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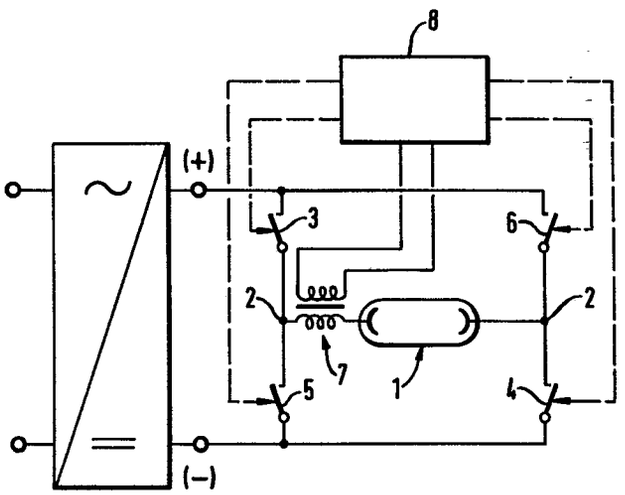
(54) Electronic mains connection device for a gas-discharge lamp.

(57) An electronic mains connection device for a gas-discharge lamp, acting as a stabilizing current limiting element and comprising an inverter circuit which from rectified mains current or from some other direct current converts the service voltage for a lamp to such a high frequency that the impedance of a discharge lamp is like normal resistance. A problem is to provice a stable current limitation without current limiting impedances, whereby the limitation of a current can be arranged to be effected only by means of the lamp's own resistance-like impedance on both half-cycles. For this end, the limitation of a current is effected during a period longer than a cycle of inverter operation by means of a feed-back control (7, 8) of the lamp current, controlling the opening times and/or operating frequency of the switches (3, 5) of said inverter circuit.



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Electronic mains connection device for a gas-discharge lamp

The present invention relates to an electronic mains connection device for a gas-discharge lamp, acting as a stabilizing current limiting element and comprising an inverter circuit which from rectified mains current or some other direct current converts the service current for a lamp to such a high frequency that the impedance of a discharge lamp is like normal resistance.

Thus, the invention relates to an inverter circuit embodied by means of semi-conductors and applied in a mains connection device of gas-discharge lamps for feeding current to the lamp.

In this context, the term gas-discharge lamps refers to lamps generally used for lighting and whose internal impedance in normal alternating current service of 50 or 60 Hz is characteristically negative resistance and which thus require a gas-discharge stabilizing current limiting element. Such lamps comprise fluorescence lamps, low-pressure and high-pressure sodium lamps, mercury vapour lamps and halogen lamps.

Prior known are a plurality of various electronic circuit solutions effected by means of semi-conductors and passive components suitable as the connection means for a gas-discharge lamp. These solutions are based on converting direct current one way or another to alternating current having substantially 50 Hz higher frequency. At this higher frequency a lamp is fed with the electric energy required by its gas-discharge. The advantages gained include improved light efficiency due to increased service frequency, reduction of the mechanical size of necessary electromagnetic components and thereby reduction of the connection device's own power loss as well as reduction of the weight of a connection device. An obvious advantage is also that it is generally easy to combine the control of a lamp's illumination level with an electronically effected connection device solution. In most circuit solutions for an electronic connection device, it is easy to develop sufficient voltage for the ignition of a discharge lamp without a separate igniter. Furthermore, an electronic connection device does not produce sound disturbances providing that service frequency is selected from above the hearing range. It is possible to eliminate a disturbing flicker from the light emitted by the lamp. An electronic connection device can also be effected, so that the curve of a current taken up by the apparatus from the alternating mains is nearly sine-shaped and its power factor is $\cos \varphi \approx 1$, whereby separate components for the compensation of the mains current are not required.

The prior art embodiments of an electronic connection device generally include some lamp current limiting impedance; a choke, a capacitor, a resistor or a combination thereof connected in series with a lamp and a source of supply voltage (e.g. DOS publication No. 2 550 550).

Physically known is that the impedance of a discharge lamp turns from negative resistance to what is like normal resistance with the lamp operated at an alternating voltage whose frequency is within the range of 1 kHz ... 150 kHz. Partially based on this phenomenon, it is known to employ a so-called blocking-oscillator circuit in one form or another (e.g. US Patent publications Nos. 3 629 648, 3 906 302 and 4 168 453). In such a circuit, a lamp is directly coupled to the supply voltage at the half-cycle a switch element (e.g. a transistor) is conducting by, and the voltage at the terminals of a lamp turns opposite on the part of a cycle on which the switch element is in non-conductive state. This inverted voltage is developed from the magnetizing energy charged in an inductance which is parallel-coupled with the lamp, said magnetizing energy discharging through the lamp as the switch element is opened.

The present invention is also based on a circuit solution capable of operating discharge lamps at the above-mentioned relatively high frequencies on which a discharge lamp behaves as normal resistance. However, a circuit solution according to the invention differs from the prior art solutions in that it does not require any inductive or capacitive member for the stabilization of a lamp's gas-discharge.

It has been found experimentally that a discharge lamp can be operated by connecting it by means of inverter switches directly to a source of supply voltage by reversing the polarity of a lamp on each half-cycle. The switching frequency must then be so high that a discharge lamp behaves as a resistance.

However, the above-described mode of operation is not stable but there is a tendency in the lamp towards

"a breakaway phenomenon" which is substantially slower than the length of a cycle of service frequency and, as a consequence of which, the current tends to increase with the voltage remaining constant. To overcome this phenomenon according to the invention, such a current breakaway phenomenon is prevented by measuring the rate of a current running through the lamp and by employing feed-back control for maintaining this current rate at a desired value. In the feed-back it is possible to employ the filtering time constant of a measuring quantity, which e.g. at a service frequency of 40 kHz can be circa o,2 ms.

The characterizing features of the present invention are set forth in the accompanying claims.

The following advantages are gained by the solution of the invention:

1. No need for winding components or capacitors dimensioned for the main current.
2. No need for capacitors whose operating temperature has a fixed range, the connection device being applicable for use at a higher operating temperature as disposed e.g. directly in connection with a lamp.
3. The connection device is low in costs since the above-mentioned expensive components are left out.
4. The above components are also the most bulky in the prior art connection devices and thus the present connection device can be made more compact without said components and be used in smaller spaces.
5. The main circuit of the connection device can be entirely effected by means of semi-conductors.

In the following, some embodiments of the invention are described in more detail with reference made to the accompanying drawings, in which

Fig. 1 illustrates the principle diagram of a mains connection device of the invention.

Fig. 2 shows another embodiment of the invention as a principle diagram.

Fig. 3 and 4 show subsequent modifications of the invention the same way as Fig. 1.

Fig. 5 shows a circuit diagram for a mains connection device according to one embodiment of the invention with only those components shown which are most essential for the operation of the device.

Referring to Fig. 1, a gas-discharge lamp 1 is connected to a source of direct current by way of four electronic switches 3-6 in a manner that these switches make up an inverter circuit by means of which the polarity of supply voltage at the terminals of lamp 1 is reversed at a high frequency which is within the range of circa 1 kHz ... 150 kHz. This reversal of polarity is effected in a manner that, with switches 3 and 4 closed, switches 5 and 6 are open and when the latter switches are closed, the former switches are opened. In addition, between closing and opening of the switches there can be an interval of adjustable length when all switches are open. This can be used for the regulation of the lamp's illumination level. As pointed out above, the circuit solution of a connection device of the invention is not provided with any current limiting impedance element but, instead, the current is only limited by means of the lamp's 1 own resistance-like impedance at said high inverting frequency. However, this would not be possible without an additional arrangement of the invention since the current of lamp 1 would tend to break away on an

on an interval substantially longer than the inverting cycle. In order to eliminate this breakaway phenomenon, the invention provides a feed-back control, wherein a current transformer 7 or some other current measuring means, such as a resistor, is used to sense the current of lamp 1 and, on the basis of this current rate, a control unit 8 controls the open times and/or operating frequency of the inverter circuit switches 3-6 in a manner that the current of lamp 1 remains constant.

The circuit illustrated in Fig. 2 is otherwise similar to that of Fig. 1 except that a lamp 1 is connected to an inverter circuit and to a source of direct current by means of an economy transformer 9 which increases the supply voltage of lamp 1 with respect to the voltage of a current source. An economy transformer 9 can be further used for glowing the cathodes of lamp 1 to improve the ignitability of the lamp. In addition, an economy transformer 9 can serve to create an ignition voltage peak sufficient for the ignition of lamp 1.

The embodiment of Fig. 3 differs from that of Fig. 1 in that switches 6 and 4 are replaced by capacitors 10 in order to simplify the circuit. This is a suitable approach in the applications in which the temperature limitation set by the capacitors is of no significance.

In the embodiment of Fig. 4, switches 3 and 6 of the circuit solution shown in Fig. 1 are replaced by an economy transformer 11, one of the terminals of a current source being connected to its central outlet. The magnetizing inductance of an economy transformer 11 can be conventionally employed for creating an ignition voltage peak for lamp 1. A resistor 16 is used for measuring a current passing through the lamp in the other direction which measuring method, as for the operation of the device, replaces the measuring effected in other embodiments by

means of a current transformer.

Fig. 5 illustrates a further developed embodiment corresponding to Fig. 3, comprising parallel to a lamp 1 an ignition voltage peak creating inductance 13 and parallel to that an overvoltage protector 14. A current transformer 7 senses a current passing through lamp 1, said current rate being passed through a rectifying circuit 15 to a control unit 8. On the basis of this current rate, a control unit 8 issues control pulses for the control electrodes of transistors serving as switches 3 and 5, the duration and/or operating frequency of said control pulses changing as necessary for maintaining the current passing through lamp 1 constant. In order to set this current to be maintained constant at various values for the regulation of illumination emitted by lamp 1, said control unit 8 is provided with a regulator 12 capable of having effect on the opening times of switch transistors 3 and 5 or on their inverting frequency.

Claims

1. Electronic mains connection device for a gas-discharge lamp, said device acting as a stabilizing current limiting element and comprising an inverter circuit which from rectified mains current or some other direct current converts the service current for a lamp to such a high frequency that the impedance of a discharge lamp is like normal resistance,
c h a r a c t e r i z e d in that the connection device does not include current limiting impedances but the limitation of a current is arranged to be effected only by means of the lamp's own resistance-like impedance on both half-cycles, whereby the limitation of a current is effected during a period longer than a cycle of inverter operation by means of a lamp current feedback control (7, 8) which controls the opening times and/or operating frequency of switches (3-6) of said inverter circuit.

2. A mains connection device as set forth in claim 1, c h a r a c t e r i z e d in that a lamp (1) is connected to an inverter circuit by way of an economy transformer (9) in a manner that the voltage of said lamp is higher than that of a current source (fig. 2).

3. A mains connection device as set forth in claim 1 or 2, c h a r a c t e r i z e d in that two of the switches of the inverter circuit between on terminal of the lamp and the terminals of a current source are replaced by capacitors (10) (Figs. 3 and 5).

4. A mains connection device as set forth in claim 1, c h a r a c t e r i z e d in that two of the switches of the inverter circuit between one terminal of the lamp and the terminals of a current source are replaced by an economy transformer, one of the

terminals of said current source being connected to its central outlet (Fig. 4).

5. A mains connection device as set forth in any of the preceding claims, c h a r a c t e r i z e d in that the feed-back is effected by means of a filtering time constant of the measuring quantity of the current passing through the lamp.

6. A mains connection device as set forth in claim 1, c h a r a c t e r i z e d in that for the ignition of said discharge lamp (1) a separate ignition element, e.g. (9; 13) is coupled parallel to the lamp.

7. A mains connection device as set forth in any of the preceding claims, wherein the switches consist of transistors, c h a r a c t e r i z e d in that a unit (8) for the regulation of the transistors' (3, 5) control voltage and acting as a feed-back control unit is accompanied by a device (12) for setting the current of lamp (1) for the regulation of illumination.

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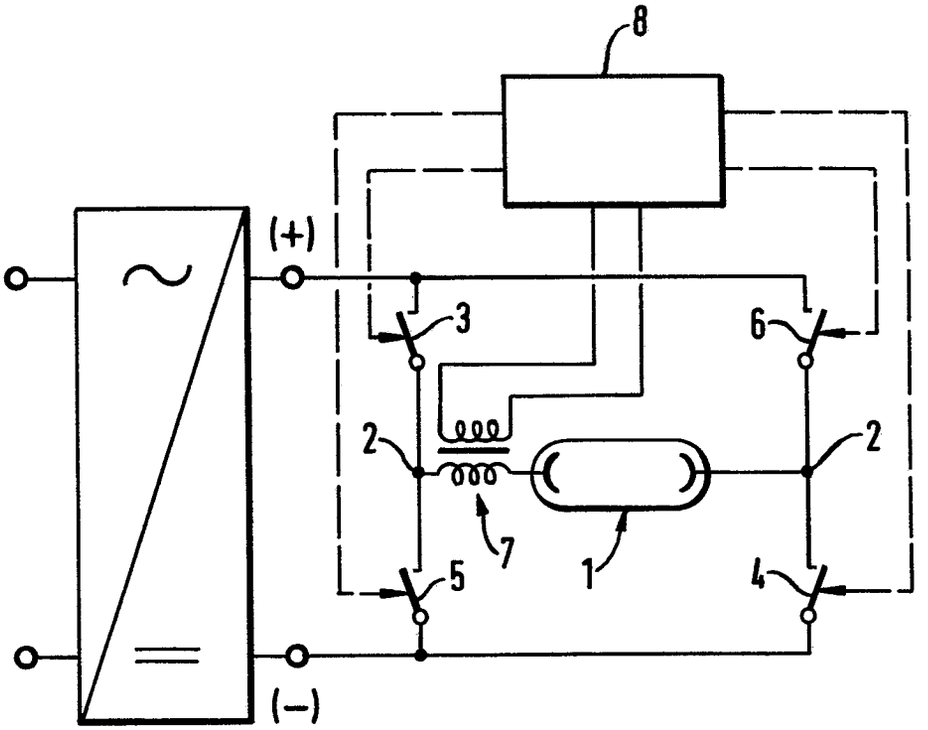


Fig. 1

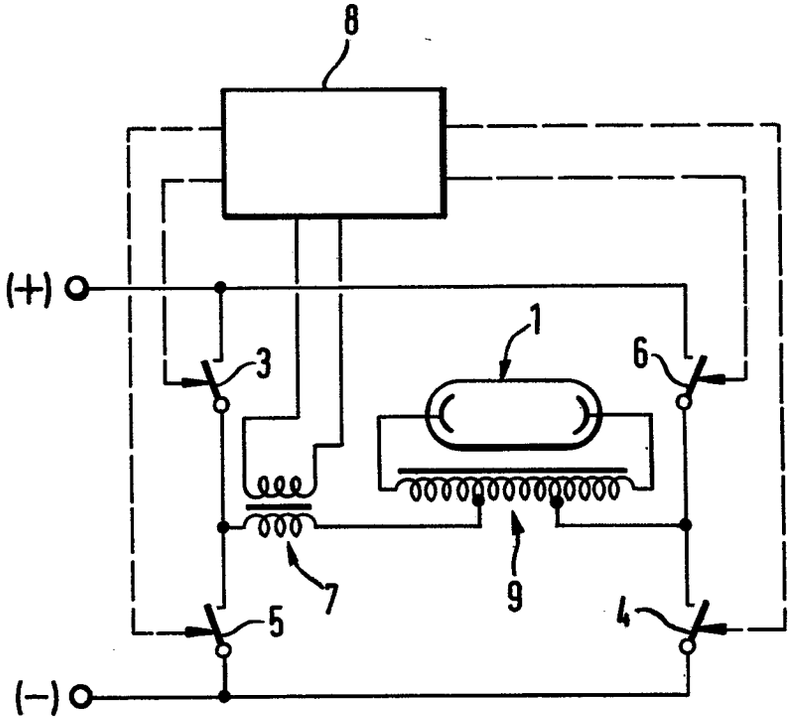


Fig. 2

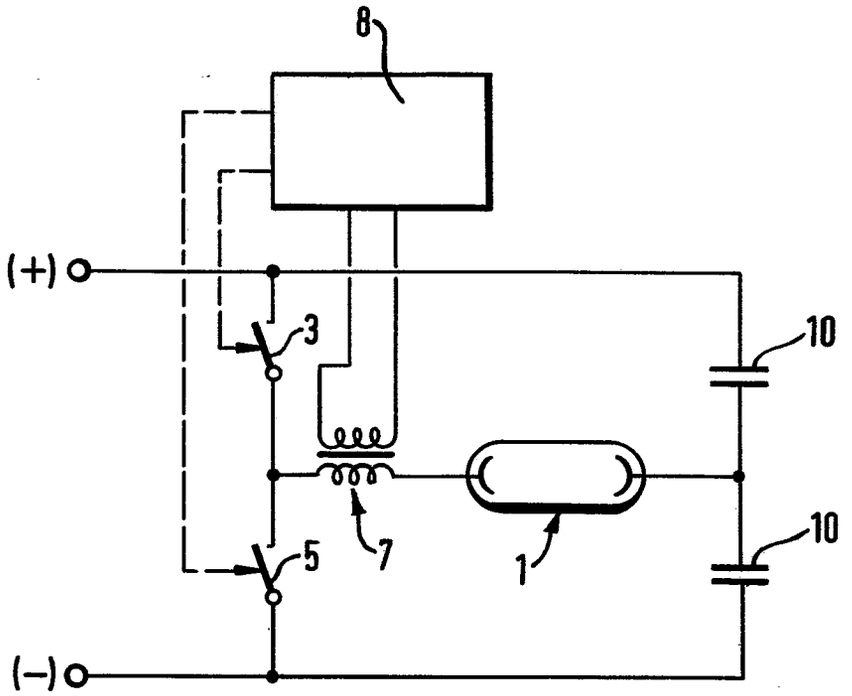


Fig. 3

Fig. 4

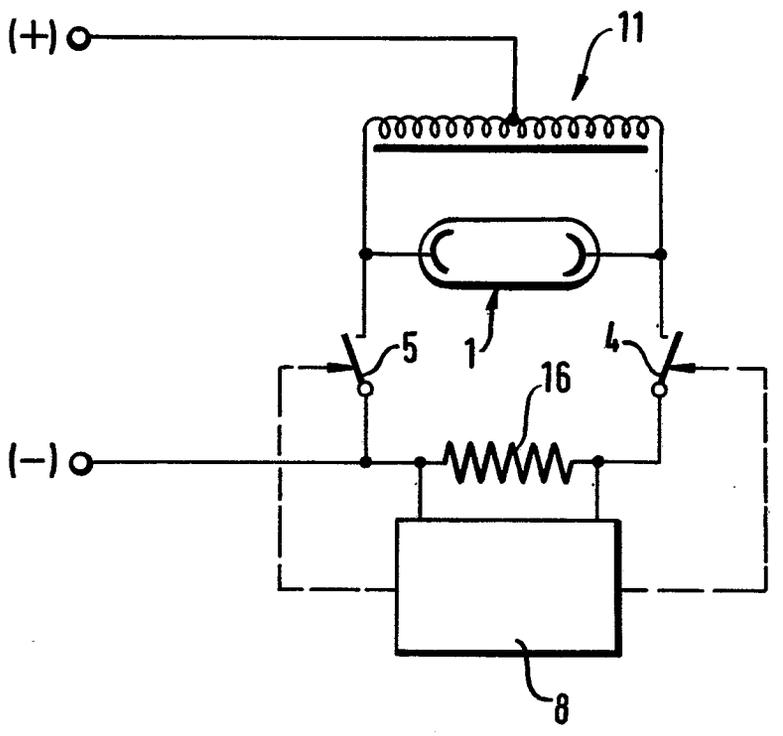
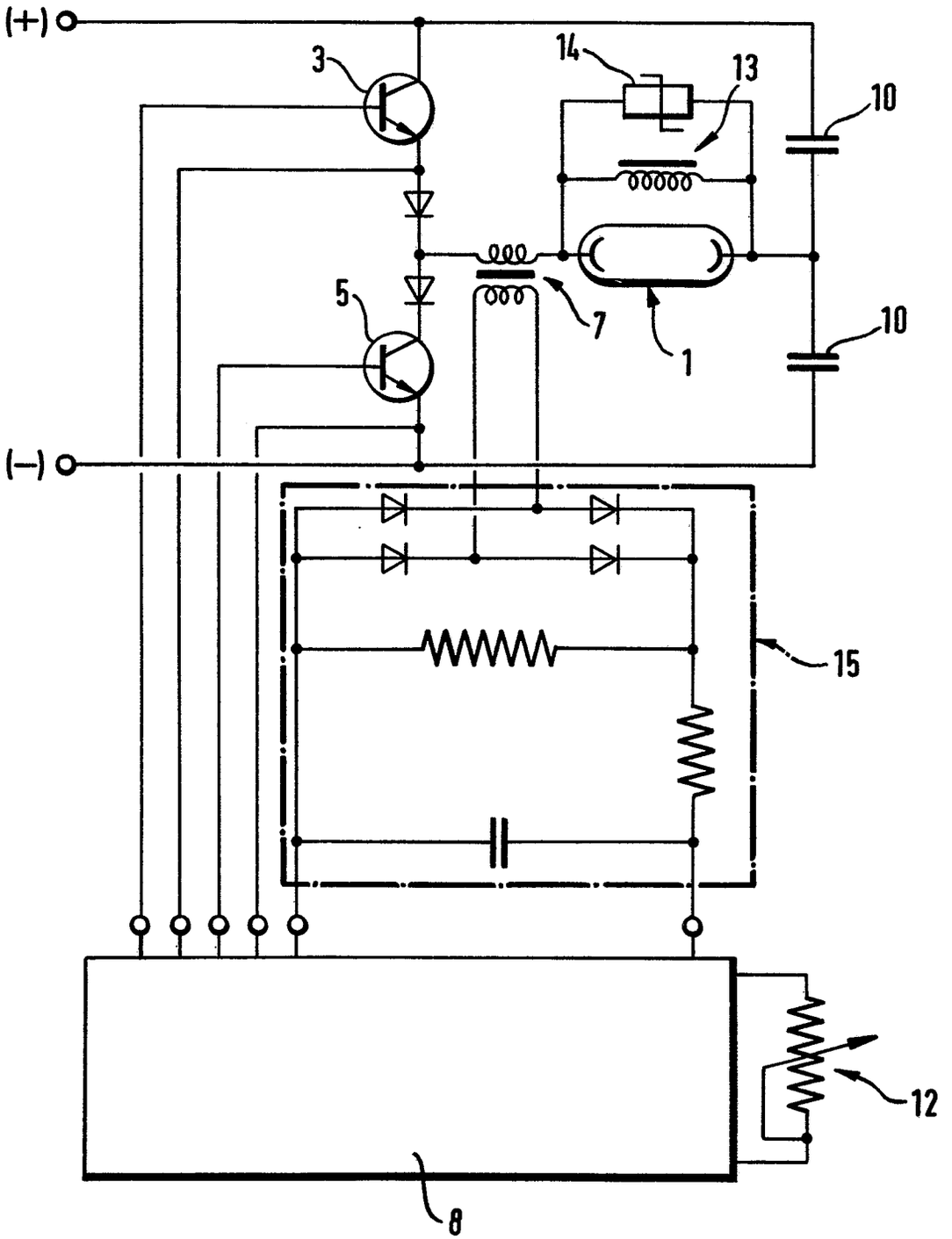


Fig. 5



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EUROPEAN SEARCH REPORT

Application number 0066754

EP 82 10 4449

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. 3)
X	US-A-3 999 100 (DENDY) *The whole document* ---	1,5,6,7	H 05 B 41/29
X	FR-A-2 451 696 (PATENT-TREUHAND) *The whole document* -----	1,3,7	

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

H 05 B 41/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16-08-1982	DUCHEYNE R.C.L.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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