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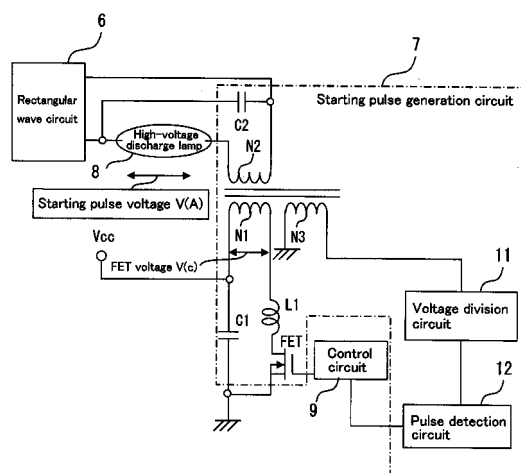
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(54) **HIGH-PRESSURE DISCHARGE LAMP OPERATING DEVICE**

(57) It is the object of the present invention to provide a high-voltage discharge lamp lighting system constituted in such a manner that a starting pulse voltage is fed back to make it invariable, whereby, even if the output wiring length is increased to increase the output capacity, the starting pulse voltage can be maintained within a prescribed value range.

A high-voltage discharge lamp lighting system comprising a high-voltage discharge lamp 8, a starting pulse generation circuit 7 which feeds a starting high-voltage to said high-voltage discharge lamp 8, and a control circuit 9 for controlling said starting pulse generation circuit 7, **characterized in that** said starting pulse generation circuit 7 comprises a transformer T1 for boosting the pulse voltage generated by the ON/OFF operation of a FET, a feedback voltage detection winding N3 provided to said transformer T1, a voltage division circuit 11 for dividing the voltage produced across a feedback voltage detection winding N3, and a pulse detection circuit 12 for detecting the starting pulse voltage component from the output delivered from said voltage division circuit 11 and feeding back the thus detected starting pulse voltage component to said control circuit 9, and said control circuit 9 keeps at a predetermined value the voltage which has been boosted by said transformer T1.

Fig. 6



C1, C2: Capacitors
FET: Field-effect transistor (an example of the switching element)
L1: Inductance
N1: Primary winding
N2: Secondary winding
N3: Feed-back voltage detection winding
T1: Transformer

Description

Technical Field

[0001] The present invention relates to a high-voltage discharge lamp lighting system and, more particularly, to a high-voltage discharge lamp lighting system provided with a starting-pulse generation circuit.

Background Technique

[0002] Fig. 7 is a block diagram showing a conventional high-voltage discharge lamp lighting system. The high-voltage discharge lamp lighting system is constituted in such a manner that, when a commercial power source 1 is turned on, a control power supply circuit 10 produces a control power supply to operate a control circuit 9, which thus transmits a control signal to a boosting inverter 3, a voltage-dropping inverter 4, a rectangular wave circuit 6 and a starting pulse generation circuit 7; and thus, these elements start to operate, respectively. The boosting inverter 3 boosts the output, which has been rectified by a rectifier circuit 2, up to a normal voltage, and the voltage-dropping inverter 4 adjusts its output so that the current flowing to a high-voltage discharge lamp 8 can become a normal current. A rectangular wave circuit 6 outputs an AC rectangular voltage of a normal frequency to a high-voltage discharge lamp 8. The rectangular wave circuit 6 outputs an AC rectangular voltage of a normal frequency. The starting pulse generation circuit 7 generates a high-voltage pulse to start the high-voltage discharge lamp 8.

[0003] Fig. 8 is a block diagram showing in detail the start pulse generation circuit 7. The start pulse generation circuit 7 operates to produce a high-voltage pulse only when the high-voltage discharge lamp 8 is to be started. The start pulse generation circuit 7 comprises a transformer T1, a FET (field-effect transistor) being a switching element which can be turned on or off by an external control signal, a capacitor C1 which is charged with a DC voltage Vcc which has been raised by a boosting inverter 3, an inductance L1 which performs the over-current protection of the FET, and a capacitor C2 which serves to block the high-voltage pulses, which are produced across the transformer T1, from running around into the rectangular wave circuit 6.

Patent Literature 1: JP Patent Application Disclosure No. (Hei) 11-307285.

Patent Literature 2: JP Patent Application Disclosure No. 2000-306688.

Patent Literature 3: JP Patent Application Disclosure No. 2002-75673.

Disclosure of the Invention

Problem to be solved by the Invention

[0004] In case of a high-voltage discharge lamp such

as a high-luminance, high-voltage discharge lamp or the like, the start pulse voltage is prescribed to be 3 to 5 kVp, for example. In case of the high-voltage discharge lamp lighting system, if the length of the output wiring is increased, then the start pulse voltage is attenuated by the resulting increase of the output capacity and thus becomes lower than the normal voltage value of the starting pulse voltage of the lamp, so that, in case the output wiring length is 10 m for example, there occurs the problem that the lamp cannot start. Therefore, there is the rule according to which the output wiring length of a high-voltage discharge lamp lighting system must be 2 meters or less; and this serves as a restriction on the make-up of said system (See Fig. 9). If a high-voltage discharge lamp lighting system is constructed in such a manner that a starting pulse voltage of 4 kVp is outputted at a point of the output wiring length which point lies 10 meters ahead, then it is accepted, but, if this high-voltage discharge lamp lighting system is operated within a distance of 2 meters, then the starting pulse voltage becomes higher than 5.6 kVp, so that there is caused the danger that a leak may be caused in the wiring, the socket, the high-voltage discharge lamp or the like.

[0005] The present invention has been made in order to give a solution to the above-mentioned problem, and it is the object of the present invention to provide a high-voltage discharge lamp lighting system constructed in such a manner that, by the feedback of a starting pulse voltage, said starting pulse voltage is stabilized, whereby the starting pulse voltage can be maintained within a normal value range even if the output wiring length is increased to enhance the output capacity.

[0006] The high-voltage discharge lamp lighting system according to the present invention which comprises a high-voltage discharge lamp, a starting pulse generation circuit which feeds a high starting voltage to said high-voltage discharge lamp, and a control circuit for controlling said starting pulse generation circuit, characterized in that

said starting pulse generation circuit comprises a boosting transformer for raising the pulse voltage generated by the ON/OFF operation of a switching element, a feedback voltage detection winding provided to said transformer, a voltage division circuit for dividing the voltage produced across said feedback voltage detection winding, and a pulse detection circuit for detecting the starting pulse voltage component from the output delivered from said voltage division circuit and feeding back the thus detected pulse voltage component to said control circuit.

Effect of the Invention

[0007] The high-voltage discharge lamp lighting system can maintain the starting pulse voltage within the normal range of values.

Brief Description of the Drawings

[0008]

[Fig. 1] shows Embodiment 1 of the present invention, wherein there is shown, particularly, the output voltage of the starting pulse generation circuit which (output voltage) is measured when the output wiring length is altered.

[Fig.2] shows Embodiment 1 of the present invention, wherein there is shown, particularly, the result of the measurement of the starting pulse voltage when the wiring length is altered.

[Fig. 3] shows Embodiment 1 of the present invention, wherein there is shown, particularly, the result of the measurement of the starting pulse voltage when the wiring length is altered.

[Fig. 4] shows Embodiment 1, wherein there are shown, particularly, the results of measuring the FET voltage V (C) and the starting pulse voltage V (B) when the wiring length is altered.

[Fig. 5] shows Embodiment 1 of the present invention, wherein there are shown, particularly, the result of measuring the FET voltage V(C) and the starting pulse voltage VB when the wiring length is altered.

[Fig. 6] shows Embodiment 1 of the present invention, wherein, particularly, the starting pulse generation circuit is shown in detail.

[Fig. 7] is a block diagram showing the conventional high-voltage discharge lamp igniting system.

[Fig. 8] shows the conventional starting pulse generation circuit 7 in detail.

[Fig. 9] shows the relationship between the conventional high-voltage discharge lamp lighting system and the starting pulse voltage thereof.

Explanation of Reference Numerals

[0009] 1: Commercial power supply, 2: Rectifier circuit, 3: Boosting inverter, 4: Voltage-lowering inverter, 5: Current-detecting resistor, 6: Rectangular wave circuit, 7: Starting pulse generation circuit, 8: High-voltage discharge lamp, 9: Control circuit, 10: Control power source circuit, 11: Voltage division circuit, 12: Pulse detection circuit.

Most desirable Embodiment for Execution of the Invention

Embodiment 1

[0010] Figs. 1 to 6 show Embodiment 1 of the present invention, of which Fig. 1 shows the output voltage measurement of the starting pulse generation circuit 7 when the output wiring length is altered, Figs. 2 and 3 show the measurement results of the starting pulse voltage when the wiring length is altered, Fig. 4 and 5 show the voltage V(C) of the FET (Field-effect transistor) and the

measurement result of the starting pulse voltage V(B) when the wiring length is altered, and Fig. 6 shows in detail the starting pulse generation circuit 7.

[0011] Additionally, the overall arrangement of the high-voltage discharge lamp igniting system is the same as that of the conventional high-voltage discharge lamp lighting system; however, the feature of this embodiment of the present invention lies in the starting pulse generation circuit 7.

[0012] As stated in the foregoing part, entitled "Background Technique", of this specification, if the output wiring length is increased, then the starting pulse voltage value falls; and thus, if the starting pulse voltage value comes to fall below the starting voltage of the high-voltage discharge lamp, then there is caused, in some cases, even the inconvenience that the high-voltage discharge lamp does not start. Generally, in the case of a high-voltage discharge lamp lighting system, the output wiring length is stipulated to be two meters or shorter. The starting of the high-voltage discharge lamp becomes irregular in case the starting pulse voltage value is 3.5 kVp, and, in case the starting pulse voltage value is 3.0 kVp, the high voltage discharge lighting system does not start.

[0013] According to the present patent application, there is proposed a starting system constructed in such a manner that, by feeding back the starting pulse voltage, a reliable starting voltage value is secured, so that no failure is caused in the starting of the lamp.

[0014] For the realization of the above-mentioned starting system, it is indispensable to assure that the below-stated two conditional points be satisfied:

(1) The first point is that the values, at a point A and a point B, of the output voltage from a starting-pulse generation circuit 7 are approximately equal to each other. For example, in case the voltage at the point B is 3 kVp even if the voltage at the point A is 5 kVp, the lamp is not started even if the output voltage (which has a value approximately the same value as the voltage value at the point A) of the starting pulse generation circuit is fed back.

(2) In the case of controlling the starting-pulse voltage, the starting pulse voltage is a high voltage of 3 to 5 kVp, and thus, it is necessary to use a large number of high voltage-withstanding parts, so that the structure is large-sized. Further, even if such high voltage-withstanding parts are mounted, they will prove to be useless at the ordinary lighting time. The voltage to be fed back is suitably 10 Vp or so. In the starting-pulse generator circuit 7 shown in Fig. 8, a transformer T1 is used, but, if there is a correlation between the FET voltage V(C) before the voltage is boosted and the starting pulse voltage V (B) being the voltage at a point B positioned ahead of the output wiring length, then the voltage at the point B located ahead of the output wiring length becomes controllable by controlling the FET voltage V (C) which is the lower voltage.

[0015] Thus, the starting pulse voltage V (A) and the starting pulse voltage V(B) at the point A and the point B in Fig. 1 referred to in the above Item (1) were measured by varying the output wiring length. The wiring used in this experiment is a VVF cable. The result of this measurement is shown in Figs. 2 and 3. Concerning the output wiring lengths, 0, 0.5, 1, 2, 4, 6, 8 and 10 meters, the starting pulse voltage V(A) and the starting pulse voltage V (B) at point A and point B were measured. As a result, it was confirmed that, as shown in Figs. 2 and 3, the starting pulse voltage V(A) and the starting pulse voltage V(B) at the point A and at the point B are approximately equal to each other irrelevantly to the output wiring length. Accordingly, if, for example, the starting pulse voltage V (A) is controlled to 4 kVp, then the starting pulse voltage V(B) can also be controlled to approximately 4 kVp.

[0016] Next, in order to confirm what is stated in above Item (2), the FET voltage V (C) and the starting pulse voltage V(A) before the boosting by the transformer T1 were measured; and the result thus obtained is shown in Figs. 4 and 5.

[0017] It has been found that, as shown in Figs. 4 and 5, the FET voltage V(C) and the starting pulse voltage V (A) are correlated to each other; that is, by controlling the FET voltage V(C) which is low in voltage value, the starting pulse voltage V (A) can be controlled. The FET voltage V(C) is less than 1/10 of the starting pulse voltage V(A) . It is sufficient to feed back a voltage which is lower than 1/10 of the starting pulse voltage V (A) ; and thus, the system can be made of a small-sized circuit. The FET voltage V (C) is higher than the desirable voltage, 10 Vp which is desirable for the feedback, but, if said FET voltage V(C) is sufficient to be about 300 Vp though it is greater than 10 Vp desirable for the feedback, then the feedback circuit can be composed by the use of a plurality, yet small in number, of circuit parts.

[0018] By reference to Fig. 6, explanation will now be made concerning the starting pulse generation circuit 7 according to this embodiment of the present invention. To a transformer T1, a feedback voltage detection winding N3 is added. More concretely, if, for example, a primary winding N1 is made of 6 turns of a wire, a secondary winding N2 is made of 88 turns of a wire, and a feedback voltage detection winding N3 is made of 1 turn of a wire, then it results that the FET voltage V(C) = 300 Vp, the starting pulse voltage (A) = 4.4 kVp, and the feedback voltage V(F) = 50 Vp.

[0019] To the feedback voltage detection winding N3, a voltage division circuit 11 is connected. The voltage division circuit 11 is made of, e.g. a resistor, whereby the given voltage is divided to arbitrary voltages. As the feedback voltage, it is also possible to lower the given voltage to the order of 10 Vp.

[0020] Moreover, to the voltage division circuit 11, a pulse detection circuit 12 is connected. In the output of the voltage division circuit 11, various voltage components are contained in addition to the necessary starting pulse voltage component. The pulse detection circuit 12

detects the starting pulse voltage component from among these voltage components.

[0021] Then the output from the pulse detection circuit 12 is fed back to a control circuit 9. This control circuit 9 controls the FET voltage V(C) so that the starting pulse voltage V (A) may become a fixed voltage of, for example, 4 kVp.

[0022] As mentioned above, according to this embodiment of the present invention, a low voltage (for example, 50 Vp) across the feedback voltage winding N3 provided in the transformer T1 is further divided, by the voltage division circuit 11, to a still lower voltage, whereby a necessary starting pulse voltage component is detected by the pulse detection circuit 12 and fed back to the control circuit 9; and therefore, the starting pulse voltage V (A) can be maintained at, e.g. 4 kVp. It has been confirmed that, up to about 10 meters in length of the output wiring, the starting pulse voltage remains approximately the same without regard to the output wiring length, so that, if the starting pulse voltage V(A) is maintained at the above-mentioned 4 kVp, then the starting pulse voltage at a point 10 meters ahead can also be held at approximately the same voltage value.

Claims

1. high-voltage discharge lamp lighting system which has a high-voltage discharge lamp, a starting pulse generation circuit for feeding a starting high-voltage to said high-voltage discharge lamp, and a control circuit for controlling said starting pulse generation circuit,
characterized in that
said starting pulse generation circuit comprises
a transformer for boosting the pulse voltage produced by the ON/OFF operation of a switching element,
a feedback voltage detection winding provided to said transformer,
a voltage division circuit for dividing the voltage produced across said feedback voltage detection winding, and
a pulse detection circuit which detects a starting pulse voltage component from the output of said voltage division circuit and feed it back to said control circuit,
wherein said control circuit maintains, at a predetermined value, the voltage after it is boosted by said transformer.

Fig. 1

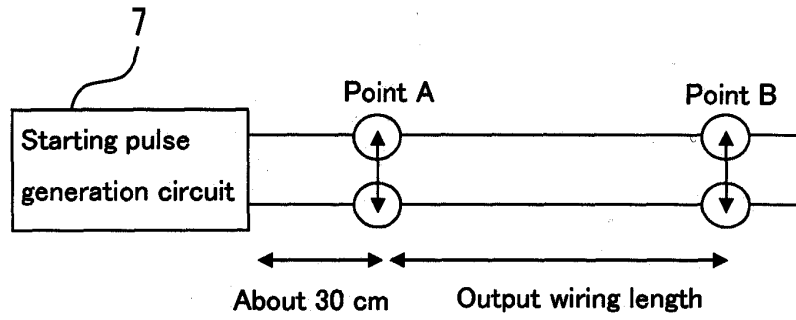


Fig. 2

Starting pulse voltage (Unit: kVp)

Output wiring length (m)	V (A)	V (B)
0	4.23	4.24
0.5	4.11	4.13
1	4.04	4.06
2	3.71	3.75
4	3.40	3.41
6	3.09	3.09
8	2.76	2.76
10	2.51	2.48

Fig. 3

Output wiring length – Starting pulse voltage

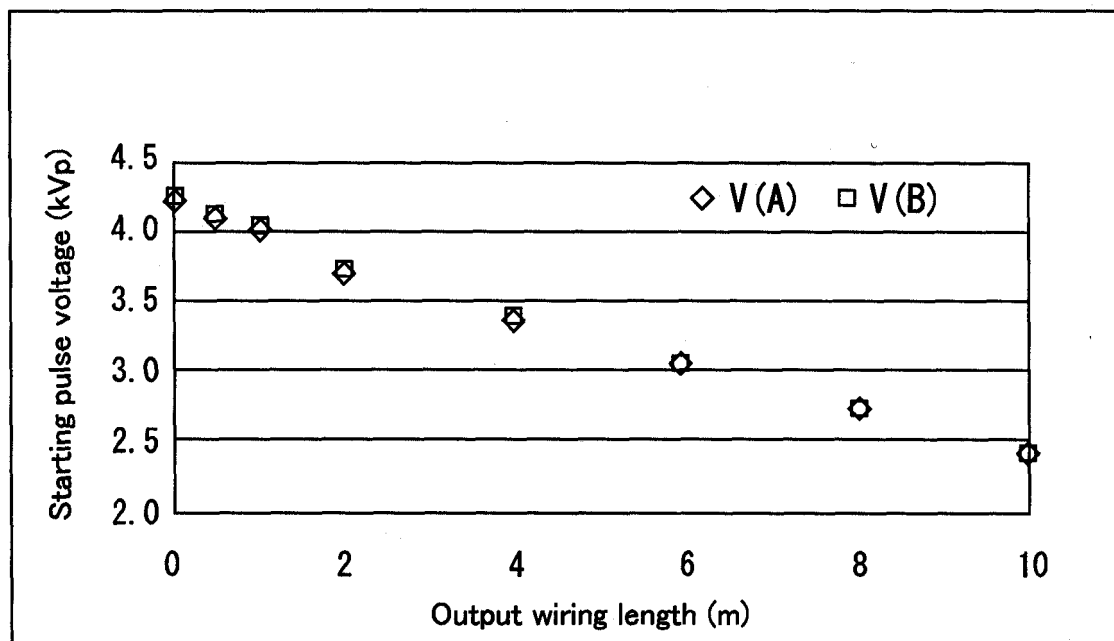


Fig. 4

Output wiring length (m)	FET voltage V(C) (Vp)	Starting pulse voltage V(A) (kVp)
0	302	4.404
0.5	304.8	4.384
1	294	4.208
2	286	4.028
3	262.8	3.688
6	226	3.184
9	189.6	2.72

Fig. 5

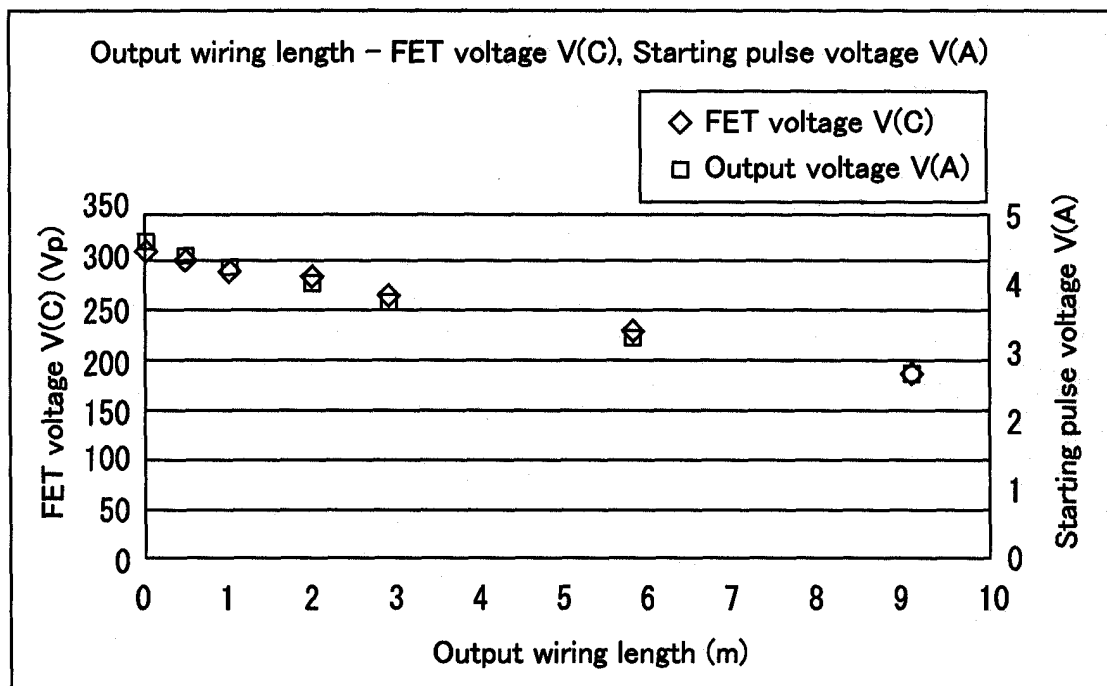
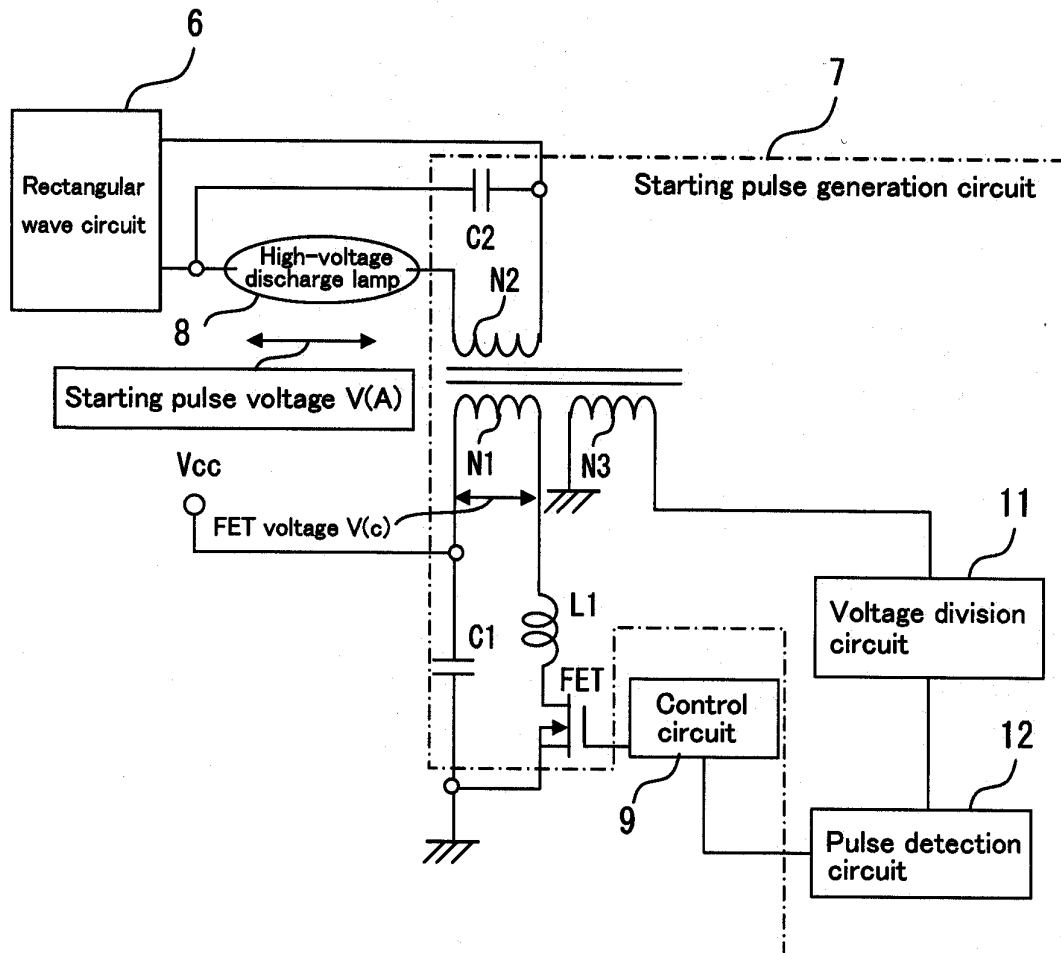


Fig. 6



C1, C2: Capacitors

FET: Field-effect transistor (an example of the switching element)

L1: Inductance

N1: Primary winding

N2: Secondary winding

N3: Feed-back voltage detection winding

T1: Transformer

Fig. 7

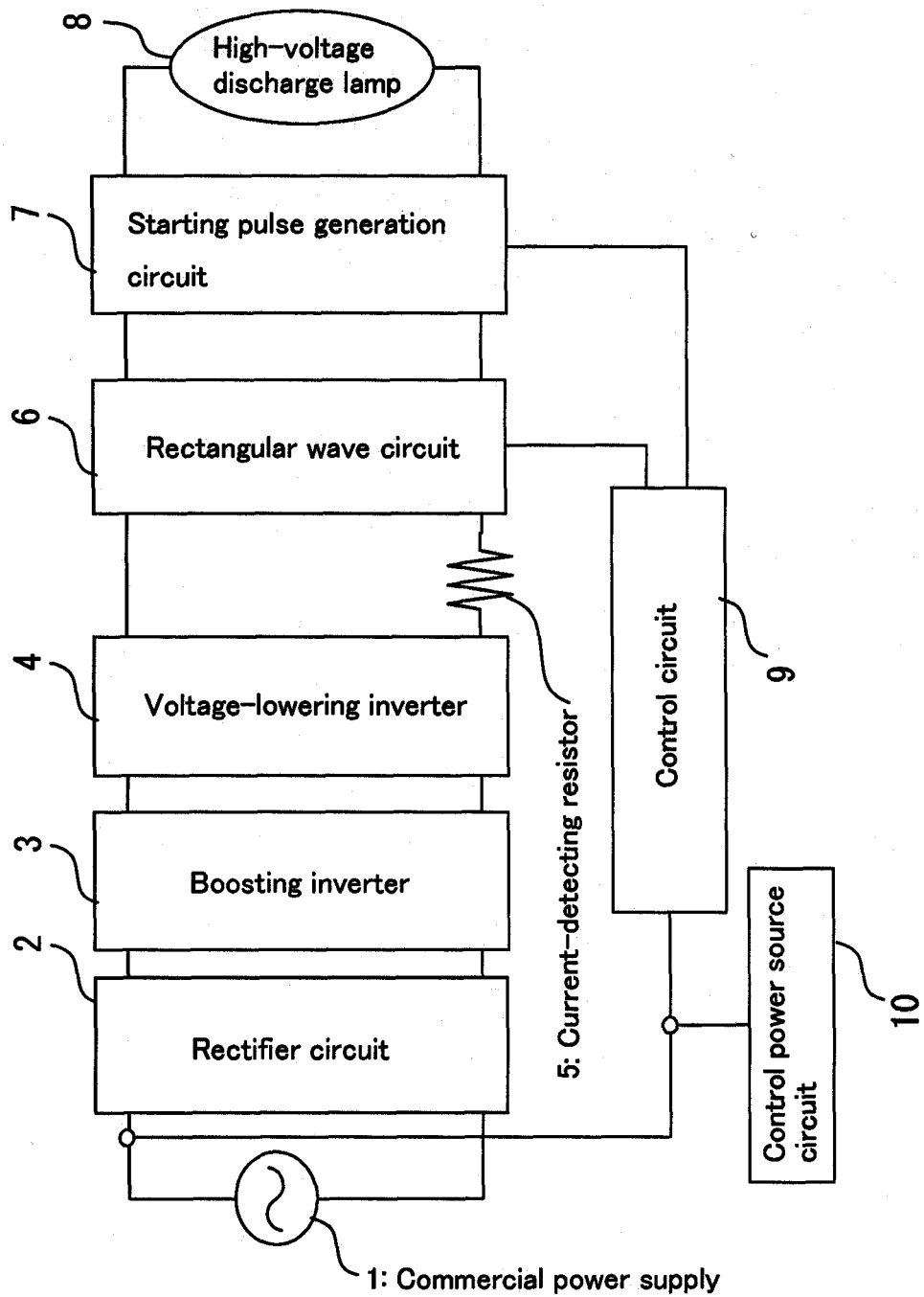


Fig. 8

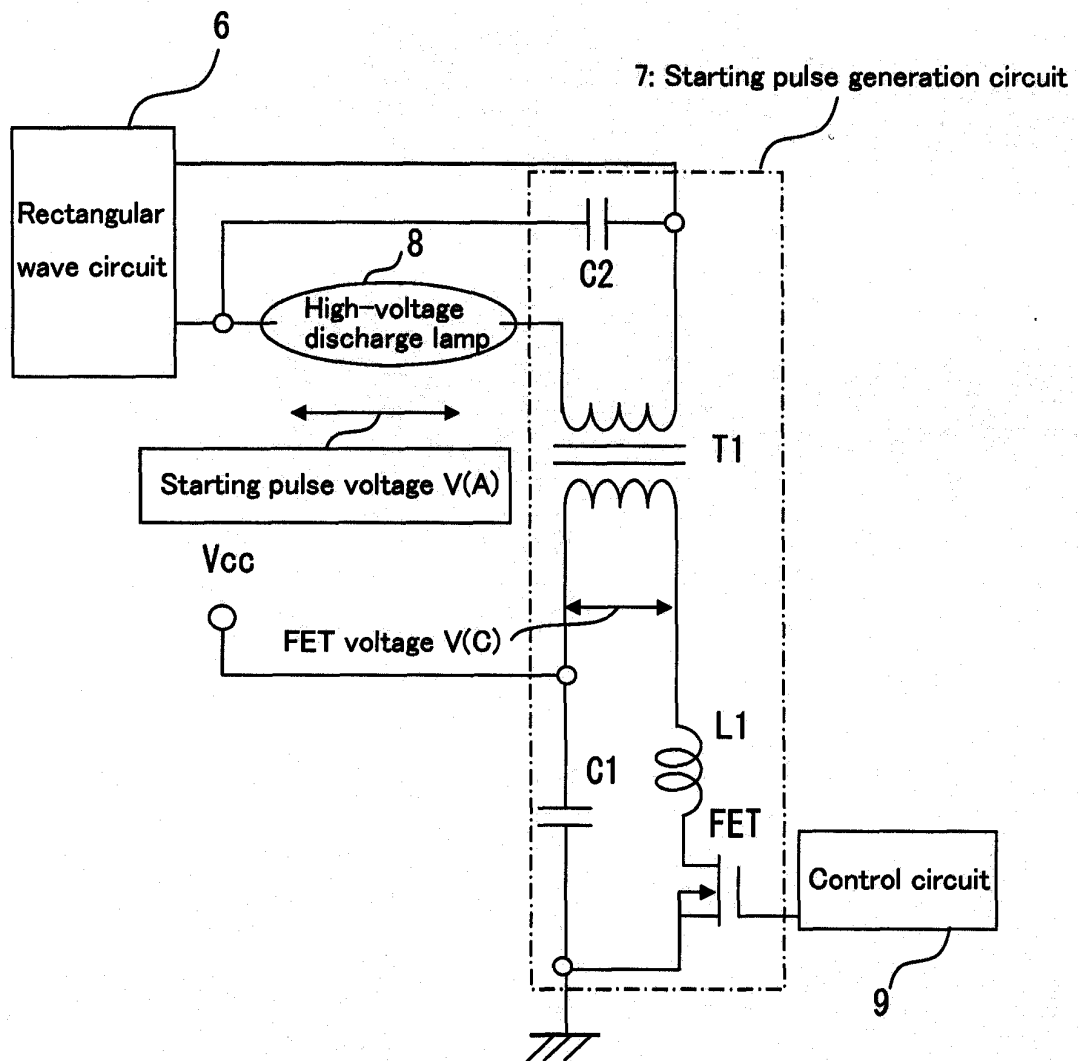
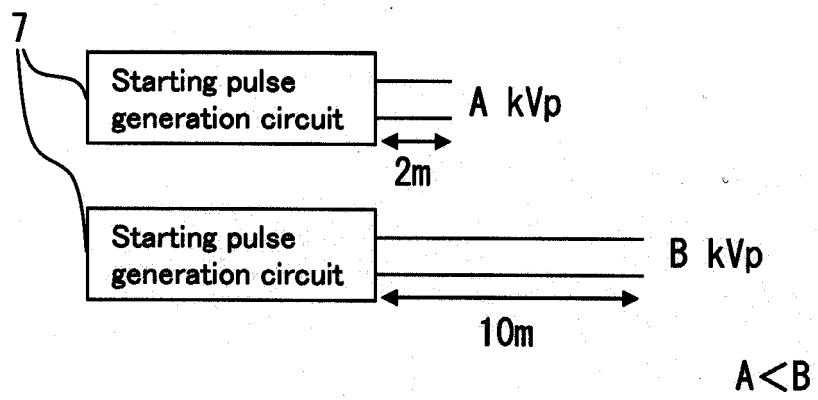


Fig. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/314686

A. CLASSIFICATION OF SUBJECT MATTER <i>H05B41/18(2006.01) i, H05B41/24(2006.01) i</i>										
According to International Patent Classification (IPC) or to both national classification and IPC										
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) <i>H05B41/18-41/298</i>										
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched <table border="0"> <tr> <td>Jitsuyo Shinan Koho</td> <td>1922-1996</td> <td>Jitsuyo Shinan Toroku Koho</td> <td>1996-2006</td> </tr> <tr> <td>Kokai Jitsuyo Shinan Koho</td> <td>1971-2006</td> <td>Toroku Jitsuyo Shinan Koho</td> <td>1994-2006</td> </tr> </table>			Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2006	Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006
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Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006							
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)										
C. DOCUMENTS CONSIDERED TO BE RELEVANT										
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.								
A	JP 2005-004980 A (Hitachi Media Electronics Co., Ltd.), 06 January, 2005 (06.01.05), Full text; all drawings (Family: none)	1								
A	JP 7-211473 A (Matsushita Electric Industrial Co., Ltd.), 11 August, 1995 (11.08.95), Full text; all drawings (Family: none)	1								
A	JP 7-114994 A (Matsushita Electric Industrial Co., Ltd.), 02 May, 1995 (02.05.95), Full text; all drawings (Family: none)	1								
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.										
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Date of the actual completion of the international search 18 August, 2006 (18.08.06)		Date of mailing of the international search report 29 August, 2006 (29.08.06)								
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer								
Facsimile No.		Telephone No.								

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/314686

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	JP 5-266984 A (Matsushita Electric Industrial Co., Ltd.), 15 October, 1993 (15.10.93), Full text; all drawings (Family: none)	1

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REFERENCES CITED IN THE DESCRIPTION

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