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(54) Fluorescent lamp electrode disconnect arrangement.

(57) A fluorescent lamp system including a switch for each electrode of the lamp system wherein each switch is operable in response to the voltage across its associated lamp after its associated lamp turns on to interrupt the connection of an associated electrode to its associated heater winding.

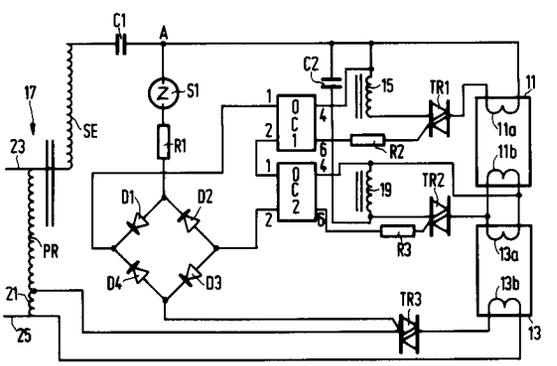

FIG. 2

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This is an invention in lighting. More particularly, it involves an arrangement for conserving power in the operation of fluorescent lamp systems.

It is desirable to decrease the power expended by fluorescent lamps by shutting off the current to the heater electrodes of such lamps after ignition. In the past a number of arrangements for doing this have been proposed. Some of these use relays (see U.S. Patent No. 4,661,745 to Citino et al and U.S. Patent No. 4,954,749 to Crawford). Relays can be noisy and are subject to wear. The use of a filament transformer has also been proposed (see U.S. Patent No. 4,399,391 to Hammer et al). Arrangements with filament transformers require auxiliary protection against excessive currents which can be developed in case a lamp electrode is damaged and the lamp acts in the manner of a rectifier.

It is an object of this invention to provide an improved arrangement for discontinuing heater electrode current flow in fluorescent lamps after the lamps are ignited.

One of the features of the invention is that it responds to the decrease in voltage across the lamps of a two lamp rapid start fluorescent lamp system which takes place after lamp ignition.

One of the advantages of the invention is that it decouples all of the filaments of a rapid start fluorescent lamp system from the filament windings upon ignition of the fluorescent lamps of the system.

In accordance with an embodiment of the invention, there is provided a fluorescent lamp system for operating one or more fluorescent lamps having a pair of electrodes. A ballast is provided for connection to a proper source of voltage. The ballast when connected to a proper source of voltage provides voltage across the lamp. The ballast includes a plurality of electrode windings. A plurality of semiconductor switches is provided, each of which connects one of the electrode windings to a respective lamp electrode. Control means is connected across the lamp and responds to the voltage across the lamp when the lamp is on to render each of the semiconductor switches non-conductive. The control means responds to the voltage across the lamp when the lamp is off to render each of the semiconductive switches conductive.

In a preferred embodiment the control means, connected across the lamp, responds to the voltage across the lamp when the lamp is off. By conducting current which current renders each switch conductive; the control means responds to the voltage across the lamp when the lamp is on by becoming non-conductive and thereby rendering each switch non-conductive.

In a further preferred embodiment of the invention the ballast comprises a transformer including a primary windings and a secondary winding, and at least one electrode winding comprises a portion of said secondary winding. Since 11 of the filaments are decoupled from the filament windings upon ignition of the fluorescent lamps of the system, no uncontrollable voltage can be generated during lamp operation.

Other objects, features and advantage of the invention will be apparent from the following description and appended claims when considered in conjunction with the accompanying drawing in which:

Figure 1 is a schematic circuit diagram of one embodiment of the invention in a two-lamp (rapid start) fluorescent system;

Figure 2 is a schematic circuit diagram of a second embodiment of the invention in a two-lamp (rapid start) fluorescent system;

Figure 3 is a schematic circuit diagram of a third embodiment of the invention in a two-lamp (rapid start) fluorescent system; and

Figure 4 is a schematic circuit-diagram of a fourth embodiment of the invention in a two-lamp (rapid start) fluorescent system.

Referring to Figure 1, there is shown therein two fluorescent lamps 11 and 13 each having a pair of electrodes 11a, 11b and 13a, 13b, respectively. Electrode 11a is connected across heater winding 15 of autotransformer 17 through triac TR1. Electrodes 11b and 13a are connected through triac TR2 across heater winding 19 of transformer 17. Electrode 13b is connected through triac TR3 across winding 21 which forms part of primary winding PR of transformer 17. As is typical primary winding PR and secondary winding SE are connected through capacitor C1 across lamps 11 and 13 to provide operating voltage thereto. Such an operating voltage will be supplied when primary winding PR is connected to a proper source of voltage through lines 23 and 25.

Starting capacitor C2 is connected across lamp 1 in order for lamp 13 to start first and lamp 11 to follow in sequence thereafter. Also connected across lamps 11 and 13 from terminal A to terminal B is a circuit comprising sidac S1 resistor R1 and a diode bridge comprising diodes D1-D4. Connected in series across the diode bridge are the inputs 1 and 2 of optical couplers OC1, OC2 and OC3. As is well known a photodiode is connected across the input terminals 1 and 2 of optical couplers OC3. As is also well known a light activated triac is connected across the output terminals 4 and 6 of each optical coupler OC1, OC2 and OC3. In this way optical couplers OC1, OC2 and OC3 provide electrical isolation between the diode bridge D1-D4 and the circuitry the light activated triacs are connected to. These light activated triacs of optical couplers

OC1, OC2 and OC3 are connected through resistors R2, R3 and R4 to the gates of triacs TR1, TR2 and TR3, respectively, to render triacs TR1, TR2 and TR3 separately controlled. Signals for the gates of triacs TR1, TR2 and TR3 are generated by the voltages across the associated electrode windings 15, 19 and 21, respectively. The main conduction paths of triacs TR1, TR2 and TR3 are connected in series with heater windings 15, 19 and 21 and their respective lamp electrodes 11a, 11b and 13a, and 13b.

In operation when a proper voltage is applied across lines 23 and 25 to primary PR of autotransformer 17 a pre-ignition voltage is applied across junctions A and B sufficient for sidac S1 to breakover and permit conduction through itself, resistor R1 and the diode bridge formed by diodes D1-D4. As a result the photodiodes in optical couplers OC1, OC2 and OC3 connected in series across the diode bridge emit radiation and turn on the light activated triacs of optical couplers OC1, OC2 and OC3. This enables current to flow from heater windings 15, 19 and 21 through respective resistors R2, R3 and R4 to the gates of triacs TR1, TR2 and TR3. As a result, triacs TR1, TR2 and TR3 are rendered conductible and permit heater windings 15, 19 and 21 to provide heating current to electrodes 11a, 11b, 13a, and 13b of lamps 11 and 13. Upon heating sufficiently electrode 13a and 13b will start conduction in lamp 13 to be followed shortly thereafter by conduction in lamp 11. Upon lamps 11 and 13 conducting the voltage across the lamps and across terminals A and B is no longer high enough to allow sidac S1 to conduct. As a consequence the light emitting diodes of optical couplers OC1, OC2 and OC3 no longer have voltage applied to them and can no longer emit light. As a consequence the light activated triacs of optical couplers OC1, OC2 and OC3 cease to conduct and no longer provide gating signals to the gates of triacs TR1, TR2 and TR3 which consequently cease conducting. As a result the electrodes of lamps 11 and 13 are no longer provided with current from heater windings 15, 19 and 21 with the consequent preservation of power which otherwise would be consumed.

In a tested embodiment using two 40 watt T12 lamps and with a power supply of 120 volts, 60 hertz applied across lines 23 and 25 autotransformer 17 produced a peak voltage across terminals A and B of 440 volts. Sidac S1 was selected with a 360 volts breakover voltage and consequently enabled conduction through resistor R1 and diodes D1-D4. Resistor R1 was selected to limit the current through the diode bridge to between 10 and 20 milliamps which met the specification for the photodiodes of optical couplers OC1, OC2 and OC3 which were made by Motorola & Harris Semi. Co. catalog number MOC3012. Triacs TR1, TR2 and TR3 for this constructed embodiment were made by Teccor Co. catalog number Q201E3. In this embodiment a total savings of about four (4) watts of power was experienced for both lamps.

In the Figure 2 embodiment which was also tested elements corresponding to those of the Figure 1 embodiment are identified by the same reference characters. In this Figure 2 embodiment it can be seen that the control means comprising sidac S1, resistor R1 and the diode bridge formed by diodes D2-D4 is not connected across terminal such as A and B of Figure 1 but directly to the gate of triac TR3 and through electrode 13b of lamp 13 to line 25. With this arrangement an optical coupler such as OC3 of the Figure 1 embodiment is no longer required. For purposes of operation, however, triac TR3 was changed from one made by Teccor Co. catalog part number Q201E3 to one made by Teccor Co. catalog part number L201E3. Other components of the Figure 2 embodiment were the same as the corresponding components of the Figure 1 embodiment. In this Figure 2 embodiment the control means comprising the circuitry containing sidac S1 and the optical couplers OC1, OC2 enabled triacs TR1, TR2 and TR3 to provide heating power to the electrodes of lamps 11 and 13 to enable them to ignite and upon ignition the control means responded to the reduction in the voltage across the lamps to render triacs TR1, TR2 and TR3 non-conductive.

In the Figure 3 embodiment the optical couplers have been identified by the reference characters OC1', OC2' and OC3' to distinguish them from the optical couplers of the other two embodiments. The reason for this is that these optical couplers were Toshiba catalog part number TLP3520 type which combines the function of an optical coupler with an output triac in a single integrated circuit package. Consequently, separate triacs such as TR1, TR2 and TR3 of the other two embodiments disclosed herein and the resistors associated therewith are not necessary in the Figure 3 embodiment. Otherwise the operation of the Figure 3 embodiment is the same as that of the Figure 1 and Figure 2 embodiments.

In the Figure 4 embodiment the electrode winding 15 forms part of the secondary winding SE and the electrode winding 21 forms part of the primary winding PR. Otherwise the operation of the Figure 4 embodiment is the same as that of the Figure 2 embodiment.

As those skilled in the art will appreciate, while only one type of ballast arrangement has been specifically disclosed herein the invention described will operate with various other ballast arrangements.

It should be apparent that modifications of the

above will be evident to those skilled in the art and that the arrangements described herein are for illustrative purposes and are not to be considered restrictive.

Claims

1. A fluorescent lamp system suitable for operating at least one fluorescent lamp having a pair of electrodes, a ballast for connection to a proper source of voltage, said ballast when connected to a proper source of voltage providing voltage across said lamp, said ballast including a plurality of electrode windings, a plurality of semiconductor switches, each connecting one of said electrode windings to a respective lamp electrode, and control means in operating conditions being connected across said lamp and responsive to said voltage across said lamp when said lamp is on to render each said semiconductor switch nonconductive, said control means responsive to said voltage across said lamp when said lamp is off to render each said semiconductor switch conductive.

2. A fluorescent lamp system according to Claim 1, wherein said control means includes a semiconductor conducting device, in operation conditions being connected in parallel with said lamp and wherein current through said semiconductor conducting device renders said plurality of semiconductor switches conductive.

3. A fluorescent lamp system according to Claim 2, wherein an optical coupler electrically isolates at least one of said plurality of semiconductor switches from the current through said semiconductor conducting device, control signals for the control electrode of said at least one semiconductor switch being generated from the electrode winding to which said at least one semiconductor switch is connected.

4. A fluorescent lamp system according to Claim 3, wherein at least one of said plurality of semiconductor switches directly receives the current through said semiconductor conducting device.

5. A fluorescent lamp system according to any of the preceding Claims, wherein said ballast comprises a transformer including a primary and a secondary winding and at least one of the electrode windings comprises a portion of said secondary winding.

6. A fluorescent lamp system according to Claim 5, wherein at least one of the electrode windings comprises a portion of said primary winding.

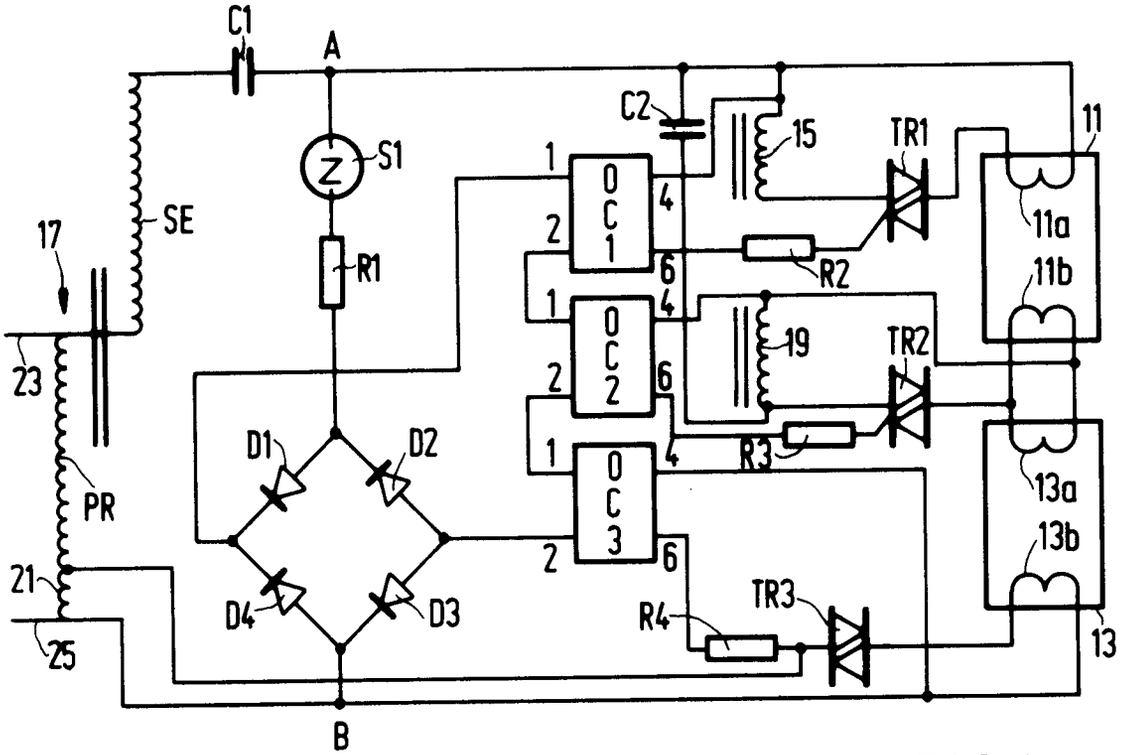
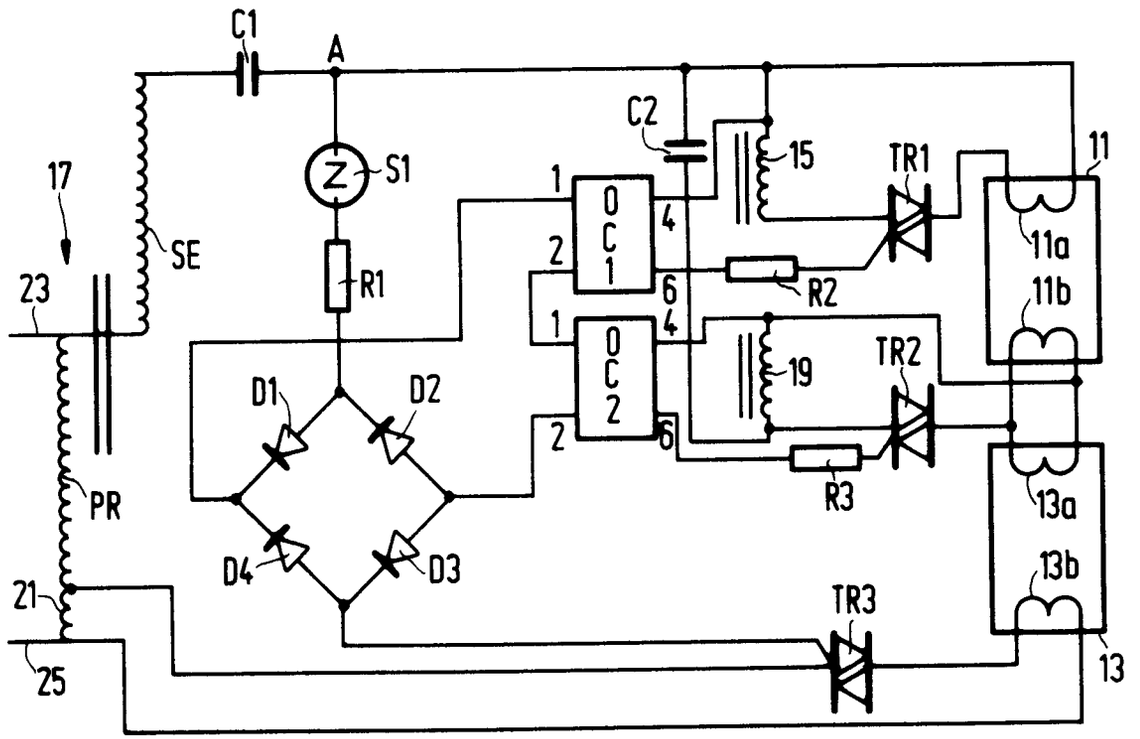

C1
A
S1
SE
17
R1
23
PR
21
25
B
D1
D2
D3
D4
OC1
OC2
OC3
C2
15
TR1
R2
19
TR2
R3
TR3
R4
11
11a
11b
13a
13b
13

FIG.1


C1
A
S1
SE
17
R1
23
PR
21
25
D1
D2
D3
D4
OC1
OC2
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TR1
R2
19
TR2
R3
TR3
11
11a
11b
13a
13b
13

FIG. 2

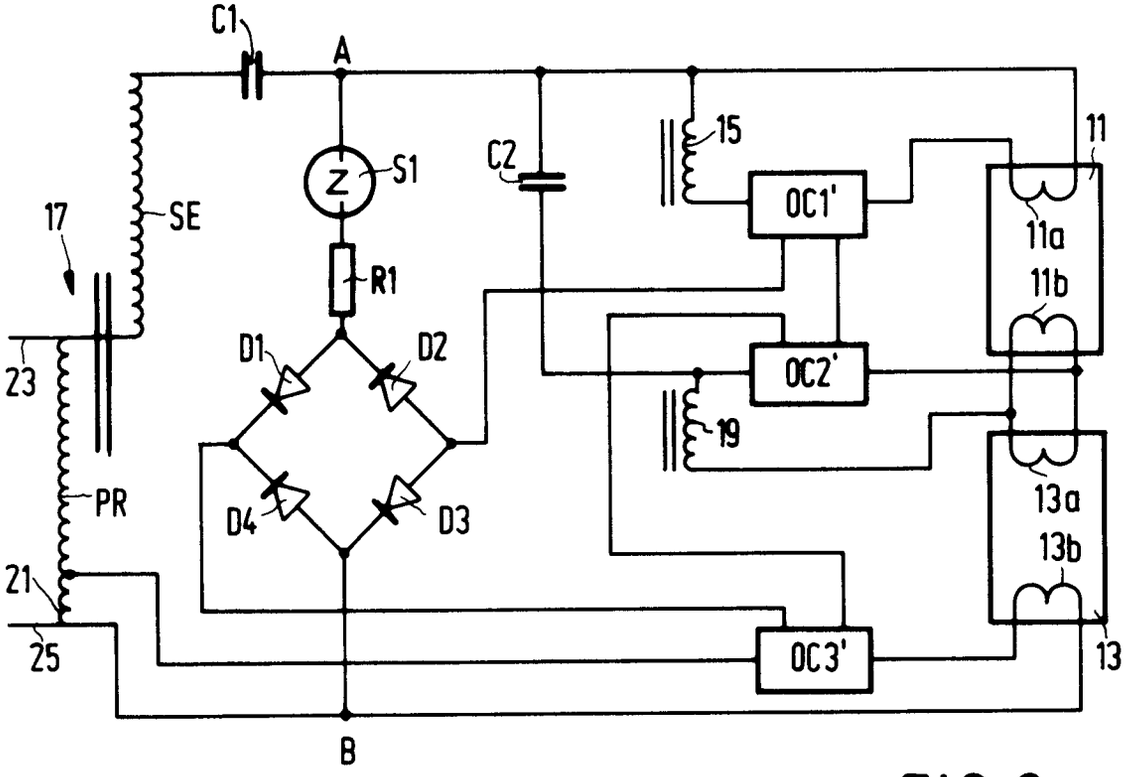
C1
A
15
11
C2
S1
OC1'
SE
17
11a
11b
R1
D1
D2
OC2'
23
19
PR
13a
13b
D4
D3
21
OC3'
13
25
B

FIG. 3

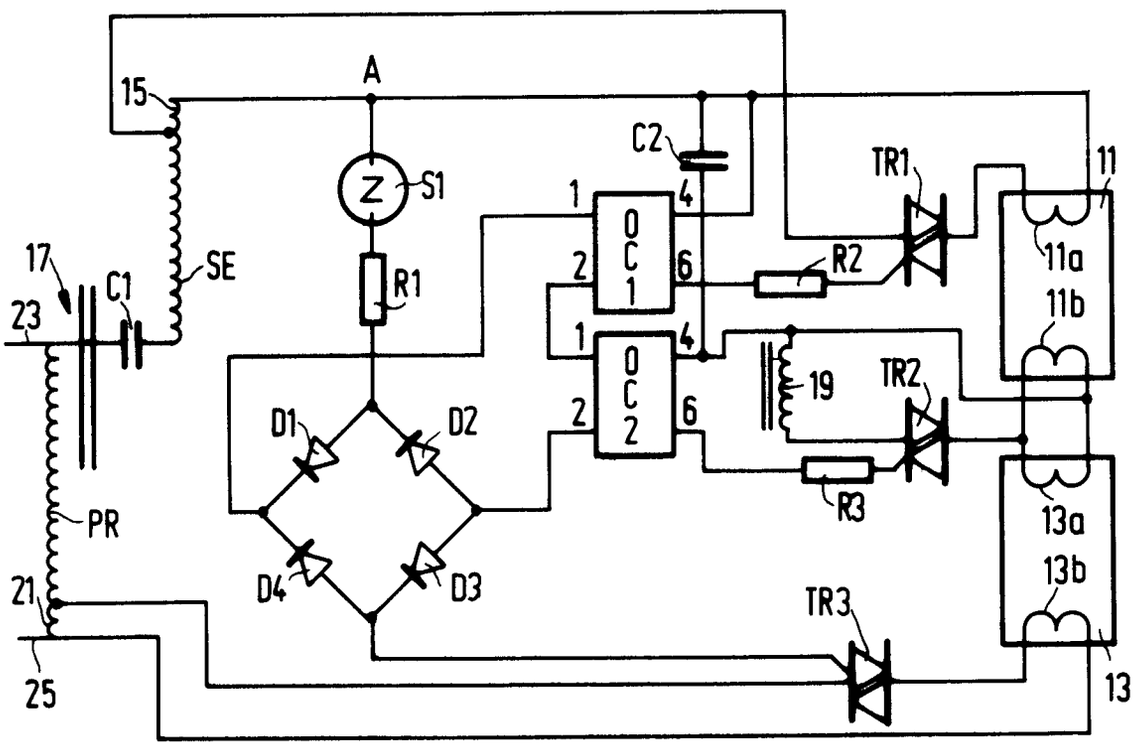
15
A
C2
TR1
11
S1
1
4
OC1
2
6
R2
17
SE
11a
11b
C1
R1
23
1
4
OC2
19
TR2
2
6
D1
D2
R3
PR
13a
13b
D4
D3
21
TR3
25
13

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 3266

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	US-A-4 010 399 (C.S. BESSONE ET AL.) * column 2, line 21 - line 58; figure 1 *	1,5,6	H05B41/04
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 239 (E-206)(1384) 25 October 1983 & JP-A-58 128 650 (MATSUSHITA DENKO K.K.) 1 August 1983 * abstract *	1	
A	FR-A-2 550 043 (DIEHL GMBH & CO.) * page 4, line 12 - page 6, line 16; figures 1,2 *	2-4	
A	DE-A-3 312 572 (TRILUX-LENZE GMBH)		
A	EP-A-0 150 585 (R.C. HOPE)		

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	03 APRIL 1992	ALBERTSSON E.G.

CATEGORY OF CITED DOCUMENTS

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