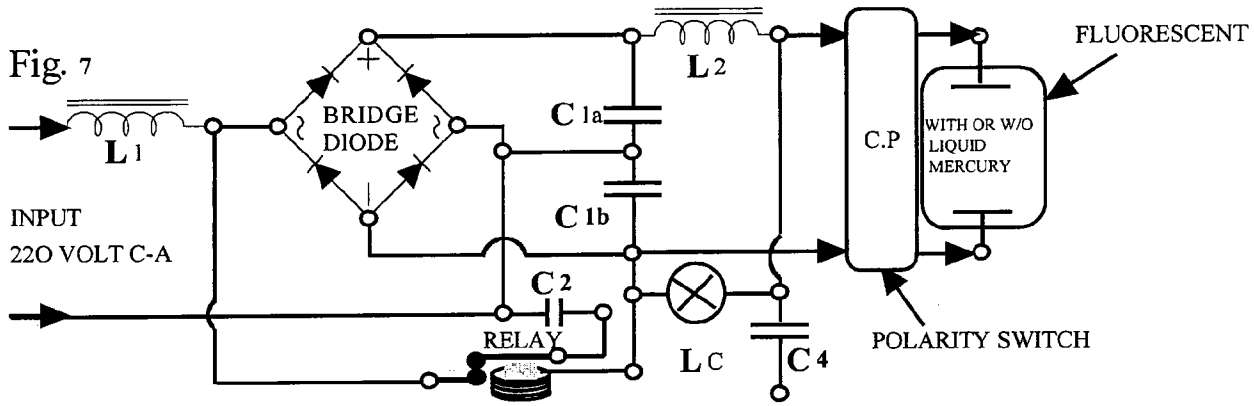


Fig. 8

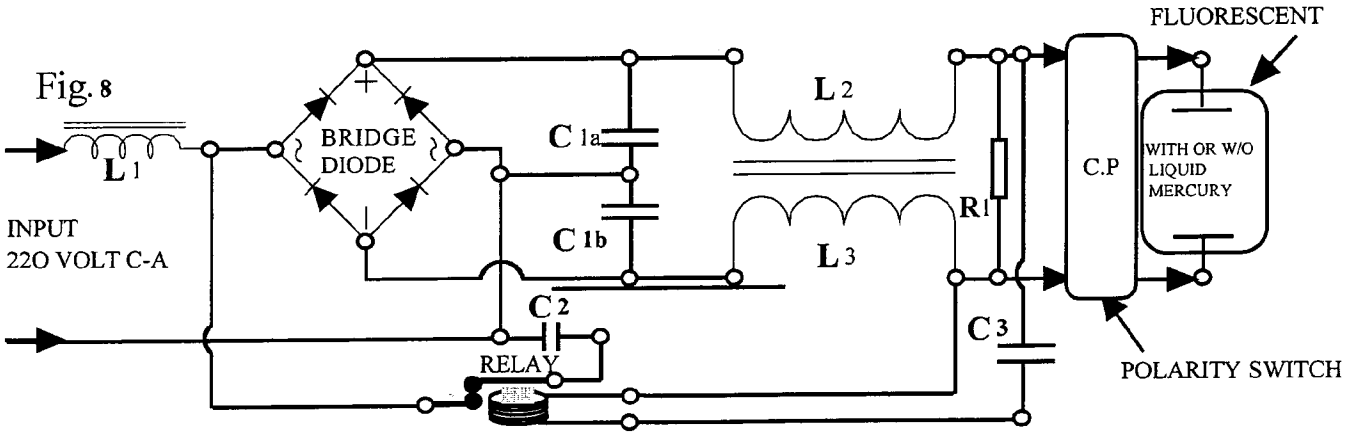


Fig. 9

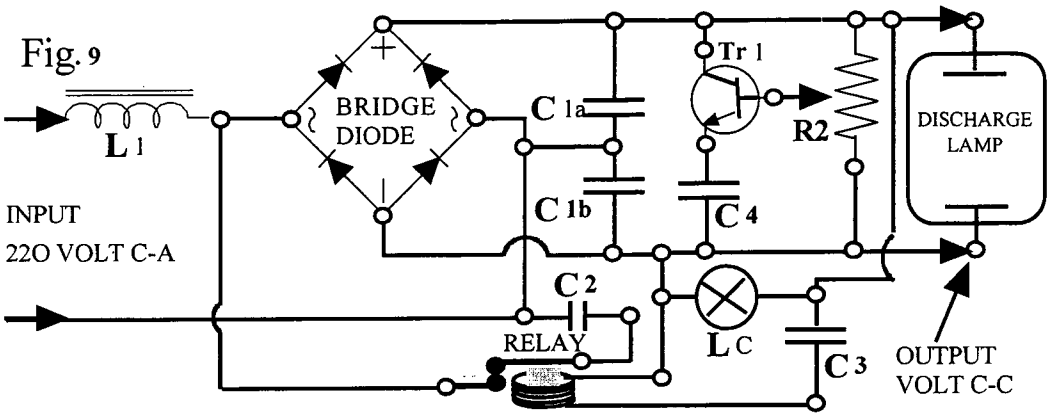


Fig. 10

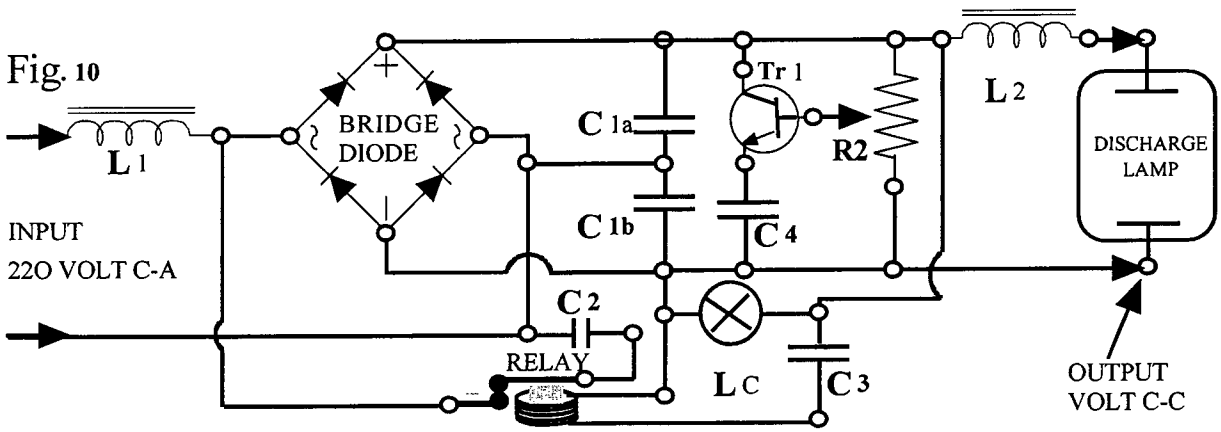


Fig. 11

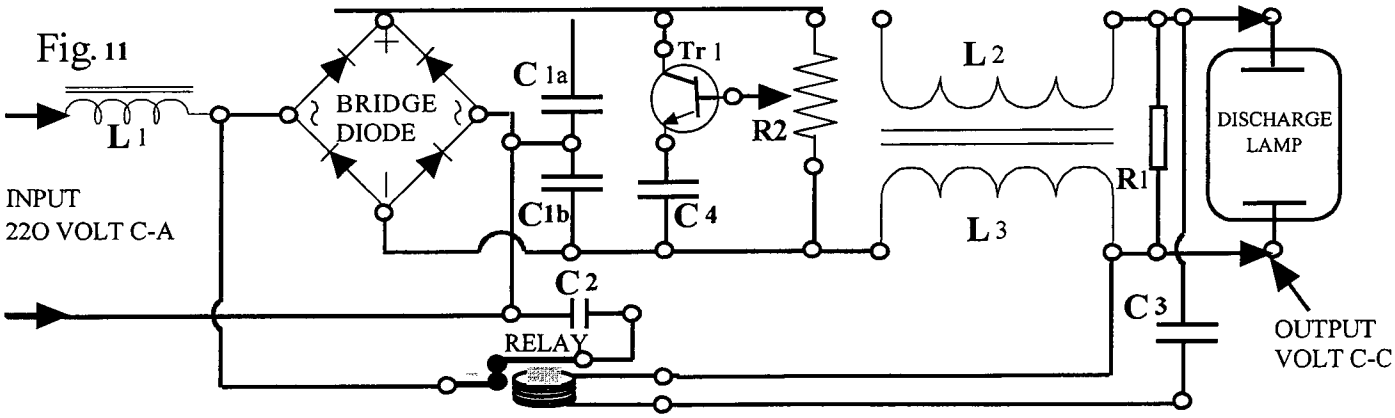


Fig.12

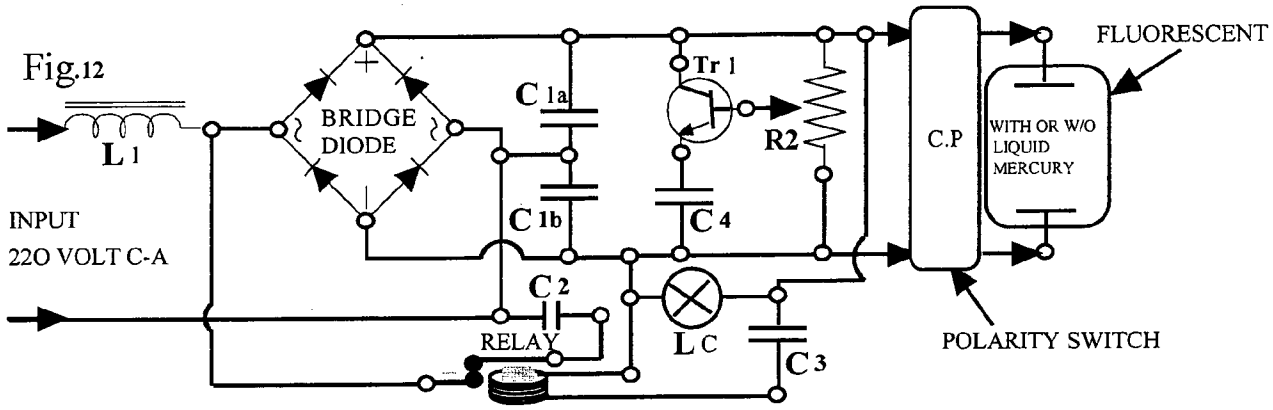


Fig.13

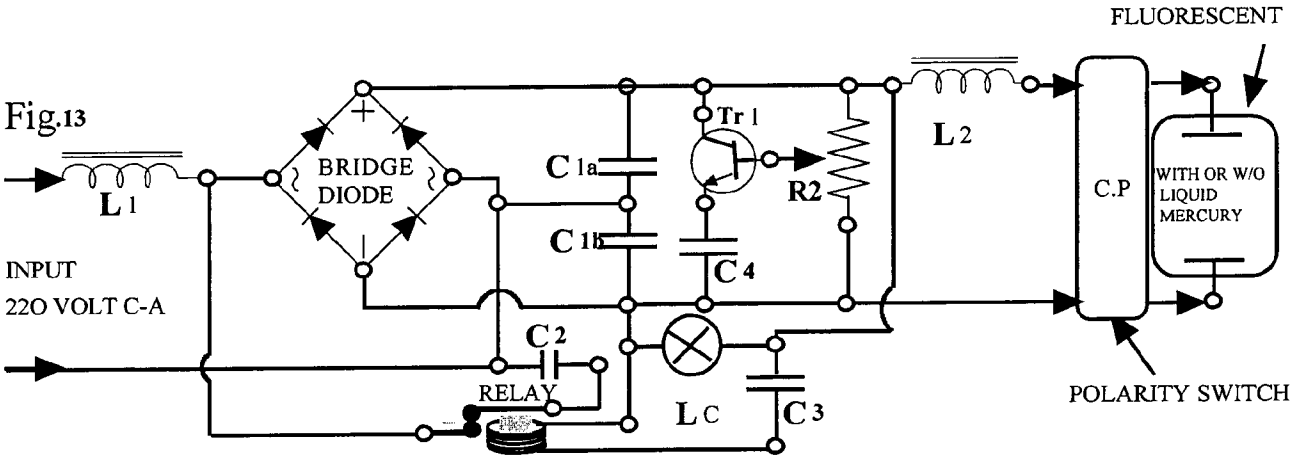


Fig. 14

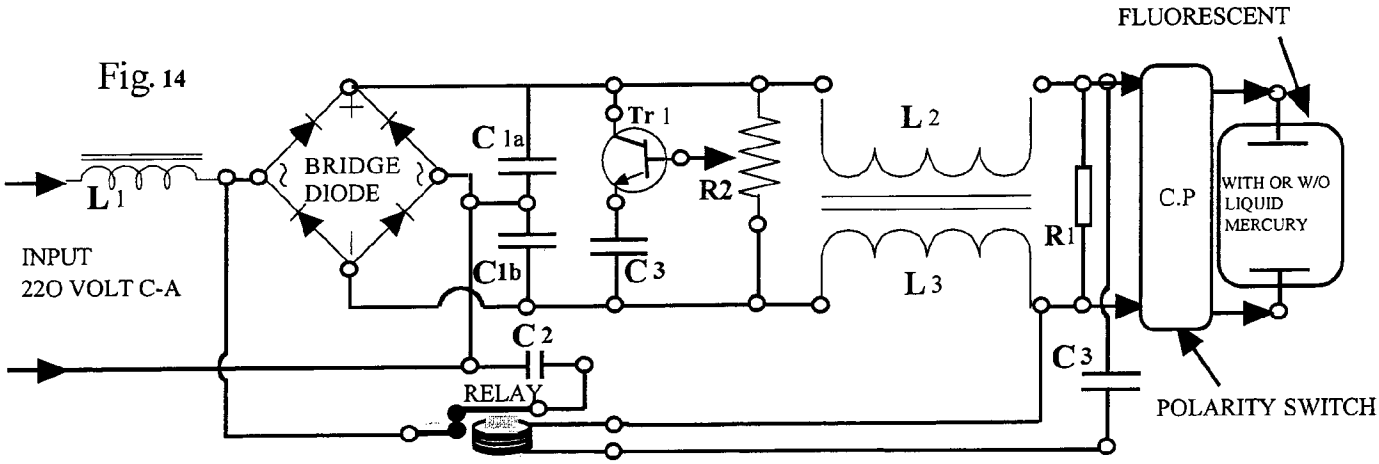


Fig. 15

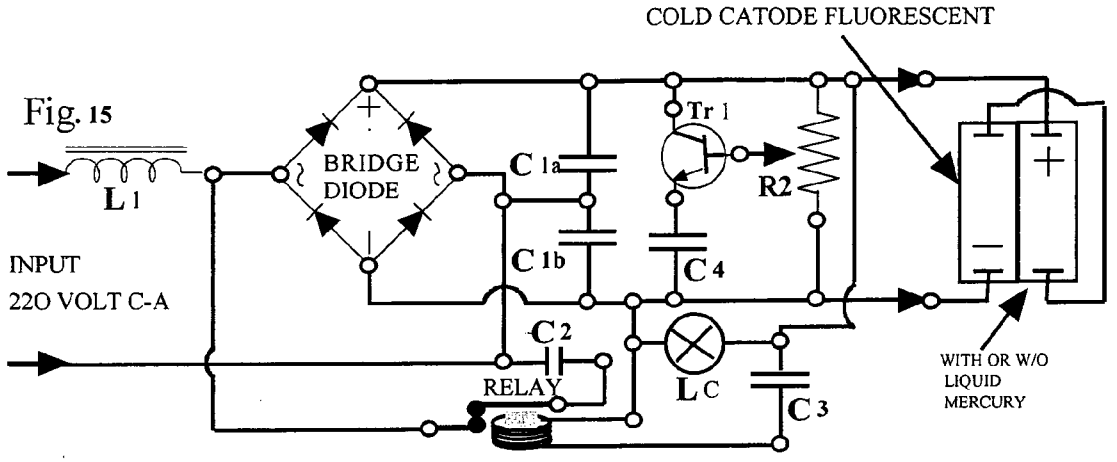


Fig. 16

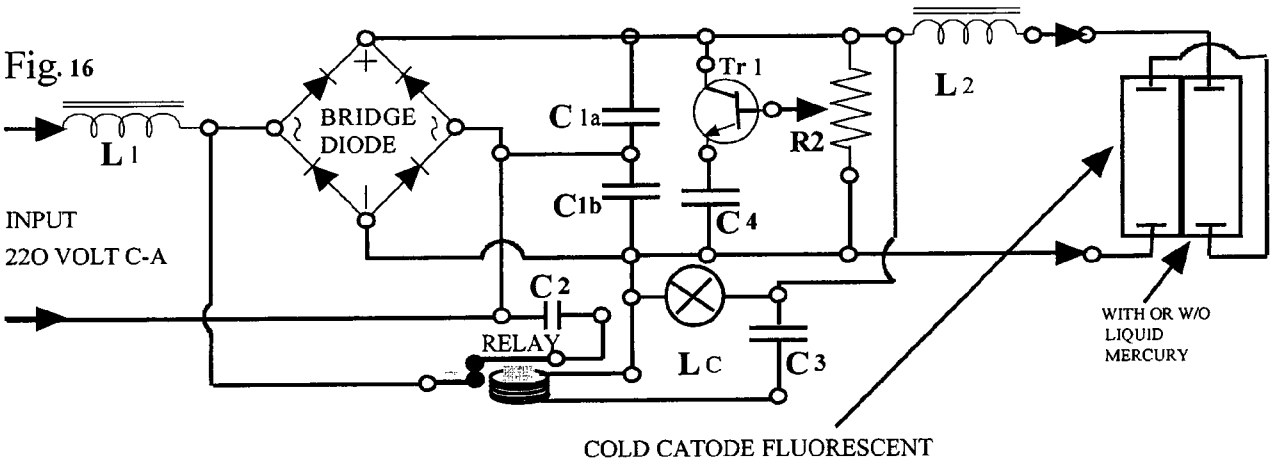


Fig. 17

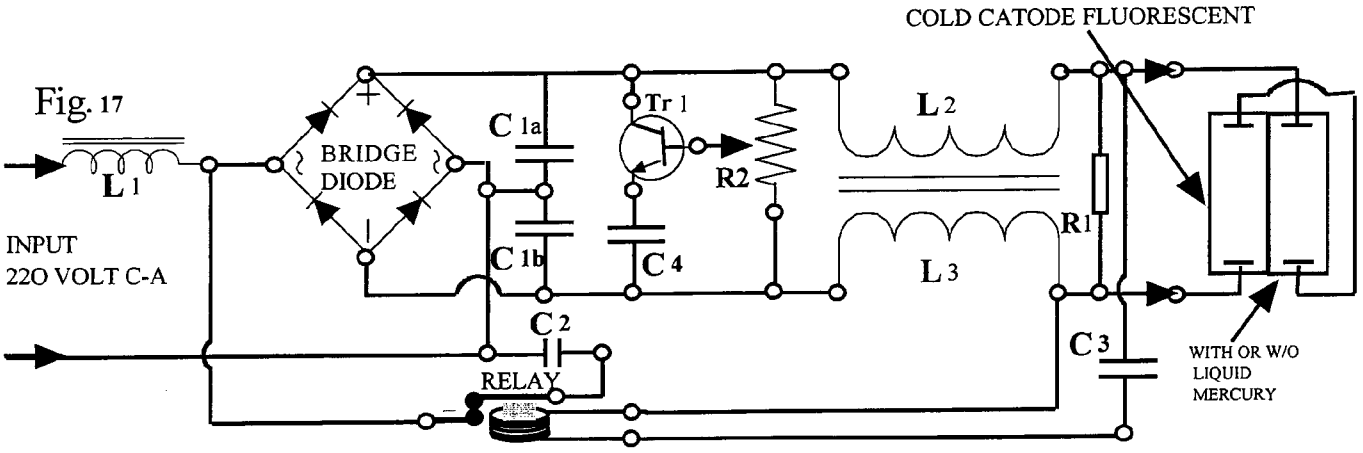


Fig. 18

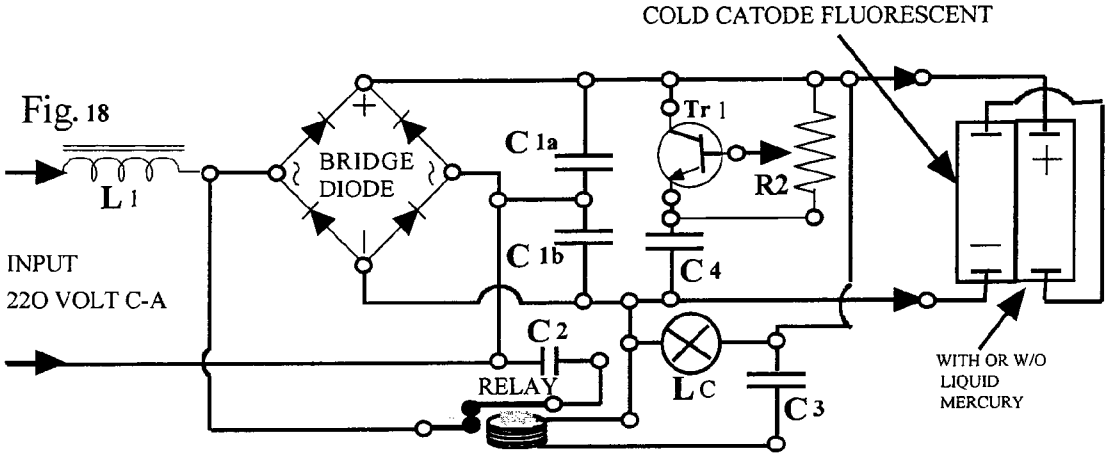


Fig. 19

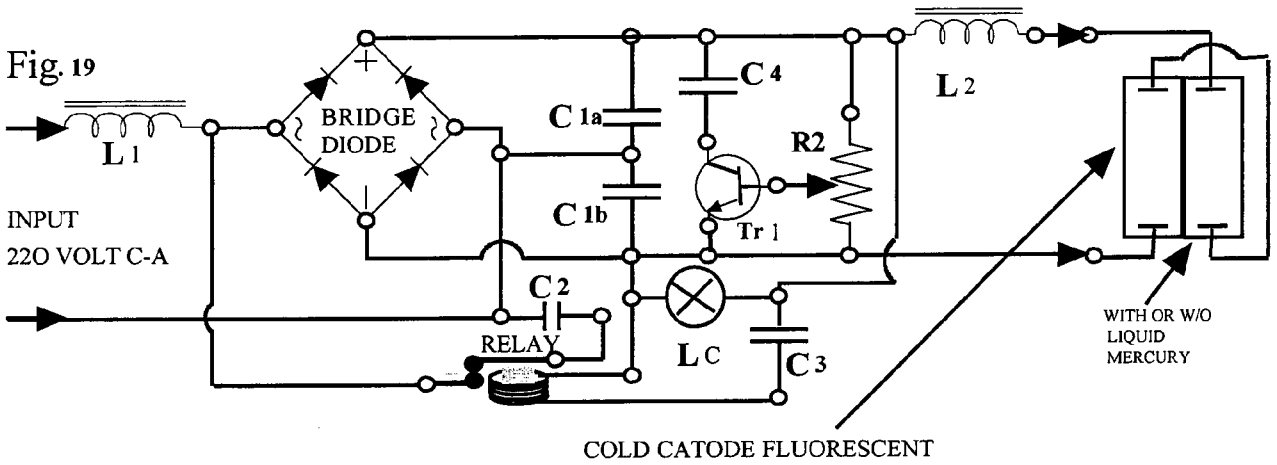


Fig. 20

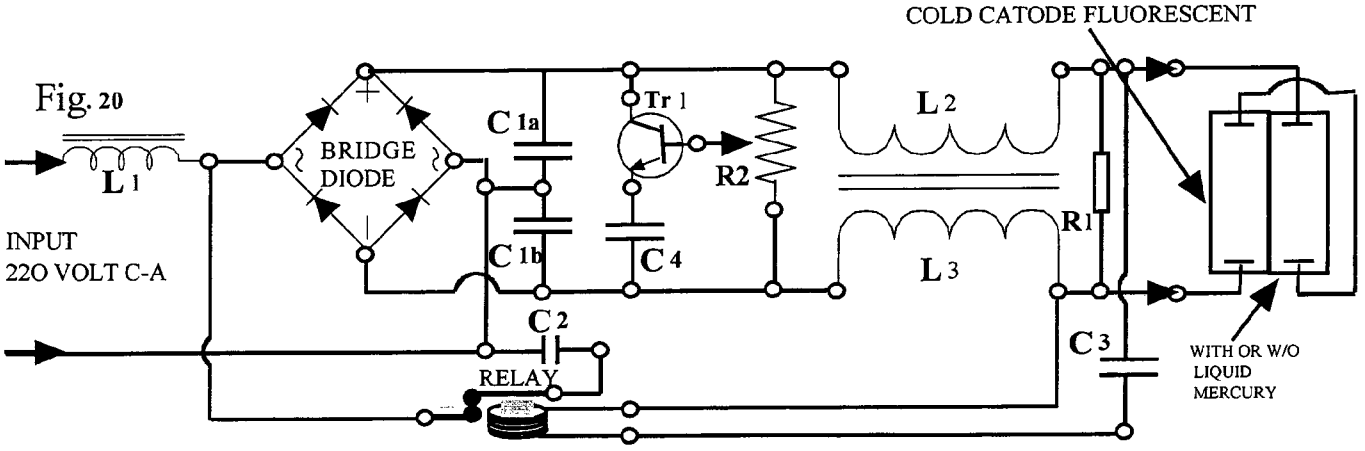


Fig. 21

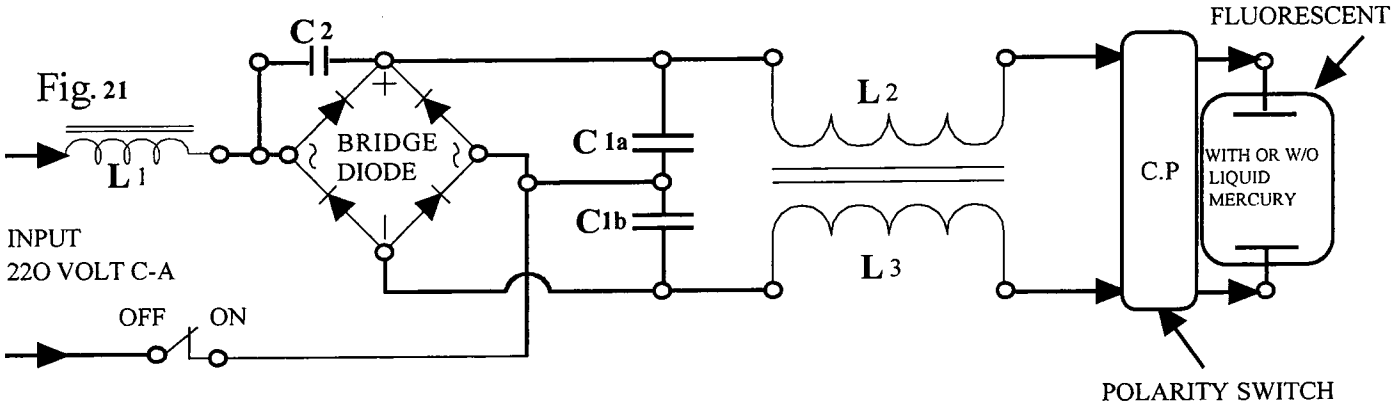
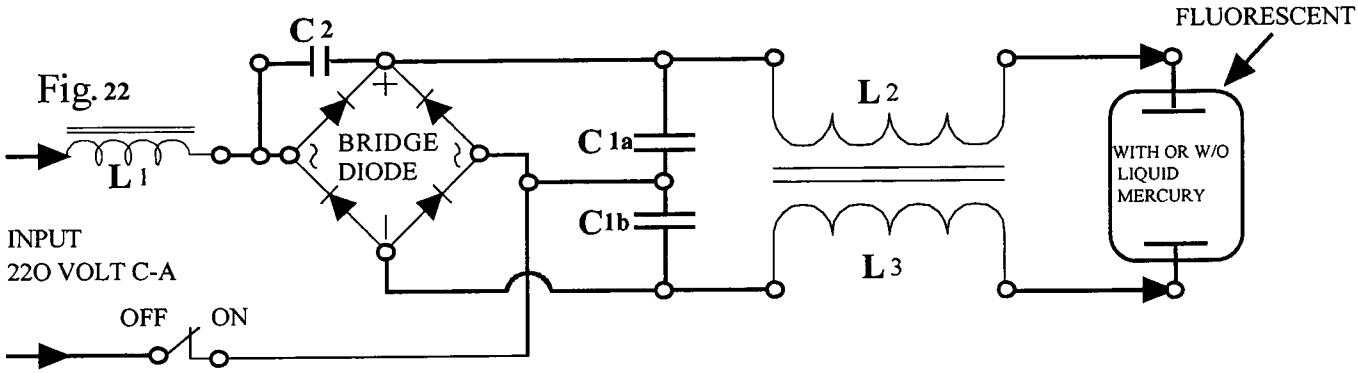

C 2
BRIDGE DIODE
C 1a
C1b
L 2
L 3
L 1
INPUT
220 VOLT C-A
OFF
ON
C.P
FLUORESCENT
WITH OR W/O LIQUID MERCURY
POLARITY SWITCH

Fig. 22


C 2
BRIDGE DIODE
C 1a
C1b
L 2
L 3
L 1
INPUT
220 VOLT C-A
OFF
ON
FLUORESCENT
WITH OR W/O LIQUID MERCURY

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2011/000182

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B41/18 H05B41/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 583 395 A (LU CHAO-CHENG [TW]) 10 December 1996 (1996-12-10) column 3, line 40 - column 5, line 29; figures 5-7, 9A,9B	1,2
X	DE 31 16 510 A1 (PRINZ FRANZ JOSEF) 11 November 1982 (1982-11-11) page 6; figure 4	10,11
A	DE 40 20 517 A1 (HOLZER WALTER [DE]) 2 January 1992 (1992-01-02) column 2, line 20 - column 4, line 27; examples 2-4	1,2,4,6, 8,9

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 June 2012	06/07/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ferla, Monica

3

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 260 932 A (JOHNSON VANCE) 7 April 1981 (1981-04-07) column 6, lines 15-39; figure 6 page 6, lines 56-61; figure 9 page 7, lines 53-58; figure 13b column 8, line 11 - column 9, line 41	1,2,4-6, 8
A	US 3 467 886 A (ALLEY ROBERT P) 16 September 1969 (1969-09-16) column 5, line 24 - column 6, line 49; figure 3	1,2,4-6
A	US 5 057 752 A (GRABNER WOLFGANG [AT] ET AL) 15 October 1991 (1991-10-15) column 2, line 11 - column 3, line 41; figures 1-3	1
A	CH 482 381 A (DETEC SA [CH]) 30 November 1969 (1969-11-30) the whole document	1
A	EP 0 134 044 A1 (SIEMENS AG [DE]) 13 March 1985 (1985-03-13) page 4, lines 19-23; figure 1	1
A	US 4 553 072 A (NEMEC FRANTISEK [CS] ET AL) 12 November 1985 (1985-11-12) column 4, line 25 - column 5, line 9; figure 6	1
A	GB 604 513 A (GEN ELECTRIC CO LTD; ALFRED BLOCH) 6 July 1948 (1948-07-06) figure 2	7
A	EP 0 748 147 A2 (VELASCO VALCKE FRANCISCO J [CO]) 11 December 1996 (1996-12-11) column 3, line 55 - column 4, line 38; figures 1,2a,4a column 7, line 46 - column 8, line 11; figure 2e	8,9

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2011/000182

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5583395 A	10-12-1996	NONE	
DE 3116510 A1	11-11-1982	NONE	
DE 4020517 A1	02-01-1992	NONE	
US 4260932 A	07-04-1981	NONE	
US 3467886 A	16-09-1969	CH 458533 A	30-06-1968
		DE 1589166 A1	30-04-1970
		GB 1137390 A	18-12-1968
		NL 6700262 A	25-08-1967
		US 3467886 A	16-09-1969
US 5057752 A	15-10-1991	AT 397326 B	25-03-1994
		AU 2795389 A	19-07-1989
		DE 3887527 D1	10-03-1994
		DK 147990 A	15-06-1990
		EP 0383831 A1	29-08-1990
		FI 93297 B	30-11-1994
		HU 206175 B	28-08-1992
		JP H03501790 A	18-04-1991
		NO 902691 A	15-06-1990
		US 5057752 A	15-10-1991
		WO 8906085 A1	29-06-1989
CH 482381 A	30-11-1969	NONE	
EP 0134044 A1	13-03-1985	DE 3331780 A1	21-03-1985
		EP 0134044 A1	13-03-1985
		FI 843314 A	03-03-1985
US 4553072 A	12-11-1985	NONE	
GB 604513 A	06-07-1948	NONE	
EP 0748147 A2	11-12-1996	AR 002332 A1	11-03-1998
		AU 698836 B2	12-11-1998
		AU 5473796 A	19-12-1996
		BR 9601787 A	03-11-1998
		CA 2178120 A1	06-12-1996
		CO 4480076 A1	09-07-1997
		EP 0748147 A2	11-12-1996
		JP 9102398 A	15-04-1997
		US 5680016 A	21-10-1997