

Description

The invention relates to a switch mode power supply according to the preamble of claim 1.

Such a switch mode power supply is known from GB-2,102,641. The switching signal is produced in the control circuit by a separate oscillator. In order to obtain a supply of current to the lamp as constant as possible, the known switch mode power supply is provided with circuit means for detection of the current through the switching means. The circuit means ensure that the current through the switching means is limited to a maximum by interrupting the production of the switching signal as soon as the maximum current is detected. As a result, the switching means pass to the non-conducting state.

A disadvantage of the known switch mode power supply is that both current detection means and a separate oscillator are required. Thus, the construction of the switch mode power supply becomes fairly complex. The invention has for its object *inter alia* to provide a comparatively simple construction for a switch mode power supply whilst maintaining the limitability of current supply to the lamp.

For this purpose, according to the invention, a switch mode power supply comprises the features mentioned in claim 1.

An advantage of the switch mode power supply according to the invention is that the use of a separate oscillator is no longer necessary. Detection of current through the induction means instead of through the switching means further has the advantage that the limitation of the current supply is not solely restrained to limitation to a maximum.

In the switch mode power supply according to the invention, the circuit means comprise a first winding part of the inductive means as a source for producing the switching-on signal, and the circuit means comprise a second winding part of the induction means as a first signal source for producing the switching-off signal. In a very simple and effective manner, the production of the switching signal is coupled to current detection in the induction means. In a further improvement of the switch mode power supply according to the invention, the circuit means also comprise capacitive means, which constitute with the induction means an oscillatory circuit for driving the source for producing the switching-on signal. This permits of obtaining a highly reproducible detection in a simple manner. Especially the transition from current decrease to current increase is a suitable criterion for detection.

Preferably, the control circuit of the switch mode power supply according to the invention comprises a bistable multivibrator controlled by means of the first signal source and serving to produce the switching-off signal. This has *inter alia* the advantage that the switching-off signal can be produced by comparative-

ly simple means, which are particularly suitable for miniaturization.

In a further advantageous embodiment, the circuit means comprise a second signal source depending upon lamp voltage for controlling the multivibrator. This makes it possible that the supply of current to the lamp cannot only be limited because of current detection, but can also be controlled in dependence upon the lamp voltage. This has the advantage that by means of the switch mode power supply the power supplied to the lamp can be controlled.

An embodiment of a switch mode power supply according to the invention will be described with reference to a drawing. In the drawing:

Fig. 1 shows a principle circuit diagram of the switch mode power supply;

Fig. 2 shows partly in detail a part of the circuit diagram of Fig. 1 for producing the switching-on signal;

Fig. 3 shows partly in detail a part of the circuit diagram of Fig. 1 for producing a switching-off signal;

Fig. 4 shows in detail a control circuit as shown in Fig. 1; and

Fig. 5 shows a current-voltage characteristic as obtained by the switch mode power supply shown in Fig. 1.

In Fig. 1, reference symbol A denotes a connection terminal for an input voltage. By means of switching means 1, induction means 2, capacitive buffer means 3 and rectifying means 4 a current for a lamp 5 is produced from the input voltage. The lamp 5 can be directly connected to the output terminal B. It is also possible for the lamp to be included in a commutation network connected to the output terminal B. The current is produced by switching the switching means 1 alternately to the conducting state and to the non-conducting state. The switching means 1 are switched by a switching signal, which is supplied by a control circuit 1. Circuit means 20 for current detection by the induction means 2 serve at the same time for producing the switching signal. The example considered is a switch mode power supply of the down converter type. In the conducting state of the switching means 1, these means constitute together with the induction means 2 and the capacitive buffer means 3 a main current circuit. In the non-conducting state of the switching means 1, the main current circuit is constituted by the rectifying means 4, the induction means 2 and the capacitive buffer means 3.

In Fig. 2, a part of the circuit means is indicated relating to the production of the switching-on signal. A first winding part 21 in the form of an auxiliary winding of the induction means 2 in the form of a choke coil constitutes both the current detection means and the source for producing the input signal. The voltage produced in the auxiliary winding 21 is supplied to the switching means 1 via a coupling capacitor 100 and

an impedance 101 of the control circuit. Reference numeral 30 denotes the part of the control circuit which relates on the one hand to the supply of the switching-off signal and on the other hand to means for maintaining a switching condition of the switching means.

The circuit means further comprise capacitive means represented as a capacitor 22, which constitute with the choke coil 2 an oscillatory circuit for driving the auxiliary winding 21 acting as a source.

When the switching means 1 have been switched to the non-conducting state, a current decreasing in value will permanently flow through the choke coil 2 via the rectifying means 4 in the form of a diode. From the instant at which the current through the choke coil 2 has become zero, further conduction via the diode 4 is impossible. However, via the capacitor 22 at the same time a current conduction path is formed so that an oscillatory circuit comprising the choke coil 2 and the capacitor 22 is obtained. As soon as the current through the choke coil 2 increases again due to oscillation of the oscillatory circuit, a positive voltage is induced in the auxiliary winding 21. This voltage supplies via the coupling capacitor 100 and the resistor 101 the switching-on signal to the switching means 1. Thus, the auxiliary winding 21 forms the source for producing the switching-on signal.

The part of the circuit means 20 for producing the switching-off signal is shown more fully in Fig. 3. A second winding part in the form of an auxiliary winding 23 of the choke coil 2 forms part of a current source 24, by which a capacitor 240 is charged. The capacitor 240 is connected to a base 27b of a bipolar transistor 27, which forms part of a bistable multivibrator 25. By increasing the number of different breakdown voltage adjustments in the voltage division network 26, the lamp voltage dependence upon the signal produced in the voltage division network 26 can be subdivided. In the embodiment shown, this is achieved in an efficient manner in that for a further breakdown voltage adjustment the Zener diode 29 already present is used. For this purpose, the voltage division network 26 is connected via a diode 264 to the Zener diode 29.

The multivibrator 25 comprises a current source constituted by a transistor 28, of which a collector 28c is connected to the control circuit I. An emitter 28e of the transistor 28, coupled to an emitter 27e of the transistor 27, is connected to earth via a common resistor 32. The transistor 27 is supplied by an auxiliary voltage +V. A base 28b of the transistor 28 is also connected to the auxiliary voltage +V and is also connected via a Zener diode 29 to earth. The emitter 28e and the base 28b are interconnected through a diode 31.

The capacitor 240 is also connected to a voltage division network 26, which is connected to the output terminal B. The voltage division network 260 is provided with a transistor 35 as impedance adaptation

with the capacitor 240. Further, the transistor 260 prevents the capacitor 240 from being discharged via the voltage division network 26. The voltage division network provides a voltage at the capacitor 240, which is related to the voltage of the output terminal B. In the embodiment considered, the voltage division network 26 comprises a first branch provided with a Zener diode 261 and a second branch provided with Zener diodes 262 and 263. Due to different breakdown voltage adjustments for the first and second branches of the voltage division network 26, it is achieved that the network acts as a signal source dependent upon the lamp voltage. Via the capacitor 240, the multivibrator 25 is then controlled.

The embodiment considered of the switch mode power supply is constructed so that in the conducting state of the switching means 1 the transistor 28 is conducting. The current flowing through the choke coil 2 induces a voltage in the auxiliary winding 23 and the capacitor 240 is charged thereby via the current source 24. The voltage at the base 27b of the transistor 27 then occurring provides an increasing current through the transistor 27 and hence an increasing voltage of the emitter 27e and so of the emitter 28e. As soon as the voltage at the emitter 28e becomes equal to the voltage at the base 28b, the transistor 28 is switched to the non-conducting state and the multivibrator is triggered. Thus, the switching-off signal is formed. When the transistor 28 is switched to the non-conducting state, the value of the current through the coil is limited to a maximum. The height of the maximum is also determined by a voltage originating from the voltage division circuit 26. For the period in which the switching means 1 are in the non-conducting state, the capacitor 240 will be discharged via a diode 40 through the coil 2 until the voltage across the capacitor 240 is equal to the voltage originating from the voltage division circuit 26. The control circuit I is designed so that, when the switching-on signal is supplied, the multivibrator is also triggered and the transistor 28 again becomes conducting.

In the embodiment considered, the control circuit is constructed in the manner shown in Fig. 4. Of the switching means 1, which are constructed as a FET, a control electrode 15 is connected through a transistor 35 to a main electrode 1d. The control electrode 15 is also connected through the impedance 102 and the capacitor 100 to the connection point E, at which the switching-on signal produced by the circuit means 20 described appears. A base 35b of the transistor 35 is connected to a tapping point on a voltage division circuit 36, 37, which is connected on the one hand to the capacitor 100 and on the other hand to the connection point D. At the connection point D the switching-off signal produced in the circuit means 20 appears. The circuit parts 35, 36 and 37 constitute the essential parts of the part 30 of the control circuit re-

lating on the one hand to the supply of the switching-off signal and on the other hand to means for maintaining a switching condition of the switching means 1. This will be explained more fully hereinafter.

The positive voltage appearing as switching-on signal at the connection point E and produced in the circuit means is supplied via the capacitor 100 and the resistor 101 to the control electrode 15, as a result of which the FET 1 passes to the conducting state. This positive voltage also ensures that the transistor 28 of the multivibrator 25 becomes conducting via the voltage division circuit 36, 37 and the connection point D. The multivibrator is then triggered.

Due to the fact that the transistor 28 becomes conducting, the voltage at the base 35b of the transistor 35 increases and the transistor 25 becomes non-conducting. As long as the transistor 28 of the multivibrator 25 is conducting, the transistor 35 remains in the non-conducting state and hence the FET 1 remains in the conducting state.

As soon as the multivibrator 25 is triggered and the transistor 28 is switched to the non-conducting state, the voltage at the base 35b of the transistor 35 increases. The transistor 35 thus becomes conducting and thus shortcircuits the control electrode 15 and the main electrode 1d. Due to the shortcircuit between the control electrode 15 and the main electrode 1d, the FET 1 is switched to the non-conducting state. Thus, the transistor 35 supplies the switching-off signal appearing at the connection terminal D to the switching means 1.

Till the instant at which the switching-on signal appears at the connection point E, the transistor 35 remains conducting and hence the FET 1 remains in the non-conducting state.

In this configuration of the control circuit, it is achieved in a particularly simple and effective manner that the switching signal produced in the circuit means 20 is supplied to the switching means 1, while at the same time the switching condition of the switching means 1 in the period between the switching-on signal and the switching-off signal and between the switching-off signal and the switching-on signal, respectively, can be maintained with certainty. The transistor 35 thus belongs to means of maintenance in the form of a switching shortcircuit means having a very simple and reliable construction, which is a further advantage of the configuration described of the control circuit. As protection for the switching means 1, an overvoltage protection may form part of the maintenance means, for example in the form of a Zener diode (not shown) parallel to the transistor 35.

In a practical embodiment of the example considered, the switching means 1 are constructed as a FET. The switch mode power supply is suitable for an input voltage of 150 to 190 V and is intended for ignition and operation of a high-pressure metal halide lamp having a nominal power of 200 W. The stable

working-point of this lamp lies at 60 V, 3.3 A. The lamp is included in a commutation network.

The induction means 2 are constructed as a choke coil consisting of a coiled coil winding having 33 and 34 turns, respectively, an auxiliary winding comprising 8 turns as a first winding part 21 and an auxiliary winding comprising 17 turns as a second winding part 23.

The Zener diode 261 of the first branch of the voltage division network 26 has a Zener voltage of 27 V (type BZX 84). The Zener diodes 262 and 263 of the second branch have in all a Zener voltage of 106 V (both of the type BZX 84). The Zener diode 29 has a Zener voltage of 6.2 V, while the auxiliary voltage +V amounts to 12 V. The transistor 28 of the bistable multivibrator 25 is of the type BF 622 and is suitable for a collector-emitter voltage of 200 V.

With the practical construction of the embodiment considered of the switch mode power supply, a current-voltage characteristic as shown in Fig. 5 is obtained. The current supplied to the lamp is plotted on the abscissa and the voltage at the output terminal B is plotted on the ordinate. The voltage at the output terminal B is limited to 120 V (point K in Fig. 5). With an increasing current, the line part K-L is followed. A voltage of 115 V and a current of 1.5 A correspond to the point L. The line part L-M and the line part M-N together form the part of the characteristic in which the power supplied to the lamp is regulated by means of the signal produced in the voltage division network 26, the subdivision in the two line parts being obtained by the breakdown voltage of the Zener diode 29. The point M corresponds to a voltage of 60 V and to a current of 3.3 A, while the point N corresponds to a voltage of 26 V and to a current of 6.8 A. A current of 6.8 A constitutes at the same time the maximum value of the current supplied to the lamp by the switching supply.

For the ignition of the lamp a current will not yet be supplied. In the characteristic, this corresponds to the point K as the working-point of the switching supply. During the ignition, which takes place by means of a starter not shown, initially a small current will be supplied. In the characteristic, this is indicated by the line part K-L. The commutation circuit in which the lamp is included then operates in a starting mode. As soon as breakdown occurs in the lamp due to starting pulses produced by means of the starter, the commutation circuit passes to the operating mode. Due to the breakdown, the voltage across the lamp becomes very low. In the characteristic, the working-point of the switch mode power supply is then displaced abruptly from the line part K-L to the line part N-O. Subsequently, the voltage across the lamp slowly increases until the stable operating condition is reached. In the characteristic shown, the working-point is displaced from the line part N-O via the line part N-M to the point M, which corresponds to the sta-

ble working-point of the lamp in operation. In the case in which the voltage across the lamp associated with the stable working-point of the lamp is higher than 50 V, the working-point of the switch mode power supply will be displaced in the characteristic shown over the line part M-L.

The lamp thus operated with the switch mode power supply described has at constant power a luminous flux of substantially constant value and is thus suitable *inter alia* for use as a light source for projection purposes.

Claims

1. A switch mode power supply suitable for ignition and operation of a high-pressure discharge lamp (5) comprising

- switching means (1), induction means (2), capacitive buffer means (3) and rectifying means (4) for producing from an input voltage a current for the lamp by switching the switching means alternately to the conducting state and the non-conducting state, and
- a control circuit (1) for supplying a switching signal comprising a switching-on signal for switching the switching means to the conducting state and a switching-off signal for switching the switching means to the non-conducting state,

the switch mode power supply comprising circuit means (20) for current detection through the induction means, which circuit means serve at the same time for producing the switching signal, characterized in that a first winding part (21) of the induction means (2) forms part of the circuit means (20) as a source for producing the switching-on signal, and in that a second winding part (23) of the induction means (2) forms part of the circuit means (20) as a first signal source for producing the switching-off signal.

2. A switch mode power supply as claimed in Claim 1, characterized in that the circuit means also comprise capacitive means (22) which constitute together with the induction means (2) an oscillatory circuit for driving the source for producing the switching-on signal.
3. A switch mode power supply as claimed in Claim 1 or 2, characterized in that the control circuit comprises a bistable multivibrator (25) controlled by means of the first signal source for producing the switching-off signal.
4. A switch mode power supply as claimed in Claim 1, 2 or 3, characterized in that the circuit means comprise a second signal source (26) dependent

upon the lamp voltage for controlling the multivibrator (25).

Patentansprüche

1. Schaltende Speisung, geeignet zum Zünden und Betreiben einer Hochdruckentladungslampe (5) mit

- Schaltmitteln (1), Induktionsmitteln (2), kapazitiven Puffermitteln (3) und Gleichrichtermitteln (4) zum aus einer Eingangsspannung Erzeugen eines Stromes für die Lampe, indem die Schaltmittel wechselweise in den leitenden und den gesperrten Zustand schalten, und
- einer Steuerschaltung (1) zum Liefern eines Schaltsignals mit einem Einschaltsignal zum Schalten der Schaltmittel in den leitenden Zustand und mit einem

Ausschaltsignal zum Schalten der Schaltmittel in den gesperrten Zustand, wobei die schaltende Speisung Schaltungsmittel (20) aufweist zur Stromdetektion durch die Induktionsmittel, wobei diese Schaltungsmittel gleichzeitig zum Erzeugen des Schaltsignals dienen, dadurch gekennzeichnet, daß ein erster Wicklungsteil (21) der Induktionsmittel (2) einen Teil der Schaltungsmittel (20) bildet als Quelle zum Erzeugen des Einschaltsignals, und daß ein zweiter Wicklungsteil (23) der Induktionsmittel (2) einen Teil der Schaltungsmittel (20) bildet als erste Signalquelle zum Erzeugen des Ausschaltsignals.

2. Schaltende Speisung nach Anspruch 1, dadurch gekennzeichnet, daß die Schaltungsmittel ebenfalls kapazitive Mittel (22) aufweisen, die zusammen mit den Induktionsmitteln (2) eine Oszillatorschaltung bilden zum Betreiben der Quelle zum Erzeugen des Einschaltsignals.

3. Schaltende Speisung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Steuerschaltung einen bistabilen Multivibrator (25) aufweist, die mittels der ersten Signalquelle zum Erzeugen des Ausschaltsignals gesteuert wird.

4. Schaltende Speisung nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß die Schaltungsmittel eine zweite Signalquelle (26) aufweisen, die von der Lampenspannung zur Regelung des Multivibrators (25) abhängig ist.

Revendications

1. Alimentation de commutation convenable pour l'amorçage et le fonctionnement d'une lampe à



ble working-point of the lamp in operation. In the case in which the voltage across the lamp associated with the stable working-point of the lamp is higher than 50 V, the working-point of the switch mode power supply will be displaced in the characteristic shown over the line part M-L.

The lamp thus operated with the switch mode power supply described has at constant power a luminous flux of substantially constant value and is thus suitable *inter alia* for use as a light source for projection purposes.

Claims

1. A switch mode power supply suitable for ignition and operation of a high-pressure discharge lamp (5) comprising

- switching means (1), induction means (2), capacitive buffer means (3) and rectifying means (4) for producing from an input voltage a current for the lamp by switching the switching means alternately to the conducting state and the non-conducting state, and
- a control circuit (1) for supplying a switching signal comprising a switching-on signal for switching the switching means to the conducting state and a switching-off signal for switching the switching means to the non-conducting state,

the switch mode power supply comprising circuit means (20) for current detection through the induction means, which circuit means serve at the same time for producing the switching signal, characterized in that a first winding part (21) of the induction means (2) forms part of the circuit means (20) as a source for producing the switching-on signal, and in that a second winding part (23) of the induction means (2) forms part of the circuit means (20) as a first signal source for producing the switching-off signal.

2. A switch mode power supply as claimed in Claim 1, characterized in that the circuit means also comprise capacitive means (22) which constitute together with the induction means (2) an oscillatory circuit for driving the source for producing the switching-on signal.
3. A switch mode power supply as claimed in Claim 1 or 2, characterized in that the control circuit comprises a bistable multivibrator (25) controlled by means of the first signal source for producing the switching-off signal.
4. A switch mode power supply as claimed in Claim 1, 2 or 3, characterized in that the circuit means comprise a second signal source (26) dependent

upon the lamp voltage for controlling the multivibrator (25).

Patentansprüche

1. Schaltende Speisung, geeignet zum Zünden und Betreiben einer Hochdruckentladungslampe (5) mit

- Schaltmitteln (1), Induktionsmitteln (2), kapazitiven Puffermitteln (3) und Gleichrichtermitteln (4) zum aus einer Eingangsspannung Erzeugen eines Stromes für die Lampe, indem die Schaltmittel wechselweise in den leitenden und den gesperrten Zustand schalten, und
- einer Steuerschaltung (1) zum Liefern eines Schaltsignals mit einem Einschaltsignal zum Schalten der Schaltmittel in den leitenden Zustand und mit einem

Ausschaltsignal zum Schalten der Schaltmittel in den gesperrten Zustand, wobei die schaltende Speisung Schaltungsmittel (20) aufweist zur Stromdetektion durch die Induktionsmittel, wobei diese Schaltungsmittel gleichzeitig zum Erzeugen des Schaltsignals dienen, dadurch gekennzeichnet, daß ein erster Wicklungsteil (21) der Induktionsmittel (2) einen Teil der Schaltungsmittel (20) bildet als Quelle zum Erzeugen des Einschaltsignals, und daß ein zweiter Wicklungsteil (23) der Induktionsmittel (2) einen Teil der Schaltungsmittel (20) bildet als erste Signalquelle zum Erzeugen des Ausschaltsignals.

2. Schaltende Speisung nach Anspruch 1, dadurch gekennzeichnet, daß die Schaltungsmittel ebenfalls kapazitive Mittel (22) aufweisen, die zusammen mit den Induktionsmitteln (2) eine Oszillatorschaltung bilden zum Betreiben der Quelle zum Erzeugen des Einschaltsignals.

3. Schaltende Speisung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Steuerschaltung einen bistabilen Multivibrator (25) aufweist, die mittels der ersten Signalquelle zum Erzeugen des Ausschaltsignals gesteuert wird.

4. Schaltende Speisung nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß die Schaltungsmittel eine zweite Signalquelle (26) aufweisen, die von der Lampenspannung zur Regelung des Multivibrators (25) abhängig ist.

Revendications

1. Alimentation de commutation convenable pour l'amorçage et le fonctionnement d'une lampe à



décharge à haute pression (5), comportant

- des moyens commutateurs (1), des moyens d'induction (2), des moyens tampons capacitifs (3) et des moyens redresseurs (4) conçus pour engendrer, à partir d'une tension d'entrée, un courant pour la lampe en commutant les moyens commutateurs alternativement à l'état conducteur et à l'état non conducteur, et 5
- un circuit de commande (1) conçu pour fournir un signal de commutation comportant un signal d'enclenchement pour commuter les moyens commutateurs à l'état conducteur, et un signal de déclenchement pour commuter les moyens commutateurs à l'état non conducteur, 10 15

l'alimentation de commutation comportant des moyens de circuit (20) conçus pour détecter un courant traversant les moyens d'induction, lesdits moyens de circuit servent en même temps à engendrer le signal de commutation, caractérisée en ce qu'une première partie d'enroulement (21) des moyens d'induction (2) fait partie des moyens de circuit (20) comme source conçue pour engendrer le signal d'enclenchement, et en ce qu'une deuxième partie d'enroulement (23) des moyens d'induction (2) fait partie des moyens de circuit (20) comme première source de signal conçue pour engendrer le signal de déclenchement. 20 25 30

2. Alimentation de commutation selon la revendication 1, caractérisée en ce que les moyens de circuit comportent également des moyens capacitifs (22) constituant conjointement avec les moyens d'induction (2) un circuit oscillant conçu pour commander la source conçue pour engendrer le signal d'enclenchement. 35
3. Alimentation de commutation selon la revendication 1 ou 2, caractérisée en ce que le circuit de commande comporte un multivibrateur bistable (25) commandé au moyen de la première source de signal conçue pour engendrer le signal de déclenchement. 40 45
4. Alimentation de commutation selon la revendication 1, 2 ou 3, caractérisée en ce que les moyens de circuit comportent une deuxième source de signal (26) dépendant de la tension de lampe et conçue pour commander le multivibrateur (25). 50

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