PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : **H04N 3/19**	**A2**	(11) International Publication Number: **WO 99/53684** (43) International Publication Date: 21 October 1999 (21.10.99)

(21) International Application Number: PCT/IB99/00573

(22) International Filing Date: 1 April 1999 (01.04.99)

(30) Priority Data:
98201138.9 9 April 1998 (09.04.98) EP

(71) Applicant: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL–5621 BA Eindhoven (NL).

(71) Applicant *(for SE only)*: PHILIPS AB [SE/SE]; Kottbygatan 7, Kista, S–164 85 Stockholm (SE).

(72) Inventors: BAX, Pieter, J.; Prof. Holstlaan 6, NL–5656 AA Eindhoven (NL). JONKMAN, Rudi; Prof. Holstlaan 6, NL–5656 AA Eindhoven (NL).

(74) Agent: STERKEN, Antoon, J., E.; Prof. Holstlaan 6, NL–5656 AA Eindhoven (NL).

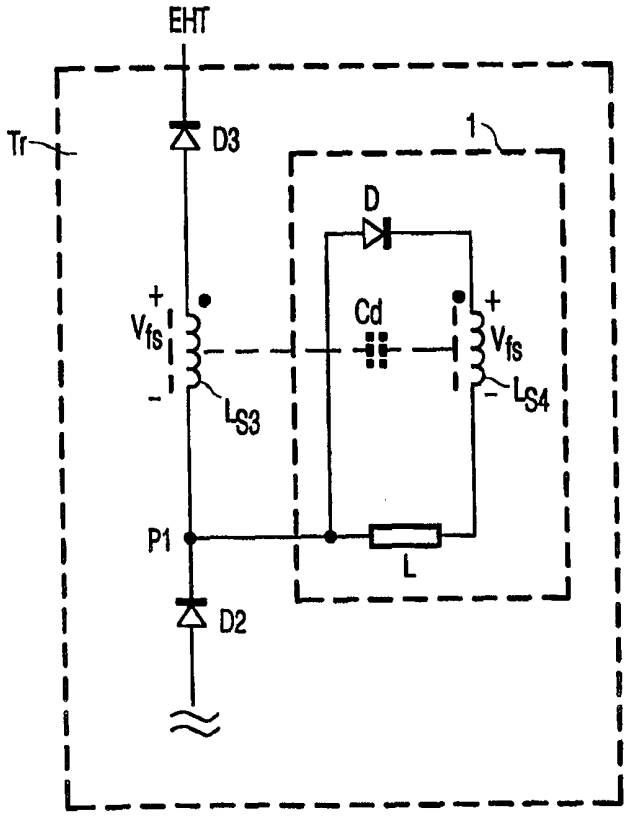
(81) Designated States: CN, JP, KR, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: A HIGH VOLTAGE TRANSFORMER

(57) Abstract

A high voltage transformer (Tr) comprises a primary winding (Lp), secondary windings (Ls1, Ls2, Ls3), and diodes (Di) coupled between successive secondary windings (Ls1, Ls2, Ls3). A polarity of the diodes (Di) and the secondary windings (Ls1, Ls2, Ls3) is selected such that the flyback voltages (Vfs) across each of the secondary windings (Ls1, Ls2, Ls3) are summed via conductive diodes (Di) during at least part of a flyback period (Tf) for generating a high voltage (EHT). A damp–circuit (1) comprises a rectifier element (D), a load (L), and a further winding (Ls4) of the high voltage transformer (Tr). These elements are arranged with respect to one of the secondary windings (Ls1, Ls2, Ls3) such that the further winding (Ls4) and said one of the secondary windings (Ls1, Ls2, Ls3) form a capacitance (Cd) across the load (L), and such that the solide (D) is non conductive during the flyback period (Tf). In this way, electrical oscillations of the high voltage transformer (Tr) are damped.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

A high voltage transformer.

The invention relates to a high voltage transformer as defined in the precharacterizing part of claim 1. The invention also relates to a display apparatus with a display device for receiving a high voltage from such a high voltage transformer as defined in the precharacterizing part of claim 7. Such a high voltage transformer is especially suitable for generating an anode voltage for a cathode ray tube.

Prior art DE-A-3830823 discloses a diode split transformer for generating the high anode voltage. The diode split transformer comprises a primary winding and a series arrangement of high voltage sections each of which comprises a series arrangement of a diode and a secondary winding. The diodes and the secondary windings all have a polarity to sum the voltages across the secondary windings when the diodes conduct during the flyback period. A damp-circuit is connected across one of the secondary windings to suppress a resonance of the transformer. The damp-circuit comprises a parallel arrangement of a load and a capacitor. The parallel arrangement is arranged in series with a diode. The diode has a polarity such that it does not conduct during the flyback period.

It is a drawback of the prior art damp circuit that the capacitor of the damp circuit is bulky as it has to withstand a high voltage.

It is an object of the invention to provide a transformer with a damp circuit which requires less space.

To this end, a first aspect of the invention provides a high voltage transformer with a damp-circuit as defined in claim 1. A second aspect of the invention provides a display apparatus with a high voltage transformer as defined in claim 7. Advantageous embodiments are defined in the dependent claims.

The damp-circuit comprises a further winding of the transformer instead of the capacitor. The further winding, the diode, and the load are arranged with respect to one of the secondary windings such that the further winding and the said of the secondary windings form

a capacitance across the load. In the claims, the secondary windings are referred to as high voltage windings.

The embodiment of the invention as claimed in claim 3 has the advantage with respect to the embodiment of the invention as claimed in claim 2 that during the flyback period no energy is dissipated in the load.

The embodiment of the invention as claimed in claim 5 has the advantage that the secondary windings and the further winding are all wound over each other, causing a large capacitance.

The embodiment of the invention as claimed in claim 6 has the advantage that the two windings form a large capacitance and are coupled very well. The excellent coupling provides substantially equal voltages across both windings, which has the advantage that substantially no AC voltage occurs across the capacitance.

These and other aspects of the invention will be apparent from and elucidated with reference to the accompanying drawings.

In the drawings:

Fig. 1 shows a block diagram of a display apparatus which comprises a high voltage transformer with a damp-circuit according to a first embodiment of the invention,

Fig. 2 shows a waveform across a secondary winding of a high voltage transformer without a damp-circuit, and

Fig. 3 shows part of a high voltage transformer with a damp-circuit according to a second embodiment of the invention.

Fig. 1 shows a block diagram of a display apparatus DA which comprises a high voltage transformer Tr with a damp-circuit 1 according to a first embodiment of the invention.

The display apparatus DA comprises a control circuit 2, a high voltage transformer Tr, a capacitor Cp, a diode Dp, and a display device DD. The display apparatus may display television or computer generated video signals. A series arrangement of a primary winding Lp of the high voltage transformer Tr and a switching element S receives a supply voltage Vb. A parallel arrangement of the capacitor Cp and the diode Dp is connected between ground and the junction of the primary winding Lp and the switching element S. The anode of the diode Dp is connected to ground. The on- and off-periods of the switching element S are

controlled by the control circuit 2 in dependence on a line synchronization signal which is separated from the input video signal V. It is also possible that the line synchronization signal is available directly, as is common practice in computer graphics adapters. The high voltage transformer Tr generates the high voltage EHT with a series arrangement of diodes Di and secondary windings Lsi. A first diode D0 has an anode coupled to ground and a cathode coupled to the first secondary winding Ls1. A second diode D1 is coupled between the first secondary winding Ls1 and the second secondary winding Ls2. A third diode D2 is coupled between the second secondary winding Ls2 and the third secondary winding Ls3. A fourth diode D3 is coupled between the third secondary winding Ls3 and a high voltage contact of the display device DD (for example, an anode contact of a cathode ray tube DD).

A damp-circuit 1 is arranged in parallel with the third secondary winding Ls3. The damp-circuit 1 comprises a diode D with a cathode coupled to a junction of the third secondary winding Ls3 and the fourth diode D3, and an anode coupled via a load L to a junction of the third secondary winding Ls3 and the third diode D2. The damp-circuit 1 further comprises a fourth secondary winding Ls4 with a first end connected to the anode of the diode D. A second end of the fourth secondary winding Ls4 floats. A distributed capacitance Cd between the fourth secondary winding Ls4 and the third secondary winding Ls3 may be considered as a lumped capacitance across the load L.

At a start of the off-period of the switching element S, a current flowing in the primary winding Lp is forced to flow into the capacitor Cp to generate a high flyback voltage Vfp across the primary winding Lp. This high flyback voltage Vfp across the primary winding Lp is transformed into high flyback voltages Vfs across the secondary windings Lsi. All diodes Di (D0 to D3) have a polarity to rectify these high flyback voltages Vfs across the secondary windings Lsi. Consequently, all diodes Di conduct during at least a part of the flyback period Tf during which the switching element S is open. All diodes Di are non-conductive outside the flyback period Tf. The operation of the damp-circuit 1 will be elucidated with respect to Fig. 2.

Fig. 2 shows a waveform across a secondary winding Lsi of the high voltage transformer Tr without a damp-circuit 1. At instant t0 at which the flyback period Tf starts, the switching element S is opened, and a flyback voltage Vfs is generated. The flyback period Tf ends at t1. During the flyback period Tf, a conducting period of the diodes Di depends on the high voltage EHT drop caused by the current drawn by the display device DD during the period of time the diodes Di are non-conductive. At t1, the diode Dp (Fig. 1) becomes

conductive and the scan period Ts starts. The supply voltage Vb occurs across the primary winding Lp and the supply voltage Vb is transformed to a scan voltage Vs across each of the secondary windings Lsi. In a stable situation (at the end of the scan period Ts, just before instant t3), a nominal scan voltage Vs occurs, which is determined by the winding ratio between the secondary winding Lsi and the primary winding Lp. At the start t1 of the scan period Ts, energy in the spread inductance of the high voltage transformer Tr causes oscillations around the nominal value of the scan voltage Vs.

At the start t1 of the scan period Ts, the capacitor Cd in the damp-circuit 1 is charged to the nominal value of the scan voltage Vs. As soon as the scan voltage Vs drops below its nominal value the diode D becomes conductive and the energy in the spread inductance is dissipated in the load L. The impedance of the load L should be selected as high as possible to prevent a significant load on the high voltage transformer Tr during the scan period. However, the impedance of the load should be small enough to dissipate the energy substantially during the first negative half period of the oscillation.

Fig. 3 shows part of a high voltage transformer Tr with a damp-circuit 1 according to a second embodiment of the invention. In Fig. 3 is shown the part of the high voltage transformer Tr of Fig. 1 which comprises the third diode D2, the third secondary winding Ls3, and the fourth diode D3. Again, the damp-circuit 1 comprises a fourth secondary winding Ls4 which forms the distributed capacitance Cd with the third secondary winding Ls3. A first end of the fourth secondary winding Ls4 is connected to a junction P1 of the third secondary winding Ls3 and the third diode D2 via the load L. A second end of the fourth secondary winding Ls4 is connected to the junction P1 via the diode D. The anode of the diode D is connected to the junction P1. As indicated by the dots near to the third Ls3 and the fourth Ls4 secondary winding, both the third and the fourth secondary windings Ls3, Ls4 have a same polarity.

Also in this embodiment of the damp-circuit 1 according to the invention, the diode D starts conducting as soon as the scan voltage Vs drops below its nominal value, and consequently the oscillations are suppressed.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims.

The switching element S may be a bipolar transistor, a field effect transistor, or any other suitable semiconductor switching element.

The high voltage transformer Tr with the damp circuit 1 according to the invention may be used in a standalone high voltage generator as shown, or in a combined line deflection and high voltage generating circuit wherein the primary winding Lp of the high voltage transformer Tr is used as a choke for the line deflection circuit.

In the embodiments of the invention, the third secondary winding Ls3 is the outer wound secondary winding of the secondary windings Lsi contributing to the high voltage EHT. By selecting the fourth secondary winding Ls4 to be the outer wound secondary winding of the high voltage transformer Tr, this fourth winding Ls4 has a very good coupling with the third winding Ls3 and moreover shields the transformer, thereby reducing Electro- Magnetical Interference.

The fourth secondary winding Ls4 of the damp-circuit 1 is wound directly over the third secondary winding Ls3 to obtain a good coupling and a large capacitance Cd. The fourth secondary winding Ls4 may also be wound directly over another one of the secondary windings Lsi. In this case, the other components of the damp-circuit 1 have to be rearranged with respect to this other one of the secondary windings Lsi. Although less favorable, it is also possible to use an extra winding between the primary winding Lp and the secondary windings Lsi as the fourth secondary winding Ls4.

The number of secondary windings Lsi and the associated diodes Di may be selected to fit a maximum allowable or desirable voltage across each secondary winding Lsi or each diode Di.

Preferably, the fourth secondary winding Ls4 and the third secondary winding Ls3 have a same number of turns. However, the oscillations will also be damped if the number of turns of the fourth secondary winding Ls4 and the third secondary winding Ls3 differ. However, too large a difference may cause too large a current through the capacitor Cd.

The so called foot-diode D0, which enables the high voltage transformer to be operated at a higher switching frequency, may be omitted.

In summary, in a preferred embodiment, the damp-circuit 1 according to the invention is applied in a layer-wound diode split transformer Tr in which the secondary windings Lsi are formed of a conductive foil. Such a layer-wound transformer Tr is often used to generate the anode voltage EHT required by a cathode ray tube DD in a display apparatus DA. Such a layer-wound diode split transformer Tr comprises a primary winding Lp, secondary windings Lsi, and diodes Di coupled between successive secondary windings Lsi. A

polarity of the diodes Di and the secondary windings Lsi is selected such that the flyback voltages Vfs across each of the secondary windings Lsi are summed via conductive diodes Di during at least part of a flyback period Tf for generating the high voltage EHT.

The damp-circuit 1 comprises a rectifier element D, a load L, and a further winding Ls4 of the high voltage transformer Tr. These elements are arranged with respect to one of the secondary windings Lsi such that the further winding Ls4 and said one of the secondary windings Lsi form a capacitance Cd across the load L, and such that the diode D is non-conductive during the flyback period Tf. In this way, electrical oscillations of the high voltage transformer Tr are damped.

In the claims, any reference signs placed between parenthesis shall not be construed as limiting the scope of the claims.

CLAIMS:

1. A high voltage transformer (Tr) comprising:

high voltage windings (Ls1, Ls2, Ls3) arranged for generating a high voltage (EHT) during a flyback period (Tf),

a damp-circuit (1) comprising a rectifier element (D) and a load (L), the rectifier element (D) being arranged as as to be non-conductive during the flyback period (Tf), characterized in that the damp-circuit (1) comprises a further winding (Ls4) of the high voltage transformer (Tr), the further winding (Ls4), the rectifier element (D) and the load (L) being arranged with respect to one of the high voltage windings (Ls1, Ls2, Ls3) such that the further winding (Ls4) and said one of the high voltage windings (Ls1, Ls2, Ls3) form a capacitance (Cd) across the load (L).

2. A high voltage transformer (Tr) as claimed in claim 1, characterized in that

a series arrangement of the rectifier element (D) and the load (L) is arranged in parallel with said one of the high voltage windings (Ls1, Ls2, Ls3),

the further winding (Ls4) has a first end coupled to a junction point of the rectifier element (D) and the load (L), and a second floating end, and

said one of the high voltage windings (Ls1, Ls2, Ls3) has an end coupled to the rectifier element (D), said end having a same polarity as the first end of the further winding (Ls4).

3. A high voltage transformer (Tr) as claimed in claim 1, characterized in that

a first end of said one of the high voltage windings (Ls1, Ls2, Ls3) is coupled to an end of another one of the high voltage windings (Ls1, Ls2, Ls3) via a further rectifier element (D2), the further rectifier element (D2) being conductive in the flyback period (Tf),

a first end of the rectifier element (D) and a first end of the load (L) are both coupled to said first end of said one of the high voltage windings (Ls1, Ls2, Ls3), the further winding (Ls4) being coupled between a second end of the rectifier element (D) and a second end of the load (L),

said first end of said one of the high voltage windings (Ls1, Ls2, Ls3) has a same polarity as an end of the further winding (Ls4) coupled to the load (L).

4. A high voltage transformer (Tr) as claimed in claim 1, characterized in that the load (L) is a resistor.

5. A high voltage transformer (Tr) as claimed in claim 1, characterized in that the high voltage transformer (Tr) is a layer wound diode split transformer.

6. A high voltage transformer (Tr) as claimed in claim 5, characterized in that the further winding (Ls4) and said one of the high voltage windings (Ls1, Ls2, Ls3) are wound directly over each other.

7. A display apparatus with a display device (DD) for receiving a high voltage (EHT) from a high voltage transformer (Tr), the high voltage transformer (Tr) comprising:

high voltage windings (Ls1, Ls2, Ls3) arranged for generating a high voltage (EHT) during a flyback period (Tf),

a damp-circuit (1) comprising a rectifier element (D) and a load (L), the rectifier element (D) being arranged so as to be non-conductive during the flyback period (Tf), characterized in that the damp-circuit (1) comprises a further winding (Ls4) of the high voltage transformer (Tr), the further winding (Ls4), the rectifier element (D) and the load (L) being arranged with respect to one of the high voltage windings (Ls1, Ls2, Ls3) such that the further winding (Ls4) and said one of the high voltage windings (Ls1, Ls2, Ls3) form a capacitance (Cd) across the load (L).

1/2

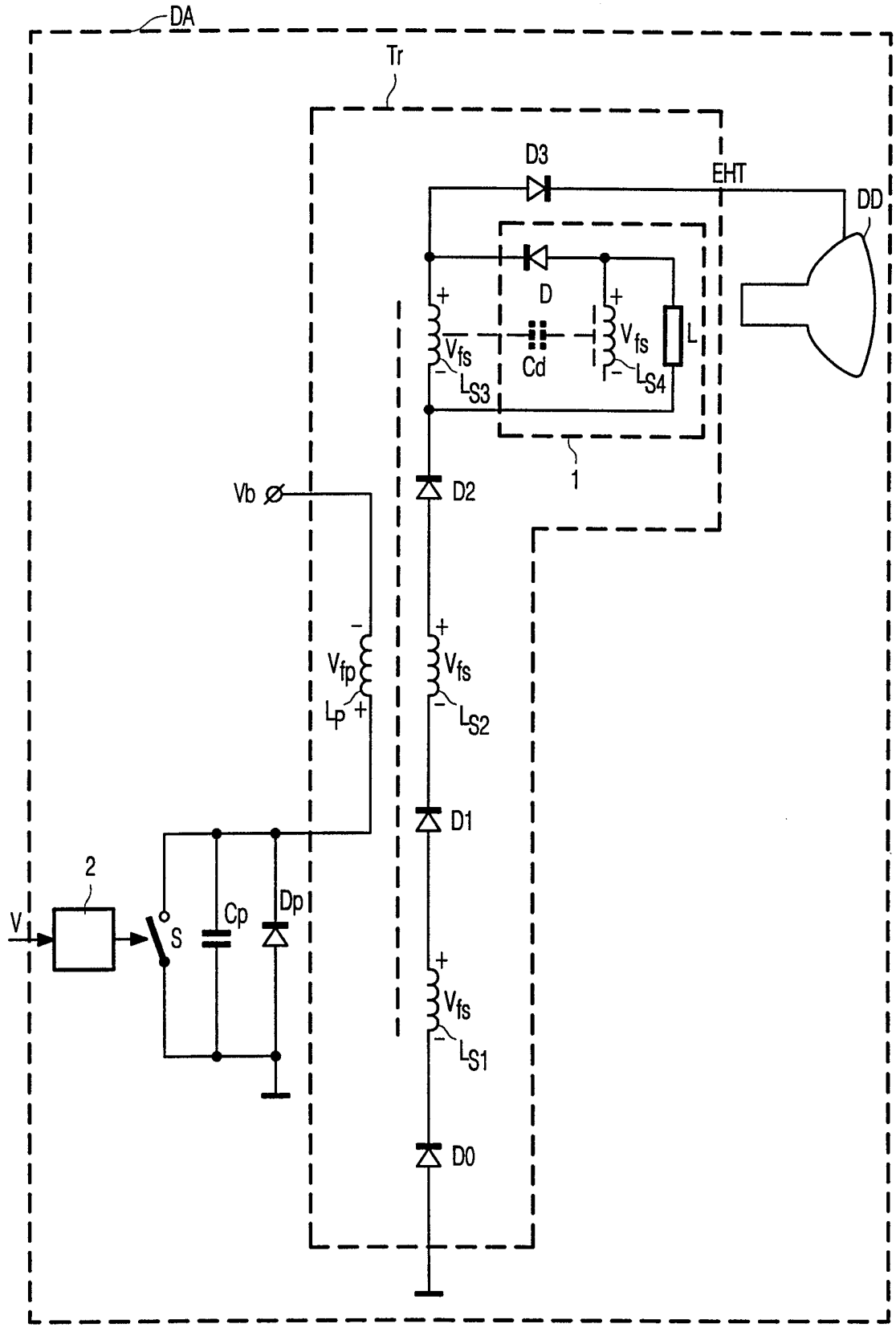

DA
Tr
D3
EHT
DD
D
Vfs
Cd
Vfs
L
LS3
LS4
1
Vb
D2
Vfp
LP
Vfs
LS2
D1
2
V
S
Cp
Dp
Vfs
LS1
D0

FIG. 1

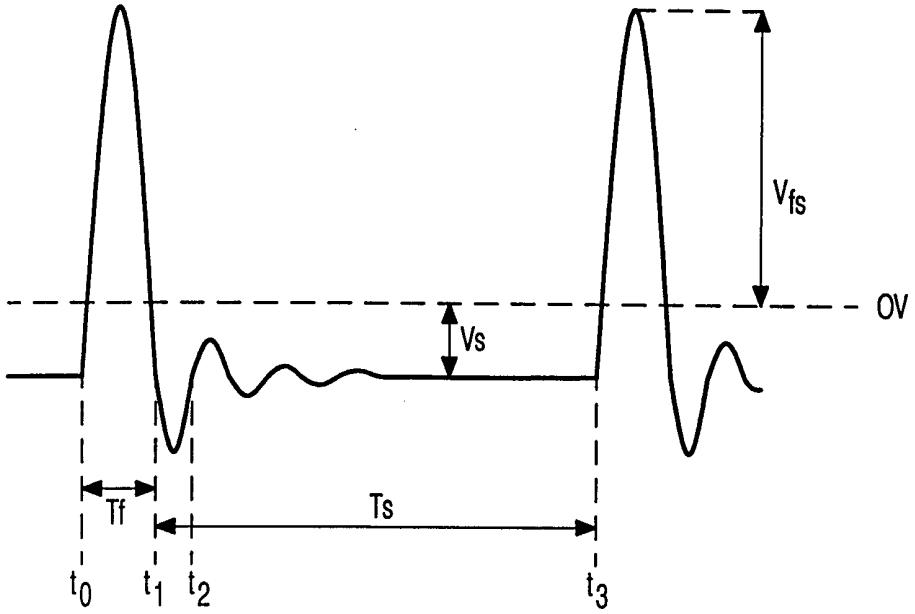


FIG. 2

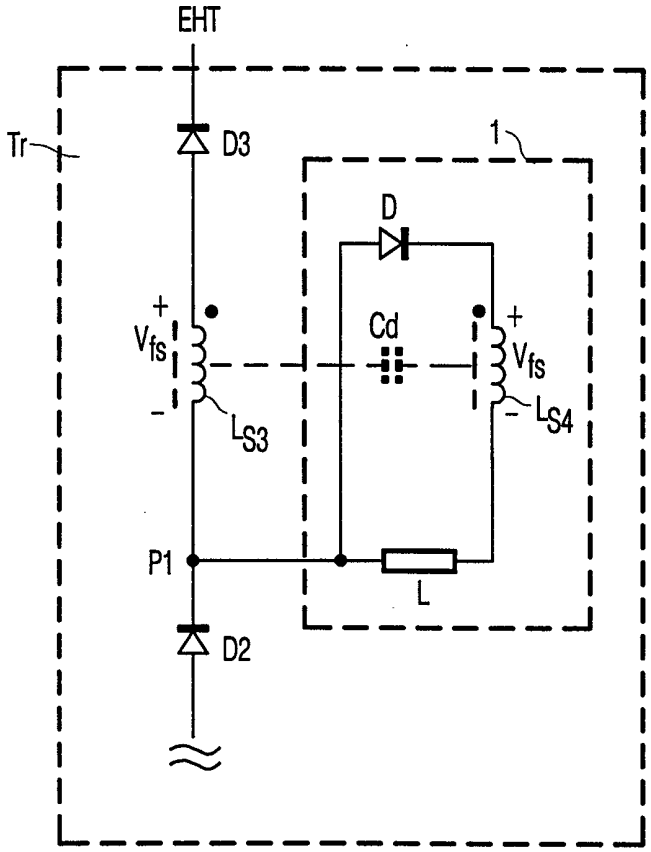


FIG. 3