(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 613 327 A1**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **93102678.5**

(51) Int. Cl.[5]: **H05B 41/29**

(22) Date of filing: **19.02.93**

(43) Date of publication of application:
31.08.94 Bulletin 94/35

(84) Designated Contracting States:
DE NL

(71) Applicant: **TALVAKO LTD.**
P.O.Box 2228
EE-0035 Tallinn (EE)

(72) Inventor: **Stukovnin,Nikolai**
c/o Talvako Ltd.,
P.O. Box 2228
EE-0035 Tallinn (EE)
Inventor: **Jakushkin, Anatoli**
c/o Talvako Ltd.,
P.O. Box 2228
EE-0035 Tallinn (EE)
Inventor: **Handogin, Vladimir**
c/o Talvako Ltd.,
P.O. Box 2228
EE-0035 Tallinn (EE)
Inventor: **Raikova, Aleksandra**
c/o Talvako Ltd.,
P.O. Box 2228
EE-0035 Tallinn (EE)
Inventor: **Blankin, Taavi**
c/o Talvako Ltd.,
P.O. Box 2228
EE-0035 Tallinn (EE)

(74) Representative: **Patentanwälte Grünecker, Kinkeldey, Stockmair & Partner**
Maximilianstrasse 58
D-80538 München (DE)

(54) **Power supply for luminescent lamps.**

(57) The present invention relates to a source of secondary power supply and may be applied as a power source for luminescent lamps.

The power supply consists of an electronic starter with a current-proportional controlled mains voltage rectifier, assembled in the half-bridge circuit. The introduced components and their connection in the power supply exclude the "cold" switching-on of the lamp, limit both the peak value of the no-load voltage and the starting current. In special versions of the power supply, provision has been made of high noise stability, exclusion of unregulated switch-on of the lamp, quick availability for operation of the electronic starter and preliminary warm-up of the lamp cathodes. The power supply provides the matching of the parameters of the lamp and the power supply in the start-up procedures, which increases the operation reliability of both the power supply and the luminescent lamps, prolonging thus their service life to a considerable extent.

EP 0 613 327 A1

POWER SUPPLY FOR LUMINESCENT LAMPS

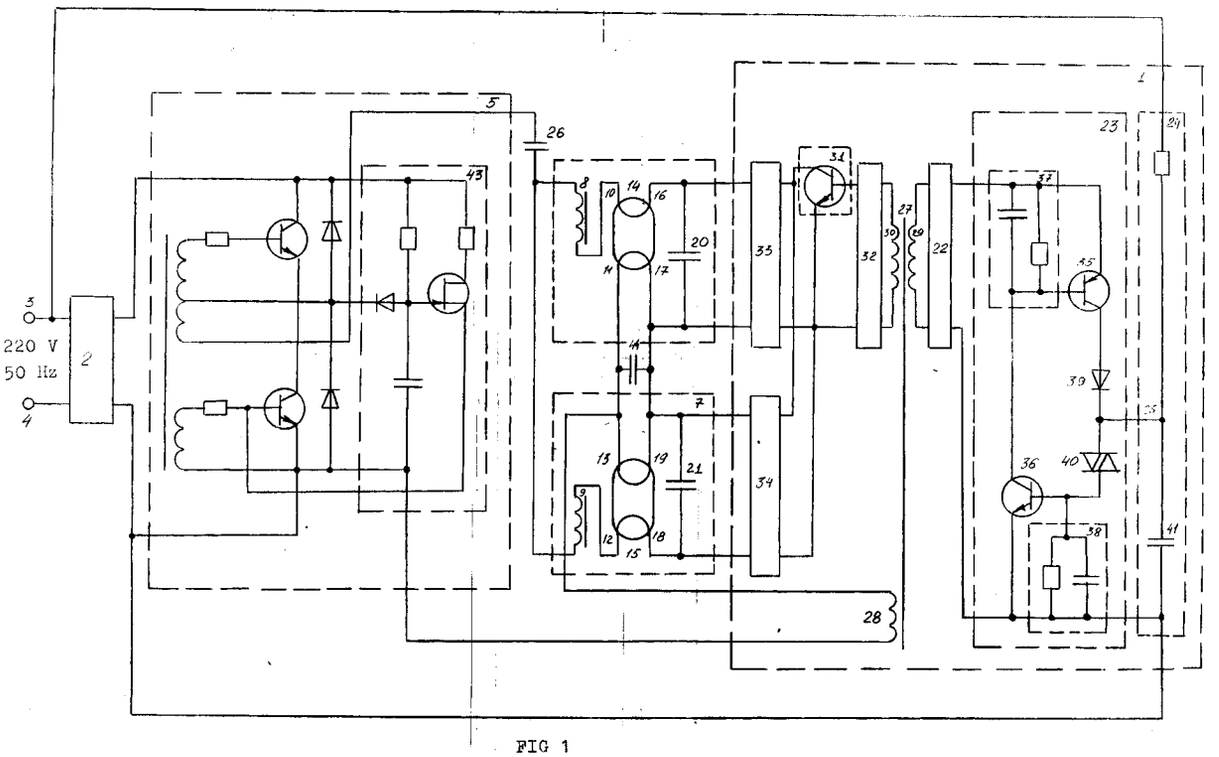

FIG 1

The invention can be classified as a source of secondary power supply and may be applied as a power source for luminescent lamps. It ensures necessary modes of switch-on, inflammation and operation of a luminescent lamp.

The existent power supply for luminescent lamps includes a starter and a ballast element, which is in series connection with the first outputs of the first and the second luminescent lamp cathode; between the second outputs of the first and the second luminescent lamp cathode, a starter /1/ has been connected. Disadvantages of such devices are - a comparatively low efficiency, heavy weight, the dimensions of electromagnetic elements (due to low frequency of the mains voltage - 50 Hz), and heavy acoustic noises. The use of inductive ballast causes phase difference between the consumption current and the voltage, which considerably overloads the power network. Besides, a rather low reliability of the starter limits the reliability of such devices on the whole.

More closer to the suggested device is a power supply for luminescent lamps, containing an electronic starter, a mains voltage rectifier with its input connected to the input terminals and the output connected to the circuit of the current-proportional controlled voltage converter, assembled in the half-bridge circuit with n-s connected in parallel to one of its arms (n = 1, 2, 3, ... chains, consisting of series connected ballast element and the first outputs of the first and the second luminescent lamp cathode respectively). A capacitor is connected between the second outputs of the first and the second luminescent lamp cathode, besides, the electronic starter includes a rectifier; a threshold element, its output connected to the output of the rectifier; and a voltage divider, the tap of which is connected to the input of the threshold element /2/. The disadvantage of this device is unreliable mode of expected switch-on. It is connected with the fact that at the moment of switch-on of the power supply by the threshold element, the electronic starter switches on too, which changes the operation mode of the voltage converter to a higher conversion frequency. At the same time the luminescent lamp is affected by the open-circuit voltage Uxx and a Ik current goes through its cathodes. After a certain period of time, the lamp ignition voltage drops (at the expence of cathode warm-up) and it lights up. After that the voltage converter goes to a lower conversion frequency. Due to the effect of the voltage Uxx on the lamp at the moment of its warm-up, a kind of mixed mode of ignition - "cold" ignition together with the warm-up of the cathodes - takes place. Because of the spread in parameters of the elements in the lamps, it is impossible to achieve the optimal ignition process, which reduces the reliability of the lamps and shortens the duration of maximum luminous efficiency during the service life, as in case of partially cold ignition, an accelerated cathode sputtering takes place. The role of the electron starter is limited to changing the conversion frequency, which is indirectly connected with starting characteristics of the luminescent lamp. Besides, the lack of agreement between the parameters of the lamp and the power supply in the starting mode limits the reliability of operation of the power supply for luminescent lamps.

The present invention is aimed to solve the task of increasing the reliability of the power supply for luminescent lamps.

The new technical property, achieved by applying the invention, is the provision of necessary modes of ignition, lighting up and operation of the luminescent lamps by forming necessary ignition delay of the luminescent lamp and by ensuring the preliminary warm-up of the cathodes, which promotes the process of ignition and results in the decrease of ignition voltage and starting current, improving thus the operation reliability of the power supply as well as of the luminescent lamp and extending their service life.

To reach this technical property the power supply for luminescent lamps (that includes an electronic starter, a mains voltage rectifier with its input connected to the input terminals and the output connected to the circuit of the current-proportional controlled voltage converter, assembled in the half-bridge circuit with n-s connected in parallel to one of its arms /n = 1, 2, 3, ... chains, consisting of series connected ballast element and the first outputs of the first and the second luminescent lamp cathode respectively/. A capacitor is connected between the second outputs of the first and the second luminescent lamp cathode, besides, the electronic starter includes a rectifier; a threshold element, its output connected to the output of the rectifier; and a voltage divider, the tap of which is connected to the input of the threshold element) is supplied with a ballast capacitor, and the electron starter has been improved with a transformer with three windings, a key element, the second rectifier and n rectifiers according to the number of chains, connected in parallel to one of the arms of the half-bridge circuit of the voltage converter, where the chains are connected in parallel to the arm of the half-bridge circuit of the voltage converter through the first winding of the ballast capacitor, the second winding of which is connected to the rectifier input and the third winding is connected through the second rectifier to the controlling input of the key element, which in its turn is in parallel connection with the joint outputs of the n rectifiers, the input of each of which is connected with the second leads of the first and the second cathode of the cor-

responding luminescent lamp of one of the n-chains. The power supply for luminescent lamps may be supplied with n/2, where n = 2, 4, 6
the n-chains are pairwise connected with the first and the second leads of the second cathodes; at the same time, the second cathodes of each pair of luminescent lamps are shunted by one of the n/2 additional ballast capacitors.

The threshold element may include two transistors with different conductivity, the base-emitter junctions of which are shunted by parallel RC-circuits, and a series circuit, consisting of a diode and a four-layer diode, connected between the collector of the first transistor and the base of the second transistor; the base of the first transistor and the collector of the second transistor are tied together, the emitters of the transistors are an outlet of the threshold element, and the junction point of the diode and the four-layer diode is an input of the threshold element.

The outputs of the voltage divider may be connected to one of the feed circuits of the voltage converter and to one of the input terminals respectively.

One of the arms of the voltage divider has been constructed with an additional capacitor from the side of its output, connected to the feed circuit of the voltage converter.

The electron starter may contain a second key element with a time-specifying network, which is in parallel connection with one of the arms of the voltage divider from the side of its output, which in its turn is connected to the feed circuit of the voltage converter.

Here, the applied elements and their connection in the power supply for luminescent lamps exclude the so-called "cold" switching of the lamp, limit both the no-load voltage amplitude and the starting current, improving thus the operation reliability of the power supply, and especially the reliability of the luminescent lamps, considerably extending their service life.

In the special version of the power supply, the corresponding accomplishment of the threshold element provides its high noise stability, excludes "cold" switching-on of the luminescent lamp with high noise level in the primary circuit (surges and follows of the circuit).

In an other special version of the power supply, the connection of the voltage divider th the input terminal provides quick availability for service of the electron starter and excludes unregulated ignitions of the luminescent lamp.

The construction of one of the arms of the voltage divider with an additional capacitor provides necessary ignition delay of the luminescent lamp and the preliminary warm-up of its cathodes rather easily.

In an other special version of the power supply, the use of a second key element with a time-specifying circuit in the electronic starter provides the necessary ignition delay of the luminescent lamp with smaller capacitance of the capacitor and enables complete exclusion of the electrolytic capacitors with short service life.

The above given cause-and-consequence relations allow algorithmic matching of the parameters of the lamp and the power supply in the start-up procedures, which increases the operation reliability of the power supply and the luminescent lamps through their optimal operation.

Figure 1 presents an example of a conscrete implementation of the power supply for luminescent lamps and figure 2 shows a version of the electonic starter.

The power supply for luminescent lamps contains (see fig. 1) an electronic starter 1, a mains voltage rectifier 2 with its input connected to the input terminals 3, 4 and its output connected to the feed circuits of the current-proportional controlled voltage converter 5, assembled in the half-bridge circuit, where n = 2 chawins 6, 7, consisting of a ballast element 8, 9 connected in series with the first outputs 10 and 11, 12 and 13 of the first and the second luminescent lamp cathode 14, 15 respectively; a capacitor 20, 21 is connected between the second outputs 16 and 17, 18 and 19 of the first and the second luminescent lamp cathode 14, 15. The electronic starter 1 includes a rectifier 22, a threshold element 23, its output connected to the output of the rectifier 22, and a voltage divider 24, the tap 25 of which is connected to the input of the threshold element 23. In addition to that, the power supply includes a ballast capacitor 26, and the electronic starter 1 includes a transformer 27 with three windings 28 - 30, a key element 31, the second rectifier 32 and n = 2 rectifiers 33, 34 according to thn number of chains 6, 7, connected in parallel to one of the arms of the half-bridge circuit of the voltage converter 5. The above chains 6, 7 are in parallel connection with the arm of the half-bridge circuit of the voltage converter 5 through the ballast capacitor 26 and the first winding 28 of the transformer 27, the second winding 29 of which is connected with the input of the rectifier 22 and the third winding 30 of the transformer is connected through the second rectifier 32 to the controlling input of the key element 31, which in its turn is connected in parallel with the joint outputs n = 2 of the rectifiers 33, 34, the input of each of which is connected to the second outputs 16 and 17, 18 and 19 of the first and the second cathode of the correcponding luminescent lamps 14,15 of one of the n = 2 chains 6, 7,

The threshold element 23 contains two transistors 35, 36 with different conductivity, the base-

emitter junctions of which are shunted by parallel RC chains 37, 38, and a series circuit, consisting of a diode 39 and a four-layer diode 40, connected between the collector of the first 35 and the base of the second 36 transistor; the base of the first 35 and the collector of the second 36 transistor are tied together, the emitters of the transistors 35, 36 are an output of the threshold element 23, and the junction point of the diode 39 and the four-layer diode 40 is an input of the threshold element 23.

The voltage dividers 24 outputs are connected to one of the feed circuits of the voltage converter 5 and to one of the input terminals 3 respectively.

The one of the arms of the voltage divider 24, wich are connected to the feed circuits of the voltage converter 5, is constructed with an additional capacitor 41.

The electron starter 1 may contain (see fig. 2) the second key element 42 with the time-specifying network, which is in parallel connection with one of the arms of the voltage divider 24 from the side of its output, which is connected to the feed circuit of the voltage converter 5.

The rectifiers 2, 22, 32 - 34 (see fig. 1, 2) may be assembled in any known circuit, for example, in half-bridge circuit. The functions of the ballast element 8, 9 may be performed by chokes.

The voltage converter 5 (see fig. 1) includes a unijunction transistor oscillator 43, which acts as a starter of the voltage converter 5. The resistors and diodes in the circuit of the voltage converter 5 (see fig. 1) are for providing the necessary operation modes of its components.

The power supply for luminescent lamps (see fig. 1) may include $n/2 = 1$ (with $n = 2$) additional ballast capacitors 44, and the luminescent lamps 14, 15 of the chains 6, 7 are connected with each other by the first 11, 13 and the second 17, 19 outputs of the second cathodes, at the same time the second cathodes of the luminescent lamps 14, 15 are shunted by an additional ballast capacitor 44.

The device works as follows: when applying alternating voltage to the input terminals 3, 4 of the power supply (see fig. 1), it is rectified and filtrated by the mains voltage rectifier 2, and after that, it reaches the feed circuits of the voltage converter 5. After starting the converter by the oscillator 43, it generates rectangular form alternating voltage of the type "meander". At the same time, the half-waves of the rectified mains voltage reach the voltage divider 24 of the electronic starter 1. The voltage on the tap 25 of the voltage divider 24 starts to increase. The connection of one of the outputs of the voltage divider 24 to the input terminal 3 (power supply by single half-period pulses of the mains voltage) allows, at the specified delay, to decrease considerably the capacitance of the capacitor 41 of the voltage divider 24. Alternating voltage from the voltage converter 5 reaches the luminescent lamps 14, 15 of the chains 6, 7 through the ballast capacitor 26, the ballast elements 8, 9 and the winding 25 of the transformer 27. The alternating voltage, induced on the winding 30 at the expense of the tie between the windings 28 and 30 of the transformer 27 opens the key element 31 of the electronic starter 1 through the rectifier 32. The key element 31 shorts out the second outputs 16 and 17, 18 and 19 of the first and the second luminescent lamp cathode 14, 15 through the rectifiers 33, 34 and provides the flow of current through the cathodes of the lamps 14, 15. The warm-up of the cathodes of the lamps 14, 15 takes place with completely shorted out electrodes (with no-load voltage $Uxx = 0$). When the voltage on the tap 25 of the voltage divider 24 reaches the threshold value of the threshold element 23, the latter opens and with its output shunts the winding 29 of the transformer 27 through the rectifier 22. At the same time, the current, going through the winding 28 and having been transformed before that to the winding 30, is switched to the shunted winding 29. The voltage, induced on the winding 30, decreases and the key element 31 closes. Here, the short circuit of the second outputs 16 and 17, 18 and 19 of the first and the second cathode of the luminescent lamp 14, 15 and the ignition of the latter at a relatively low voltage (at the expense of the preliminary warm-up of the cathodes of the lamps 14, 15) take place. The capacitors 20, 21 provide the flow of additional current through the cathodes, and together with the ballast elements 8, 9, they form a resonant circuit for maintaining the voltage on the lamp 14 (15), when the input voltage decreases (partial stabilization).

It should be pointed out, that the key element 31 may commutate analogically any number of luminescent lamps through the corresponding number of rectifiers, connected to the second outputs of their cathodes. The lamps are switched on in the corresponding number of chains, analogical to the chains 6, 7 connected through the ballast capacitor 26 and the winding 28 of the transformer 27 of the electronic starter 1 in parallel with one of the arms of the voltage converter 5.

To explain the concrete realization of the voltage divider 24 and the threshold element 23, it is necessary to stress, that the resistance of the resistor of the voltage divider 24 is determined by starting current of the four-layer diode and the holding time of the luminescent lamp in the mode of preliminary warm-up. The capacitance of the capacitor 41 of the voltage divider 24 is determined only by the holding time. In this connection it is possible to ensure the necessary holding time with

considerable values of resistance of the resistor of th voltage divider 24 and small values of capacitance of the capacitor 41 (and also at the expense of the connection of one of the outputs of the voltage divider 24 to the input terminal 3). This enables to exclude the application of electrolytic capacitors, which have higher leakage currents and comparatively high time-instability of the capacitance. The increase of resistance of the resistor of the voltage divider 24 reduces the power of losses and diminishes its dimensions.

The threshold element 23 contains a four-layer diode 40, the starting current of which determines (limits) the resistance of the resistor of the voltage divider 24. At the moment of switch-on of the four-layer diode 40, the transistors 35, 36 open. These transistors shunt the winding 29 of the transformer 27 through the rectifier 22. The flow of the current from the winding 29 through the rectifier 22, the transistor 35, the diode 39, the four-layer diode 40, the resistor 38 and the transistor 36 provides the retention current of the four-layer diode 40. Hereby, it is not required to conduct considerable amount of current through the resistor of the voltage divider 24, which allows to increase its resistance. The diode 39 prevents inverted switching of the transistor 35.

The transformer 27 is a current transformer, where the current is transformed through the winding 28 either to the circuit of winding 30 or to that of winding 29 after the warm-up of the lamp.

The RC chains 37, 38, which are in parallel connection with the base-emitter junctions of the transistors 35, 36, increase the noise stability of the threshold element 23.

In the version of the electronic starter 1 in fig. 2, the second key element 42 with a time-specifying network provides the effect of capacitance multiplication of the capacitor (Miller's circuit) at the expense of the connection to one of the arms of the voltage divider 24, which enables in this type of connection to reduce considerably the capacitance of the time-specifying capacitor, determining the holding time of the lamp (delay time of lamp ignition), providing the required warm-up time of the luminescent lamp (2 - 5 sec.). Reduction of the capacitance allows the microminiaturization of the circuit of the electronic starter 1. As for the rest, then the processes going on in the electronic starter 1 in fig. 2 are similar to those described above for the electronic starter in fig. 1.

The connection of the capacitor 44 in parallel with one of the cathodes of the luminescent lamps 14, 15 (n = 2) enables to provide low current of one of the cathodes 11 - 17, 13, - 19. During a long-term use (more than 8000 hours) of the lamps, as a rule, a failure (break) may occur with a cathode 10 - 16 (12 - 18); the current through the choke 8 (9) fails, the lamp 14 (15) is not lit. Then the lamps 14 (15) should be turned round so, that the cathodes 10 - 16 (12 - 18) and 11 - 17 (13 - 19) exchange their places; then the earlier unloaded cathode 11 - 17 (13 - 19) provides current through the choke 8 (9), and the failed cathode 10 - 16 (12 - 18), which is shunted by the capacitor 44 has no influence on the operation of the voltage converter 5, as the alternating current goes through the capacitor 44. Thus the service life of the luminescent lamp increases two times with minimal technical expenditures; every two luminescent lamps 14, 15 require one capacitor 44. The use of a reserve cathode does not disturb the processes going on in the tube of the lamp 14 (15), but the reliability of the power supply with the lamp increases.

On the bases of the presented above, the proposed device allows to provide algorithmically reliable operation modes for one; two or more luminescent lamps; to exclude the unreliable components from the device, to miniaturize the device and also to increase considerably who reliability of the power supply, to extend the service life of the luminescent lamps and to achieve the reliability indexes of the best specimen in the world: OSRAM, PHILIPS, SIEMENS (10 000 - 16 000 hours).

Experiments and testing of normal operation of the specimen of the power supply for luminescent lamps were performed with the lamps type K 36 in cooperation with the VNIIIS in Saransk.

References:

1. Handbook of Lighting Engineering (Eisenberg, editor) - Moscow, Energoatomizdat, 1983, p. 145, fig. 6, 20 (in Russian)
2. S. Georgobiani, O. Malkova, A. Shakhparunyants. "Electronic Start-controlling Device for Luminescent Lamps." Lighting Engineering 1992; No. 5, p. 7.

Claims

1. The power supply for luminescent lamps, containing an electronic starter, a mains voltage rectifier with its input connected to the input terminals and the output connected to the circuit of the current-proportional controlled voltage converter, assembled in the half-bridge circuit with n connected in parallel to one of its arms (n = 1, 2, 3, ... chains, consisting of series connected ballast element and the first outputs of the first and the second luminescent lamp cathode respectively). A capacitor is connected between the second outputs of the first and the second luminescent lamp cathode, besides, the electronic starter included a rectifier; a threshold element, its output connected to the

output of the rectifier; and a voltage divider, the tap of which is connected to the input of the threshold element, being **distinguished** by the fact, that it is supplied with a ballast capacitor, and the electron starter has been improved with a transformer with three windings; a key element, the second rectifier and n rectifiers according to the number of chains, connected in parallel to one of the arms of the half-bridge circuit of the voltage converter, here the chains are connected in parallel to the arm of the half-bridge circuit of the voltage converter through the ballast capacitor and the first winding of the transformer, the second winding of which is connected to the rectifier input and the third winding of the transformer is connected through the second rectifier to the controlling input of the key element, which in its turn is in parallel connection with the joint outputs of the n rectifiers, the input of each of which is connected with the second outputs of the first and the second cathode of the corresponding luminescent lamp of one of the n-chains.

2. The power supply for luminescent lamps according to point 1, being **distinguished** by the fact, that it is supplied with n/2, where n = 2, 4, 6 ... additional ballast capacitors and the luminescent lamps of the n-chains are pairwise connected with the first and the second leads of the second cathodes; at the same time, the second cathodes of each pair of luminescent lamps are shunted by one of the n/2 additional ballast capacitors.

3. The power supply for luminescent lamps according to points 1, 2, being **distinguished** by the fact, that the threshold element two transistors with different conductivity, the base-emitter junctions of which are shunted by parallel RC-circuits, and a series circuit, consisting of a diode and a four-layer diode, connected between the collector of the first transistor and the base of the second transistor; the base of the first transistor and the collector of the second transistor are tied together, the emitters of the transistors are an outlet of the threshold element, and the junction point of the diode and the four-layer diode is an input of the threshold element.

4. The power supply for luminescent lamps according to points 1, 2, 3, being **distinguished** by the fact, that the outputs of the voltage divider have been connected to one of the feed circuits of the voltage converter and to one of the input terminals respectively.

5. The power supply for luminescent lamps according to points 1, 2, 3, 4, being **distinguished** by the fact, that one of the arms of the voltage divider from the side of its output, which is connected to the feed circuit of the voltage converter, completed with an additional capacitor.

6. The power supply for luminescent lamps according to points 1, 2, 4, being **distinguished** by the fact, that the electron starter includes a second key element, supplied with a time-specifying circuit, connected in parallel to one of the arms of the voltage divider from the side of its output, connected to the feed circuit of the voltage converter.

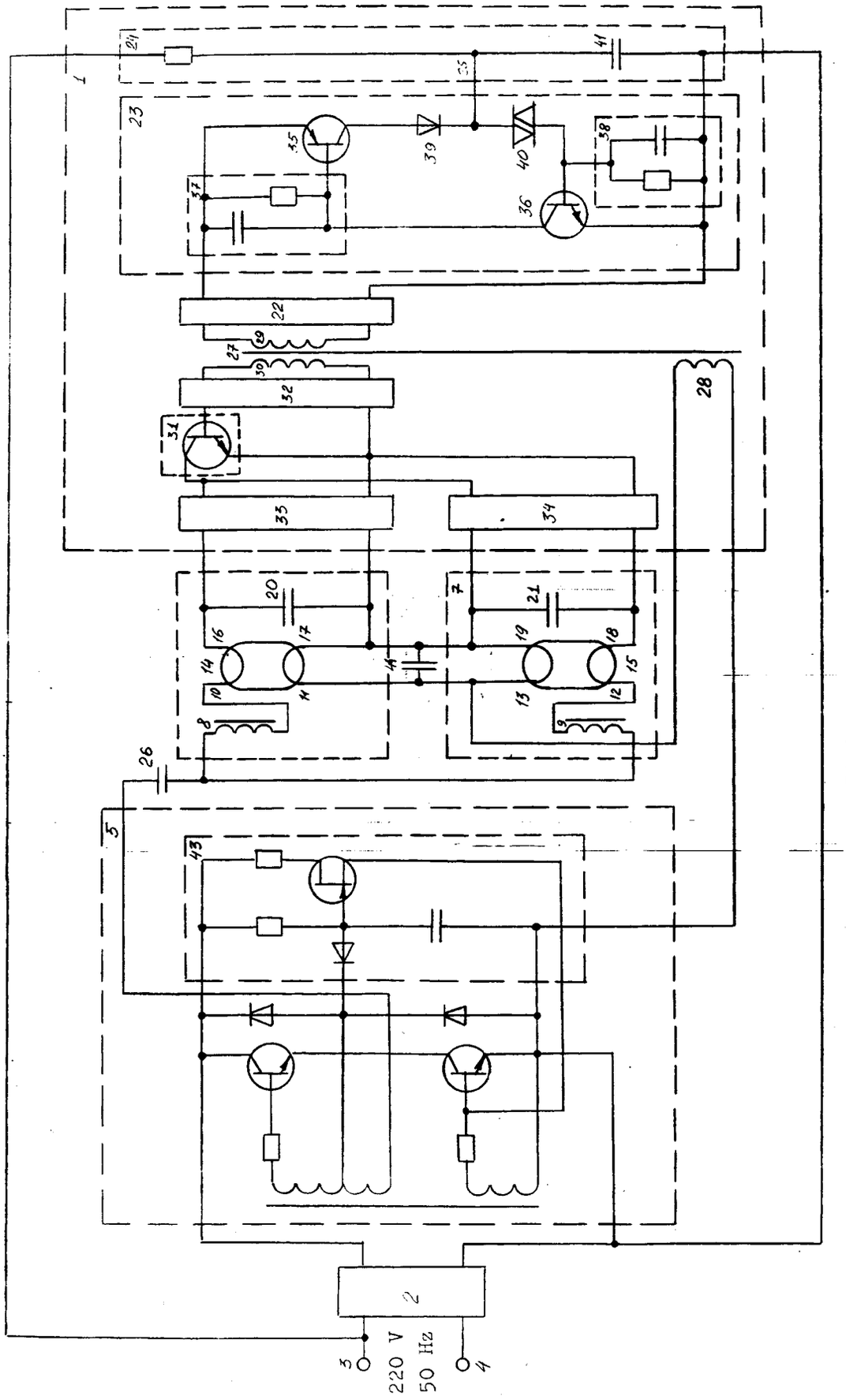
1
2
3
4
5
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
38
39
40
41
43
220 V
50 Hz

FIG 1

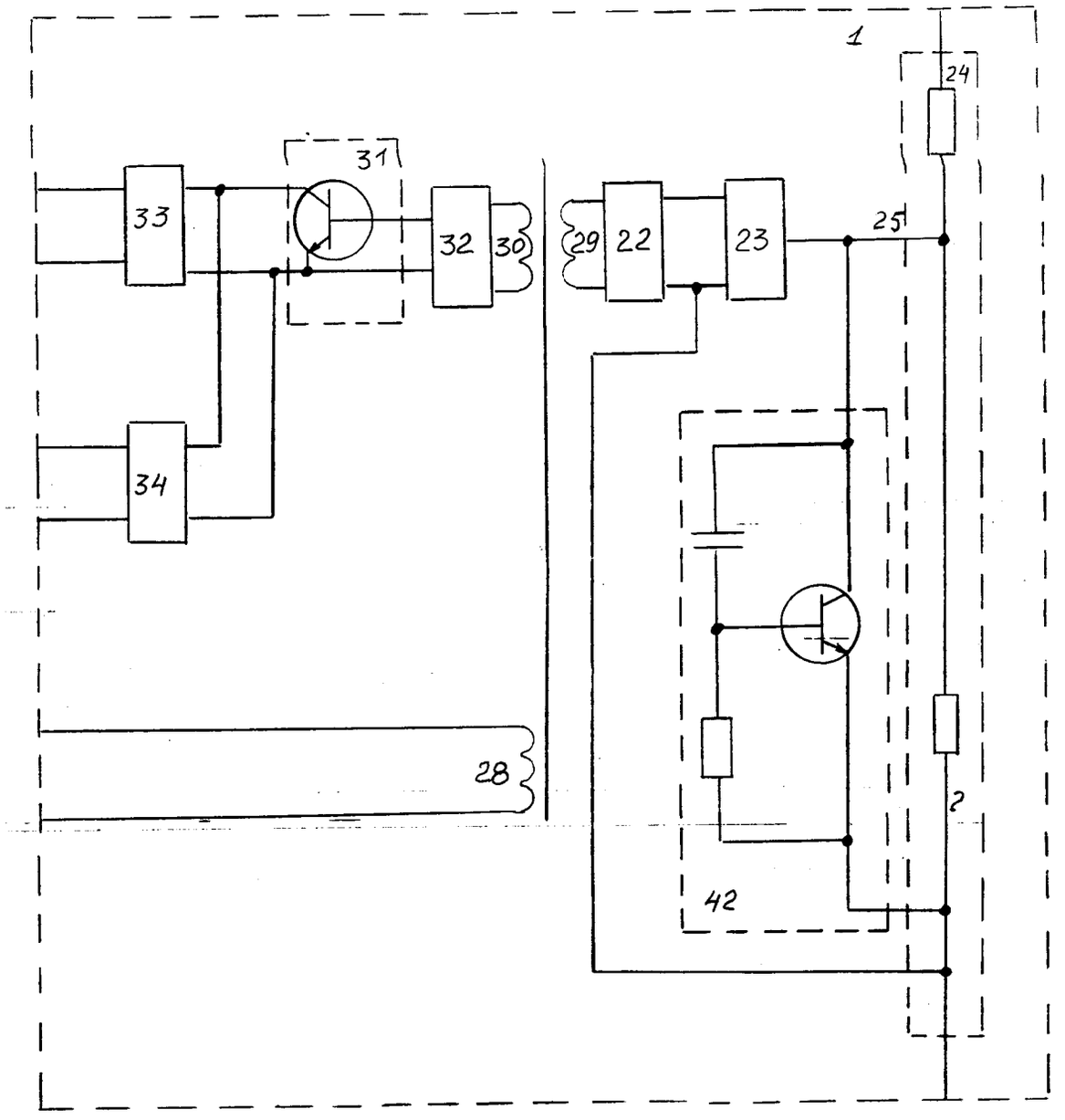

FIG 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 2678

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE-A-3 938 677 (TRILUX) * column 4, line 16 - column 4, line 37; figures 1,2 * ---	1	H05B41/29
A	GB-A-2 053 592 (SILIANI) * abstract; figure 1 * -----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 JUNE 1993	SPEISER P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)