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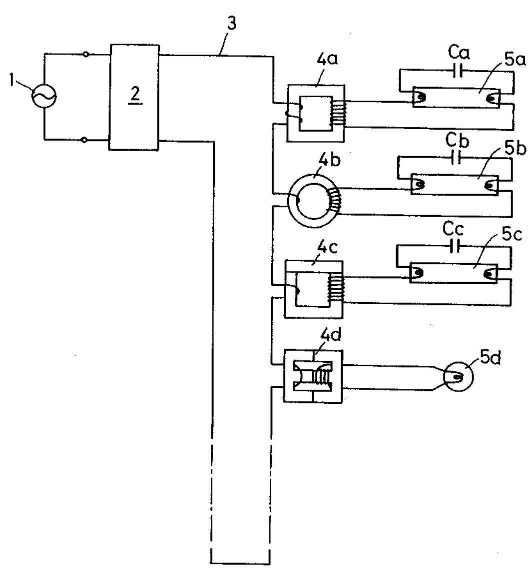
(54) High-frequency constant-current feeding system.

(57) A high-frequency constant-current feeding system for supplying electric power from a high-frequency constant-current power supply to loads by using current transformers includes a high-frequency constant-current power supply and a plurality of current transformers each having a primary and secondary windings. A load is connected to the secondary winding of each current transformer, and the primary windings of all of the current transformers are serially connected to the high-frequency constant-current power supply.

FIG. 1



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Technical Field

This invention relates to a high-frequency constant-current feeding system for supplying electric power from a high-frequency constant-current power supply to a load by using a current transformer.

Related Background Art

In the prior art, commercial and other power supplies usually are of the constant-voltage type. Depending upon the type of load, however, there are occasions where constant-current power supplies are convenient. For example, when the load is a fluorescent lamp, the characteristic is a negative load characteristic, and therefore it is very difficult to vary the brightness of the lamp by increasing or decreasing the discharge voltage. With a constant-current power supply, however, it is simple to achieve a variation in brightness by increasing or decreasing the discharge current, and lamp brightness can be controlled in stable fashion. For this reason, the constant-current power supply is preferred over the constant-voltage power supply. Further, in the case of an incandescent lamp, the filament exhibits a low resistance before the lamp is lit. After a current is passed through the filament to light the lamp, the resistance value thereof attains the steady state once a high temperature has been reached. Accordingly, if an incandescent lamp is lit using a constant-voltage power supply, an excessively large current flows through the filament in a short period of time when the lamp is lit, and therefore the filament sustains considerable fatigue at such time. If the lamp is lit by a constant-current power supply, however, there is no flow of excessive current at lighting of the lamp. This makes it possible to lengthen markedly the service life of the lamp.

Disclosure of the Invention

Accordingly, an object of the present invention is to provide a high-frequency constant-current feeding system for supplying electric power from a high-frequency constant-current power supply to a load by using a current transformer.

According to the present invention, the foregoing object is attained by providing a high-frequency constant-current feeding system which comprises a high-frequency constant-current power supply, and a plurality of current transformers each having a primary winding and a secondary winding; a load being connected to the secondary winding of each current transformer, and the primary windings of all of the current transformers being serially connected to the high-frequency constant-current power supply.

In another aspect of the present invention, the foregoing object is attained by providing a high-frequency constant-current feeding system which comprises a high-frequency constant-current power supply, and a plurality of current transformers each having a core exhibiting magnetic resistance, means for adjusting the magnetic resistance of the core, and a primary winding and a secondary winding; a load being connected to the secondary winding of each current transformer, and the primary windings of all of the current transformers being serially connected to the high-frequency constant-current power supply.

Means for adjusting the magnetic resistance of the core includes a movable member provided on a portion of the core, wherein the effective cross-sectional area of the core or the magnetic gap of the core is varied by moving the movable member, thereby adjusting the magnetic resistance of the core.

Further, the high-frequency constant-current power supply has means for regulating the value of an output current thereof.

In terms of operation when a load is a fluorescent lamp, the associated current transformer is saturated and almost no current flows through its secondary winding before discharge of the fluorescent lamp is started. After the start of discharge, however, a discharge current, which is decided by the value of the current which flows through the primary winding of the current transformer as well as by the winding ratio, flows through the fluorescent lamp. Stable operation is achieved when the terminal voltage of the secondary winding has fallen to a discharge voltage corresponding to the discharge current of the fluorescent lamp. In a case where the current transformer is provided with means for adjusting the magnetic resistance of its core, the value of the current which flows into the secondary winding can be adjusted. As a result, the brightness of the fluorescent lamp connected to this current transformer can be varied stably without any loss. In addition, the brightnesses of all connected fluorescent lamps can be varied by adjusting the current value using current adjusting means provided on the high-frequency constant-current power supply.

Furthermore, if the magnetic resistance of the current transformer is adjusted to infinity, the value of the current which flows through the secondary winding becomes zero. As a result, the power supplied to the load connected to this current transformer can be interrupted and means for adjusting the magnetic resistance can be provided with a switch function.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

Brief Description of the Drawings

Fig. 1 is a diagram for describing an embodiment of a high-frequency constant-current feeding system according to the present invention;
Fig. 2 is a perspective view illustrating one current transformer in the system of Fig. 1; and
Fig. 3 is a perspective view illustrating another current transformer in the system of Fig. 1.

Description of Special Embodiment

A preferred embodiment of a high-frequency constant-current feeding system according to the present invention will be described with reference to Fig. 1.

As shown in Fig. 1, an inverter 2 is connected to a commercial power supply 1, a conductor 3 in the form of a loop is connected across the output terminals of the inverter 2, and the primary windings of all of a plurality of current transformers 4a, 4b, 4c, 4d, ... are connected in series with the conductor 3. Fluorescent lamps 5a, 5b, 5c having starting capacitors Ca, Cb, Cc, respectively, are connected as the loads to secondary windings of the respective current transformers 4a, 4b, 4c, and an incandescent lamp 5d is connected as a load to the secondary winding of the current transformer 4d. Other fluorescent lamps, incandescent lamps, motors, heaters and other loads are connected to other current transformers, which are not shown.

The output of the inverter 2 is a high-frequency constant current, in which f = 65 kHz and I_0 = 10 A. Each of the current transformers includes an annular core consisting of ferrite, which exhibits an excellent high-frequency characteristic, and having a cross-sectional area of 1 cm^2, as well as primary and secondary windings wound upon the core. The primary and secondary windings of the current transformer 4a consist of two turns and 36 turns, respectively, and the fluorescent lamp 5a connected to the current transformer 4a is rated at 110 W and is one available on the market. The capacitor Ca of this fluorescent lamp has a capacitance of 0.0023 μF. The primary windings of the current transformers 4b, 4c each consist of one turn, which is obtained merely by passing the conductor 3 through the annular core, and the secondary windings of these current transformers consist of 24 turns each. The fluorescent lamps 5b, 5c are rated at 40 W, and the capacitance of the associated capacitors Cb, Cc is 0.0023 μF. The current transformer 4d comprises a combination of two E-shaped cores and has a primary winding consisting of one turn, which is obtained by passing the conductor 3 through the annular core, as well as a secondary winding having ten turns. The incandescent lamp 5d connected to the current transformer is rated at 100 V, 100 W.

The current transformers 4c and 4d have means for adjusting the magnetic resistance of the core. As illustrated in Fig. 2, the core of the current transformer 4c includes a generally U-shaped main portion 6 and a movable portion 7 supported on the main portion 6 so as to be capable of being turned. By turning the movable portion 7 while keeping it in contact with the main portion 6, the effective cross-sectional area of contact between the two portions can be increased or decreased to make it possible to adjust the overall magnetic resistance. Further, as shown in Fig. 3, the core of the current transformer 4d comprises two E-shaped cores 8 which turn about a hinge 9 to increase or decrease the magnetic gap between them, thereby adjusting the magnetic resistance.

The operation of the fluorescent lamps will be described with regard to fluorescent lamp 5a.

A high-frequency current is passed through the conductor 3. Before the fluorescent lamp 5a begins to discharge, a current $Ia = I_0 \times n_1/n_2 = 10 \times 2/36 = 0.55$ A flows into the secondary winding of the current transformer 4a through the capacitor Ca, thereby heating the heater of the fluorescent lamp 5a. The impedance of the capacitor Ca at a frequency f of 65 kHz is 520 Ω. Accordingly, the heater of the fluorescent lamp 5a develops a voltage of 290 V and a transition to hot-cathode discharge is made in a short period of time. The characteristic of the fluorescent lamp 5a is such that when discharge starts, the voltage falls to a discharge voltage of 180 V, which corresponds to a discharge current of 0.55 A. When this state has been attained, the fluorescent lamp 5a fires and lights in a stable manner.

A current of Id = 1 A which initially flows through the secondary winding of the current transformer 4d flows into the filament of the incandescent lamp 5d. During the time that the resistance value of the filament is initially small, the lamp 5d lights darkly. However, as the filament gradually heats up and the resistance value thereof rises, the incandescent lamp 5d grows brighter. The steady state is attained 0.2 ~ 0.5 sec after the start of current flow.

When the movable portion 7 of the current transformer 4c is turned in a horizontal plane, as shown in Fig. 2, after the fluorescent lamp 5c has attained the stably lit state, the effective cross-sectional area of this portion of the core is reduced so that the overall magnetic resistance of the core increases. As a result, the lines of magnetic flux diminish so that the value of the current which flows through the secondary winding can be reduced. More specifically, the brightness of the fluorescent lamp 5c can be varied by adjusting the angle through which the movable portion 7 is turned. Similarly, by turning the E-shaped cores 8 of the current transformer 4d vertically relative to each other to change the magnetic gap between them, the brightness of the incandescent lamp 5d can be varied. If the inverter 2 is provided beforehand with means for increasing and decreasing the value of the output current, the power supplied to all of the loads can be regulated uniformly.

It should be noted that the frequency of the output current of the inverter 2 is not limited to the value mentioned in the above-described embodiment but is capable of being suitably selected over a wide range of 1 ~ 150 kHz. However, at frequencies below 20 kHz, there is the possibility that audio-frequency noise will be produced, and there is the risk that frequencies in the range of 30 ~ 37 kHz will cause erroneous operation of remote-control devices for television and the like. Accordingly, a frequency above 40 kHz is desirable. In addition, the current value of the output current, the shape and dimensions of the current transformers, the shape of the movable portion, the numbers of turns of the primary and secondary windings and the number of loads, etc., can all be designed and changed as required.

Industrial Applicability

In accordance with the high-frequency constant-current feeding system according to the present invention, as described above, it is possible to feed current to each of a variety of loads. In particular, when the current feeding system is applied to fluorescent lamps, operation of the lamps can be controlled much more stably in comparison with current feed using a constant-voltage power supply. The appliances can be made small in size since it is unnecessary to provide a lighting stabilizer or lighting inverter for each and every fluorescent lamp. Furthermore, since transient abnormal current or abnormal voltage is not produced, the lifetime of fluorescent lamps and incandescent lamps can be greatly prolonged. By providing means for adjusting the magnetic resistance of the cores of the current transformers, the power supplied to the individual loads can be regulated very easily without loss. If the high-frequency constant-current power supply is provided with means for adjusting the value of the output current, the power supplied to all of the loads can be regulated in a uniform manner.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

Claims

1. A high-frequency constant-current feeding system which comprises:

a high-frequency constant-current power supply; and

a plurality of current transformers each having a primary winding and a secondary winding;

a load being connected to the secondary winding of each current transformer, and the primary windings of all of said current transformers being serially connected to said high-frequency constant-current power supply.

2. The system according to claim 1, wherein said high-frequency constant-current power supply has means for regulating the value of an output current thereof.

3. A high-frequency constant-current feeding system which comprises:

a high-frequency constant-current power supply; and

a plurality of current transformers each having a core exhibiting magnetic resistance, means for adjusting the magnetic resistance of the core, and a primary winding and a secondary winding;

a load being connected to the secondary winding of each current transformer, and the primary windings of all of said current transformers being serially connected to said high-frequency constant-current power supply.

4. The system according to claim 3, wherein said high-frequency constant-current power supply has means for regulating the value of an output current thereof.

5. The system according to claim 3, wherein said means for adjusting the magnetic resistance of the core includes a movable member provided on a portion of said core, the effective cross-sectional area of said core being varied by moving said movable member, thereby adjusting the magnetic resistance of said core.

6. The system according to claim 3, wherein said means for adjusting the magnetic resistance of the core includes a movable member provided on a portion of said core, the magnetic gap of said core being varied by moving said movable member, thereby adjusting the magnetic resistance of said core.

FIG. 1

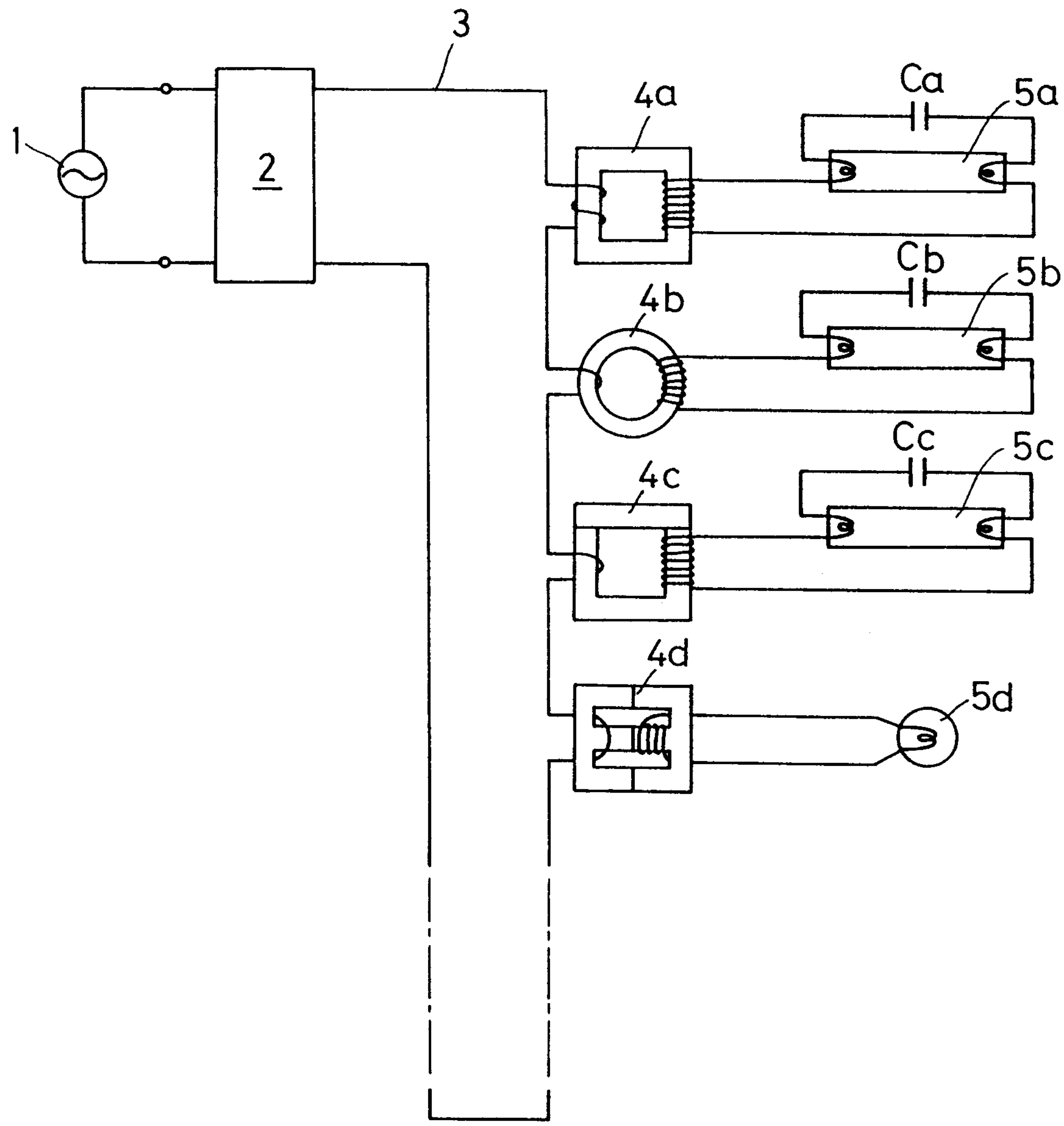


FIG. 2

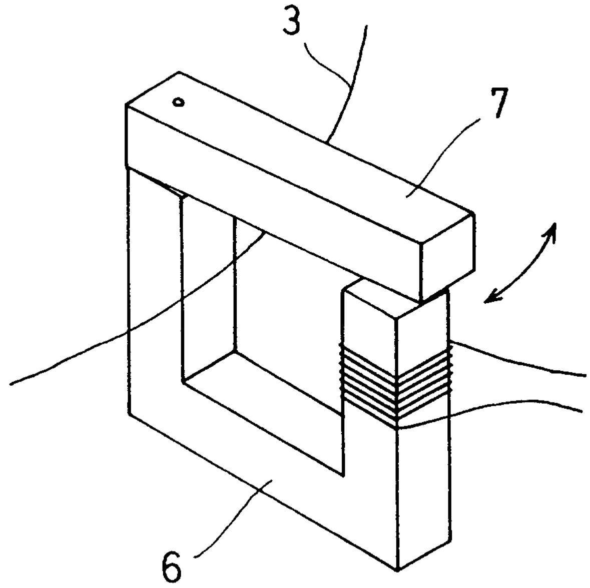
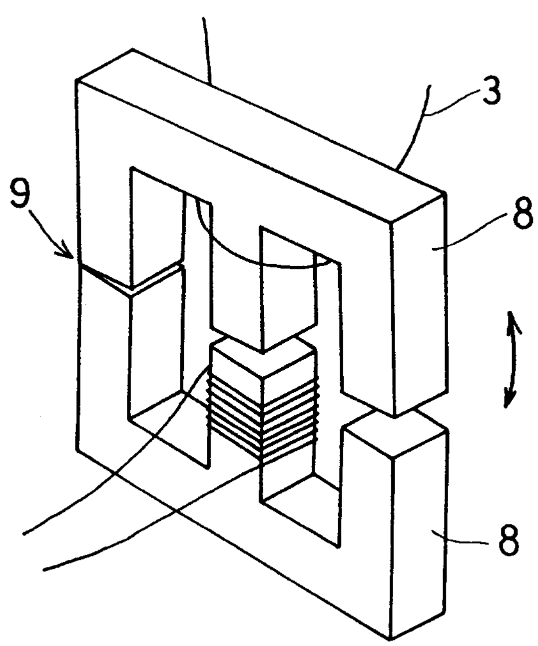


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 5671

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)
X Y	EP-A-0 264 135 (TOSHIBA) * the whole document * ---	1,2 3-6	H05B41/392
Y	DE-A-2 056 680 (PFISTER) * page 3, line 1 - line 11; figures 1,2,7 * -----	3-6	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
H05B H01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 MAY 1993	GENTILI L.

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