Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2178443 C 2005/04/05

(11)(21) 2 178 443

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

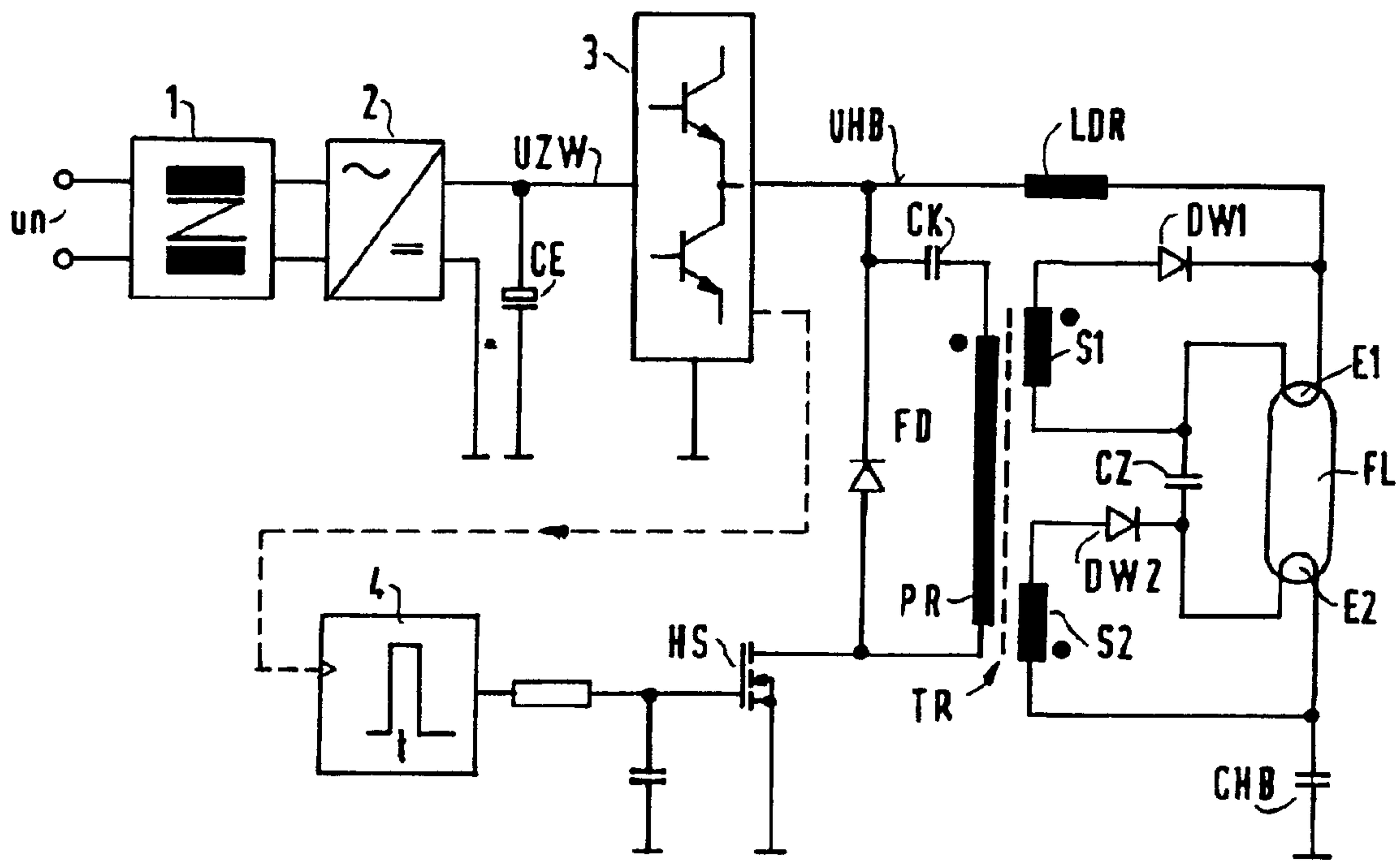
(22) Date de dépôt/Filing Date: 1996/06/06
(41) Mise à la disp. pub./Open to Public Insp.: 1996/12/09
(45) Date de délivrance/Issue Date: 2005/04/05
(30) Priorité/Priority: 1995/06/08 (195 20 999.0) DE

(51) Cl.Int.^{6}/Int.Cl.^{6} H05B 41/26
(72) Inventeur/Inventor:
KRUMMEL, PETER, DE

(73) Propriétaire/Owner:
SIEMENS AKTIENGESELLSCHAFT, DE

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : ARRANGEMENT DE CIRCUIT DE RECHAUFFAGE D'UN ENROULEMENT DE LAMPE FLUORESCENTE
(54) Title: CIRCUIT ARRANGEMENT FOR COIL PRE-HEATING OF FLUORESCENT LAMPS



(57) Abrégé/Abstract:
The circuit arrangement comprises an electronic ballast equipment having an inverter (3), at whose output a high-frequency half-bridge voltage (VHB) is supplied to at least one load circuit having a lamp throttle (LDR), the fluorescent lamp (FL), an ignition capacitor (CZ) and a half-bridge capacitor (CHB). In order to achieve a short pre-heating period of the coils (E1, E2) of the fluorescent lamp, a switchable voltage source (TR, DW1, DW2, HS) is provided that can be activated during the pre-heating period and is connected to the output (HBO) of the inverter (3) and that has outputs constructed pair by pair, to which respectively one of the coils (E1 or, respectively, E2) of the fluorescent lamp (FL) is connected in parallel. This voltage source preferably comprises a transformer (TR) having a primary winding (PR) that is coupled to the inverter (3) and is switched transmissive via a switching means (4, HS), and having secondary windings (S1, S2) to which respectively one of the coils (E1 or, respectively, E2) of the fluorescent lamp (FL) is connected in parallel.

Abstract

Circuit arrangement for coil pre-heating of fluorescent lamps

The circuit arrangement comprises an electronic ballast equipment having an inverter (3), at whose output a high-frequency half-bridge voltage (VHB) is supplied to at least one load circuit having a lamp throttle (LDR), the fluorescent lamp (FL), an ignition capacitor (CZ) and a half-bridge capacitor (CHB). In order to achieve a short pre-heating period of the coils (E1, E2) of the fluorescent lamp, a switchable voltage source (TR, DW1, DW2, HS) is provided that can be activated during the pre-heating period and is connected to the output (HBO) of the inverter (3) and that has outputs constructed pair by pair, to which respectively one of the coils (E1 or, respectively, E2) of the fluorescent lamp (FL) is connected in parallel. This voltage source preferably comprises a transformer (TR) having a primary winding (PR) that is coupled to the inverter (3) and is switched transmissive via a switching means (4, HS), and having secondary windings (S1, S2) to which respectively one of the coils (E1 or, respectively, E2) of the fluorescent lamp (FL) is connected in parallel.

Figure

Specification

Circuit arrangement for coil pre-heating of fluorescent lamps

The invention relates to a circuit arrangement for the pre-heating of the coils of at least one fluorescent lamp according to the preamble of patent claim 1.

Circuit arrangements of the named type are for example known from DE-C2-31 52 951. In connection with electronic ballast equipment, of which the named circuit forms a part, it is often standard to heat the coils or, respectively, the electrodes of the fluorescent lamp to be switched on to the emission temperature before the actual switching on of the lamp, and thereby to prepare an ignition that conserves the fluorescent lamp. It is immediately quite obvious to dimension this pre-heating phase as short as possible, since with electronic ballast equipment it is attempted precisely, among other things, to ignite the fluorescent lamp with as little delay as possible upon application of the network voltage to the ballast equipment. Since a certain quantity of energy is necessary for the heating of the coils of the fluorescent lamp to the emission temperature, it would be accordingly required to dimension the heating current as high as possible.

With respect to the circuitry, there indeed exist many possibilities for the realization of particular functions in electronic ballast equipment with a corresponding circuit outlay. For reasons of economy, however, embodiments requiring a large circuit outlay can have only limited success in the market.

In the currently most economical circuit-oriented construction of known electronic ballast equipment, a load circuit is used that normally comprises a series resonance circuit having a lamp throttle and ignition capacitor. In this load circuit, the electrodes or, respectively, the coils of the fluorescent lamp (restricting consideration to a one-lamp ballast equipment, for the sake of simplicity) are connected in series. This load circuit drives an inverter having a half-bridge arrangement made of two semiconductor switches connected in series, whose common connection point forms the output of the half-bridge arrangement. The inverter produces a half-bridge voltage in the form of a high-frequency square wave pulse sequence, and supplies this to the load circuit. For cost reasons, the switches of the half-bridge arrangement are mostly fashioned as bipolar power transistors, whereby the inverter is so constructed that the two switches are alternatively activated with a short switching pause.

This inverter drives the load circuit during ignition and in normal operation, and can be influenced in its frequency. Frequency alterations of the half-bridge voltage are required for matching to the particular lamp functions in different operating states, such as pre-heating, ignition or normal operation. An essential disadvantage of the solution discussed here is that the current in the resonance circuit is connected directly with the voltage adjacent to the lamp, i.e. is then the predetermined pre-heating current during the pre-heating phase. In order to obtain a relatively high pre-heating current, which is a precondition for a rapid heating of the electrodes of the fluorescent lamp, a correspondingly high lamp voltage is thus simultaneously required. For its part, the lamp voltage must however be limited during this pre-heating phase in order to exclude premature attempts to ignite the fluorescent lamp. Thus, with the depicted circuit, only pre-heating periods of the order of magnitude of about 1.5 to 2 seconds can be achieved.

From EP-A1-0 429 716, an electronic ballast equipment for the parallel driving of several fluorescent lamps is known, whose construction shows a possible way of reducing the required pre-heating period. In the known circuit, the individual lamp load circuit consists respectively of a fluorescent lamp, an ignition capacitor and a high-reactance transformer. The ignition capacitor is thereby connected in parallel to the fluorescent lamp via first terminals of the coils. A primary winding of the high-reactance transformer is applied via a coupling capacitor to the output of the inverter that carries the half-bridge voltage, and at the other side to ground reference potential. A secondary winding of the high-reactance transformer, connected with second terminals of the coils of the fluorescent lamp, is likewise arranged parallel to this lamp. The leakage inductances of the high-reactance transformer, together with the capacitance of the ignition capacitor, form a series resonance circuit of the lamp load circuit, which is tuned close to the high-frequency operating frequency of the inverter. If several lamp load circuits are provided, each of these lamp circuits has a series resonance circuit of this type, whereby the secondary windings of the high-reactance transformers are connected in series in such a way that a DC circuit is formed, in which the electrodes of the fluorescent lamps and the secondary windings lie in series with one another.

In order to achieve a high heat power, this DC circuit is connected to the supply voltage of the inverter (usually designated as intermediate circuit voltage) via a switch to be closed during the pre-heating period, as well as a pre-heating resistor. A time switch element is allocated to the circuit, which element is triggered by the intermediate circuit voltage that builds up when the electronic ballast circuit is activated, and holds closed the switch for the predetermined duration of the pre-heating period. Besides the expense for a high-reactance transformer, which transformer is not unproblematically controllable in series production, the known circuit has the disadvantage that it requires a galvanic separation of the lamp load circuits.

The underlying aim of the invention is to indicate a further solution for a circuit arrangement of the type named above, by means of which it is possible, in a simple way and with an economical circuit construction, to create the preconditions for a sure and, in particular, rapid pre-heating of the coils of the fluorescent lamp.

In accordance with this invention, there is provided a circuit arrangement for pre-heating electrodes of at least one fluorescent lamp operated with electronic ballast equipment, said electrodes being respectively disposed at opposite ends of said fluorescent lamp, the circuit arrangement comprising: means for supplying a stabilized intermediate circuit voltage; inverter means for emitting a half-bridge voltage in the form of a high frequency pulse sequence, said inverter means having an input connected to said means for supplying a stabilized intermediate circuit voltage and having an output; a load circuit including a lamp throttle, connected to a first of said electrodes, an ignition capacitor connected across said electrodes, and a half-bridge capacitor connected to a second of said electrodes, said load circuit connected between said output of said inverter and a ground reference potential; a switchable voltage source including a transformer having a primary winding, connected to said output of said inverter and to said ground reference potential, said switchable voltage source further comprising secondary windings having outputs connected in parallel with said electrodes, said secondary windings having a synchronized winding direction; and means, connected to said switchable voltage source, for activating said switchable voltage source during a predetermined pre-heating period of said electrodes.

Given the cost pressure that exists today for the manufacturing of electronic ballast equipment, the economic efficiency of the inventive solution is of essential importance. Not only is the component outlay relatively small in the inventive solution, but inexpensive components can also be used for it. Regarded functionally, the inventive solution enables the coils of the connected fluorescent lamp to be heated to the emission temperature quickly with a high heating current, despite the fixed lamp voltage, which is relatively low during the pre-heating phase. The inventive solution thus offers the possibility of realizing pre-heating periods not achievable with conventional solutions, in a range of less than 0.5 s.

An exemplary embodiment of the invention is specified more precisely below on the basis of the drawing; the single figure thereby shows, partly as a schematic diagram, an electronic ballast equipment, as well as (in circuit details) an inventively constructed circuit arrangement for pre-heating the coils of a fluorescent lamp before the actual ignition process.

A harmonic filter 1, connected to an AC supply voltage un, is shown schematically in the drawing, which filter, as an interference suppression filter, serves to limit perturbations of the supply network due to high-frequency interference voltages, which arise as a result of switching processes in the electronic ballast equipment. A rectifier arrangement 2 is connected to the output of this harmonic filter 1, which rectifier on the one hand transforms the AC supply voltage un into a rectified voltage, and on the other hand can additionally contain a sine correction circuit. A corrected direct voltage, connected to a ground reference potential, is thus emitted at the output of the rectifier arrangement 2, which is supplied to a back-up capacitor CE, constructed as an electrolytic capacitor, which lies at ground reference potential with a further terminal at the other side. In this way, a stabilized intermediate circuit voltage UZW, not affected by modulations of the AC supply voltage un, is produced for the continuous supply of a inverter 3. For this inverter 3 it is indicated that in general it comprises a half-bridge arrangement of two power transistors, often of bipolar construction, which are arranged between the intermediate circuit voltage UZW and ground reference potential via their contact gaps lying in series, and are so controlled that they are alternatively switched transmissive. At the common point of connection of the contact gaps of these two power transistors, a high-frequency impulse sequence is thus produced, which forms the output signal of the inverter 3, and in general is designated as half-bridge voltage UHB.

This half-bridge voltage UHB forms the voltage supply for a lamp load circuit connected to the inverter 3. This load circuit is [...] here as a series resonance circuit arranged between the output of the inverter 3 and ground reference potential, and comprises a lamp throttle LDR, a fluorescent lamp FL and a half-bridge capacitor CHB. In addition, an ignition capacitor CZ lying parallel to the fluorescent lamp FL is provided, which capacitor is connected to the coils E1, E2 of the fluorescent lamp FL.

As so far described above, the circuit arrangement for electronic ballast equipment for driving at least one fluorescent lamp is thoroughly known; a more detailed representation and description is thus not necessary here.

In cooperation with the connected lamp load circuit, the inverter 3 controls all operating functions of the fluorescent lamp in the lamp load circuit. After the commissioning of the electronic ballast equipment through the application of the AC supply voltage un, the series resonance circuit of the lamp load circuit is operated during a pre-heating period, for the conservative switching on of the fluorescent lamp FL, with a frequency that lies above the resonance frequency. A high current is thereby supposed to flow via the electrodes E1, E2 of the fluorescent lamp FL in order to heat this lamp to the emission temperature as quickly as possible. However, at the same time the voltage thereby present at the fluorescent lamp FL may not be too high, in order to prevent a premature ignition. As soon as the electrodes E1, E2 of the fluorescent lamp FL are brought to the emission temperature at the end of the pre-heating period, the fluorescent lamp FL should ignite as immediately as possible. For this purpose, an ignition voltage is required that is significantly higher than the normal operating voltage of the fluorescent lamp FL. This high voltage is produced in that the frequency of the half-bridge voltage UHB is sunk so far that the series resonance circuit of the lamp load circuit is operated close to its resonance frequency. As soon as the fluorescent lamp FL has ignited, a high current flows at first in the lamp load circuit, limited by the reactance of the lamp throttle LDR. An operating circuit of this type for a fluorescent lamp also permits a dimming function, in which the fluorescent lamp emits only a predetermined portion of its nominal luminous flux. For this purpose, the operating frequency of the inverter 3 is raised in a defined way, so that the effective reactance of the lamp throttle LDR increases. The current through the fluorescent lamp FL is thereby limited so far that this lamp emits only the predetermined portion of its nominal luminous flux.

Of the above-named operating functions, in the present case the pre-heating of the coils E1, E2 of the fluorescent lamp FL is of particular interest. As indicated above, during this pre-heating period the voltage at the fluorescent lamp FL may not exceed a defined value, in order to exclude a premature ignition with coils that are not yet sufficiently heated. For this reason, the inverter 3 is controlled so that during the predetermined pre-heating period it supplies a half-bridge voltage UHB, having an impulse frequency that lies above the resonance frequency of the series resonance circuit in the lamp load circuit. At this high frequency, the lamp throttle LDR has a current-limiting effect. Conditioned by the circuit arrangement in the lamp load circuit, an upper limit is thereby given for the heat power that can be supplied to the coils E1, E2 of the fluorescent lamp FL, so that the pre-heating period must be dimensioned correspondingly long.

In order to meet this difficulty, in the exemplary embodiment shown in the drawing an internal voltage source, which is supplied via the half-bridge voltage UHB and can be activated during the pre-heating period, is allocated to the lamp load circuit, in addition to the already-described circuit parts assumed as known in themselves. This voltage source comprises a transformer TR having a primary winding PR, which winding is immediately connected to the output of the inverter 3 via a coupling capacitor CK. The terminal of the primary winding PR turned away from the coupling capacitor CK is set to ground reference potential via the contact gap of a semiconductor switch HS, which is constructed, for example, as a field-effect transistor. A time switch element 4 is connected to the control input of this semiconductor switch HS via a matching network. A free-wheeling diode FD is connected in parallel to the series circuit of the coupling capacitor CK and the primary winding PR of the transformer TR.

The secondary side of the transformer TR is formed by two secondary windings S1, S2 that are synchronized in their winding direction. The winding direction of the primary and secondary windings PR or, respectively, S1, S2 of the transformer TR is symbolically indicated in the drawing. Each of the secondary windings S1 or, respectively, S2 of the transformer TR is immediately connected, with one terminal, to one of the two electrodes E1 or, respectively, E2 of the fluorescent lamp FL, while in the branch of the circuit between the other winding end and the second terminal, which is connected with the ignition capacitor CZ, of the corresponding coil E1 or, respectively E2, a rectifier diode DW1 or, respectively, DW2 is provided.

In the following, the function of the described circuit arrangement is explained. In the normal case, a switching-on process for the fluorescent lamp FL is triggered by the application of the supply voltage un to the electronic ballast equipment. The intermediate circuit voltage UZW thereby builds up at the back-up capacitor CE, and the inverter 3 is activated. For the duration of the given pre-heating period, the frequency of the half-bridge voltage UHB lies far above the resonance frequency of the series resonance circuit in the lamp load circuit, so that the voltage present at the fluorescent lamp FL is significantly lower than the ignition voltage. With the beginning of the pre-heating period, the time switch element 4 is supposed to be triggered, in order to switch the semiconductor switch HS transmissive for the duration of the pre-heating of the coils E1, E2 of the fluorescent lamp FL. There are different possibilities for the generation of a corresponding triggering signal for the time switch element 4 during the start-up of the electronic ballast equipment. Thus, for this purpose the rise of the intermediate circuit voltage UZW building up at the back-up capacitor CE, or, for example, also the half-bridge voltage UHB can be used, or, respectively, in another way a rise in current can be detected in the lamp load circuit, for instance can be measured as a fall in voltage at a resistor lying serially in the lamp load circuit. In any case, it is advantageous if the time switch element 4 can be triggered only when the inverter 3 is also building up. This case, shown schematically in the drawing, takes into account that the inverter in some known electronic ballast equipment is shut down in an error state in which the connected fluorescent lamp is difficult or even impossible to ignite, without however having to shut off the supply voltage. After a change of lamps, the inverter 3 starts up again automatically in these ballast equipment without switching off the supply voltage, and attempts to ignite the exchanged fluorescent lamp. If the trigger signal for the time switch element 4 is derived from a start/stop switch known in itself for the inverter 3, or, respectively, from the corresponding alterations in the lamp load circuit at the beginning of the switching-on process, this operating function is then also unambiguously taken into account.

With the activation of the semiconductor switch HS by the time switch element 4, the primary winding PR of the transformer TR is switched transmissive and supplied through the half-bridge voltage UHB. The output voltages of the transformer TR at the secondary windings S1 or, respectively, S2 are constant, and, rectified via the rectifier diodes DW1 or, respectively, DW2, are respectively supplied to one of the coils E1 or, respectively, E2 of the fluorescent lamp FL. At the beginning of the pre-heating period, these coils are at a low temperature and are thus of low resistance. This has the consequence of a high heating current, whereby the supplied heat power is extremely large, since it increases as the square of the heating current. The coils E1, E2 of the fluorescent lamp FL are thus quickly heated. The coil resistance thereby rises, and heating current and heating power decrease with rising coil temperature. In this way it is ensured that the coils are not overheated. It is thus made possible in a simple way, in particular through the selection of the transformation ratio of the transformer TR, to determine the output voltages at the secondary coils S1 or, respectively, S2, and thereby to set the heating power, and, as a result, to achieve a correspondingly short pre-heating period. In this way, a pre-heating period of less than 0.5 s can be achieved.

After the predetermined pre-heating period has run out, the semiconductor switch HS is blocked via the reset time switch element 4. The transformer TR is thereby no longer excited at the primary side, and the heating of the coils E1, E2 of the fluorescent lamp FL is thereby ended. Via the free-wheeling diode FD, residual energy that may still be present in the transformer TR is quickly allowed to decay. Corresponding to the operating function of the electronic ballast equipment, in particular of the inverter 3, after the end of the pre-heating period the frequency of the half-bridge voltage UHB is lowered. As described above, the voltage at the fluorescent lamp FL thereby rises until the ignition voltage is achieved and the lamp ignites. During normal operation of the fluorescent lamp FL, the lamp throttle LDR limits the current flowing through the fluorescent lamp FL on the basis of the throttle's reactance, which is very high at this operating frequency.

From the preceding functional specification, it does not immediately result why the rectifier diodes DW1 or, respectively, DW2 are provided, since they do not seem to be absolutely necessary for the described heating function. These rectifier diodes serve to limit high voltages at the sockets of the fluorescent lamp FL, thus preventing on the one hand an undesired build-up of the lamp circuit. On the other hand, they thereby serve for operating safety during a change of lamps with voltage present.

In the above-described exemplary embodiment of the invention, only a single lamp current circuit is connected to the electronic ballast equipment. An expansion of the specified circuit arrangement to several lamp current circuits is unproblematically possible, without fundamentally altering anything in the specified circuit arrangement. For electronic ballast equipment for several lamps, corresponding to the number of the electrodes to be heated of two or three fluorescent lamps, the number of secondary windings of the transformer is to be multiplied. Given a fundamentally identical circuit construction, for electronic ballast equipment for several lamps only the number of the secondary windings of the transformer increases, as well as, correspondingly, the number of rectifier diodes to be arranged in the heating circuit. Since electronic ballast equipment for several lamps are thoroughly known, no separate schematic graphic representation is required for the specification of such an exemplary embodiment of the invention, having more than one fluorescent lamp operated via an electronic ballast equipment.

27813-78

CLAIMS:

1. A circuit arrangement for pre-heating electrodes of at least one fluorescent lamp operated with electronic ballast equipment, said electrodes being respectively disposed at opposite ends of said fluorescent lamp, the circuit arrangement comprising:

means for supplying a stabilized intermediate circuit voltage;

inverter means for emitting a half-bridge voltage in the form of a high frequency pulse sequence, said inverter means having an input connected to said means for supplying a stabilized intermediate circuit voltage and having an output;

a load circuit including a lamp throttle, connected to a first of said electrodes, an ignition capacitor connected across said electrodes, and a half-bridge capacitor connected to a second of said electrodes, said load circuit connected between said output of said inverter and a ground reference potential;

a switchable voltage source including a transformer having a primary winding, connected to said output of said inverter and to said ground reference potential, said switchable voltage source further comprising secondary windings having outputs connected in parallel with said electrodes, said secondary windings having a synchronized winding direction; and

means, connected to said switchable voltage source, for activating said switchable voltage source during a predetermined pre-heating period of said electrodes.

2. The circuit arrangement in claim 1 wherein said means for activating said switchable voltage source further comprises:

a time-dependent switching element connected in series to said primary winding.

3. The circuit arrangement in claim 2, wherein said time-dependent switching element is a thermistor.

4. The circuit arrangement in claim 2, wherein said time-dependent switching element further comprises:

a semiconductor switch having a conductive path connected in series with said primary winding and an input; and

a time switch element having an output connected to said input of said semiconductor switch.

5. The circuit arrangement in claim 1 further comprising a rectifier diode connected in series with each of said secondary windings.

6. The circuit arrangement in claim 1, further comprising a free-running diode connected in parallel with said primary winding.

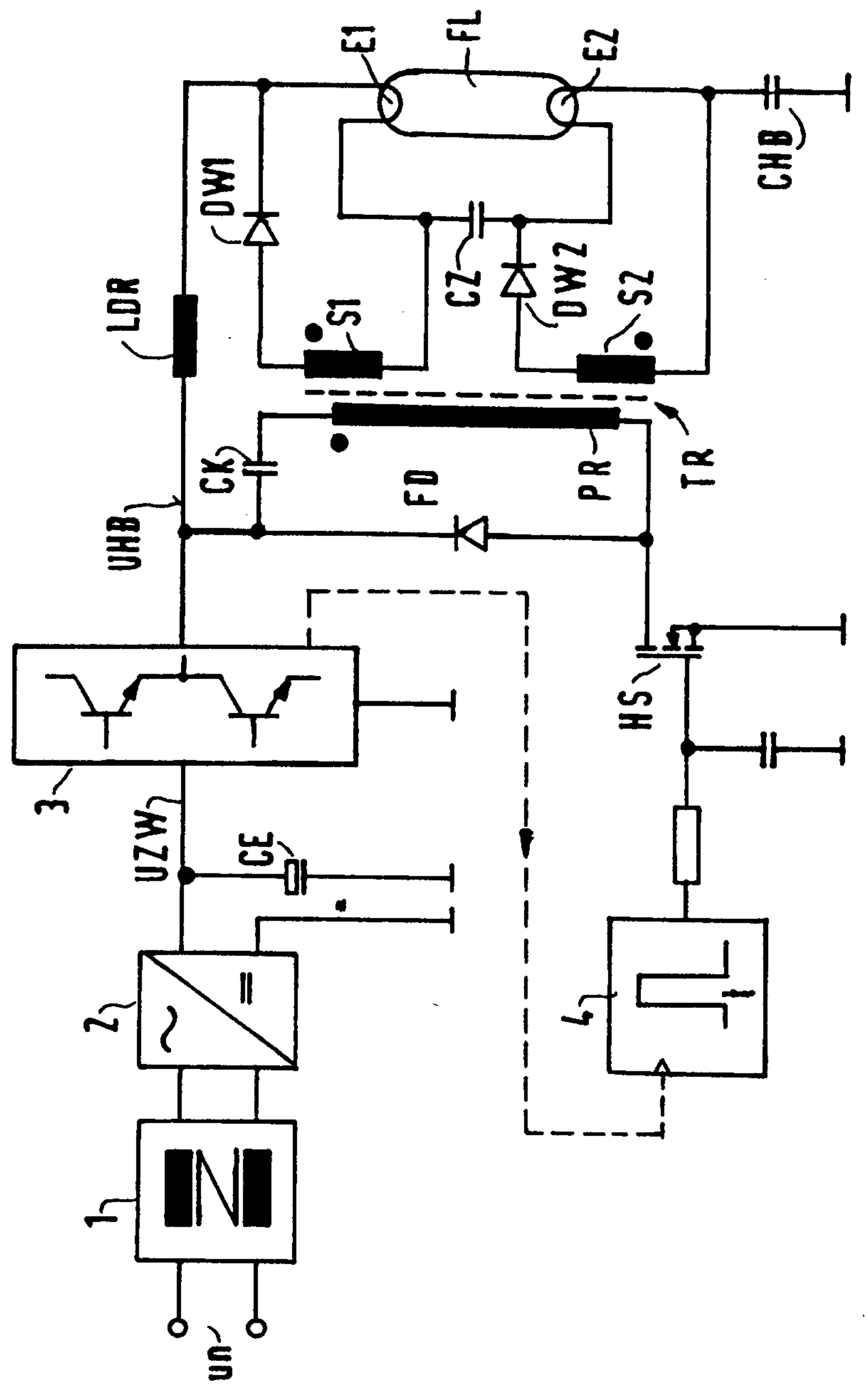
FETHERSTONHAUGH & CO.

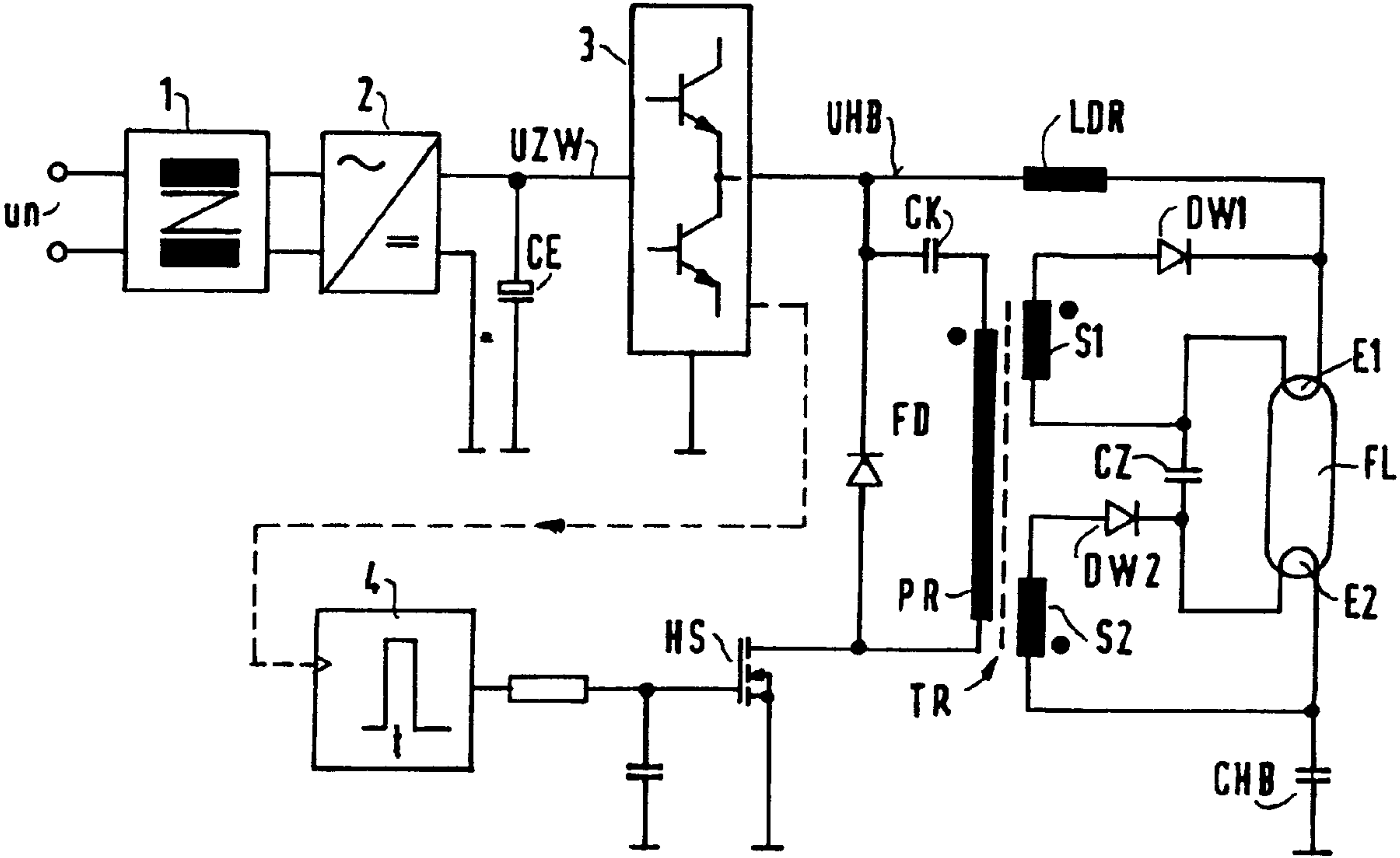
PATENT AGENTS

OTTAWA, CANADA

95 P 1 5 0 6

2178443





1
2
3
4
un
UZW
CE
UHB
LDR
CK
DW1
S1
E1
FD
CZ
FL
DW2
PR
E2
HS
S2
TR
CHB