

Description

The present invention relates to a triggering circuit, for example for spark plugs or ignitions of internal combustion engines.

As is known, the present triggering circuits of the type indicated comprise a transformer whose primary is connected in series to a capacitor and whose secondary is connected in parallel to a spark plug of an internal combustion engine or to an ignition of a turbine engine. The circuit also comprises a switched-voltage generator which initially permits the charging of the capacitor at medium voltage and is then short-circuited to permit the discharge of the capacitor through the primary of the transformer. There is therefore a very fast voltage rise in the primary, which induces a corresponding voltage rise in the secondary capable of causing the discharge of the spark plug or ignition.

The circuit described above has the disadvantage that its components are made with discrete elements, as a result of which its size is considerable and it is affected by losses which limit its efficiency.

The object of the present invention is to improve a triggering circuit of the type indicated in such a way as to reduce its overall dimensions and to improve its efficiency.

According to the present invention, a triggering circuit for ignition devices is provided, comprising at least a first and a second inductive element coupled magnetically together and to a magnetic core, and a capacitive element connected to the said first inductive element, the said second inductive element being connected to an ignition device, characterized in that it comprises a capacitive transformer including at least a first and a second sheet of conductive material wound around the said magnetic core and coupled magnetically to a secondary winding in such a way as to form the said first and second inductive elements and the said capacitive element.

The invention will now be described with reference to the attached drawings, which illustrate non-restrictive embodiments of the invention, in which:

Figure 1 is a view from above of a capacitive transformer used in the present triggering circuit;

Figure 2 is a partial lateral perspective view of the capacitive transformer shown in Fig. 1;

Figure 3 shows a first simplified electrical circuit of the transformer shown in Fig. 1, with four terminals; Figure 4 shows a second simplified electrical circuit of the transformer shown in Figs. 1 and 2, with six terminals;

Figure 5 shows a first embodiment of the triggering circuit according to the invention, incorporating the transformer shown in Figs. 1 and 2, as in the electrical circuit shown in Fig. 3;

Figure 6 shows a first variant of the triggering circuit according to the invention, using the capacitive

transformer shown in the electrical circuit in Fig. 3; and

Figure 7 shows a further variant of the present triggering circuit, using the capacitive transformer as shown in the electrical circuit in Fig. 5.

According to one aspect of the present invention, the present triggering circuit comprises a capacitive transformer made from a single component 1 having capacitive and inductive characteristics (a capacitive transformer). The capacitive transformer 1, shown in Figures 1 and 2, comprises a core 13 of ferromagnetic material around which is wound a conducting wire 14 forming the secondary of the transformer. Two conductive leaves or sheets 15, 16, typically made of metal, are wound around the secondary 14 to form a pair of plates separated from each other by a dielectric 17. The plates 15 and 16 have ends (corresponding to the ends of the two spirals visible in the view from above in Fig. 1) forming terminals A, C and D, B respectively, while the ends of the conducting wire 14 (secondary) are indicated by L and H.

If the terminals C and D are not used, the capacitive transformer 1, which forms a variant of a capacitive and inductive element which is the subject of an associated patent application filed on the same date and having the title "Capacitive and inductive element", has a simplified equivalent circuit 20 with four terminals as shown in Fig. 3. The equivalent circuit 20 comprises a theoretical transformer 2 formed by a primary 3 and a secondary 4, and a capacitor 5 arranged in series with the primary 3 and interposed between the primary and the terminal A. The primary 3 also forms the terminal B, while the secondary forms the terminals L, H; the terminals A, B, H, L shown here correspond to those with the same letters in Fig. 1. The node between the capacitor 5 and the primary 3 corresponds to the terminal D, illustrated here but not used.

The plates 15, 16 may be insulated from each other by any dielectric material suitable for the purpose. Additionally, instead of two single leaves, it is possible to provide for each plate a plurality of leaves or sheets connected in the form of a comb and interdigitated, in other words arranged in such a way that two adjacent leaves of one plate have one leaf of the other plate inserted between them, as described in greater detail in the previously cited associated patent application.

In practice, the capacitive transformer 1 according to Figs. 1 and 2 has a primary which also incorporates the capacitor 5, thus making it possible to obtain a very compact device, a reduction of manufacturing costs and a higher efficiency of the component.

When the terminals C and D of the capacitive transformer 1 are also taken into consideration, the transformer 1 can be shown diagrammatically as represented in Fig. 4 by the circuit 22. In detail, the circuit 22 in Fig. 4 has six terminals A-D, H, L, similar to the corresponding terminals in Fig. 1; an inductor 23 is arranged between the terminals A and C; a capacitor 24

is arranged between the terminals A and D; a capacitor 25 is arranged between the terminals C and B; an inductor 26, forming the primary of the transformer, is arranged between the terminals D and B and an inductor 27, coupled magnetically to the inductor 23 and to the inductor 26 and consequently forming the secondary of the transformer, is arranged between the terminals H and L.

According to the invention, the capacitive transformer 1 is used in a triggering circuit for ignition devices, one embodiment of which is shown by way of example in Fig. 5. The triggering circuit 30 in Fig. 5 comprises a continuous voltage generator 8 connected to the terminals A and B of the capacitive transformer 1, in parallel with a switch 6. The equivalent circuit 20 in Fig. 3 of the capacitive transformer 1, comprising the primary 3 and the secondary 4 and the capacitor 5, is shown here. A spark plug 7 or other ignition device is connected in parallel with the secondary 4 of the capacitive transformer 1.

The operation of the circuit 30 is as follows. Initially, the switch 6 is open and the voltage generator 8 charges the capacitor 5 at a medium voltage (typically 100-600 V). When the switch 6 is closed, the capacitor 5 discharges through the primary 3 of the transformer 2, inducing a potential difference in the secondary 4 sufficient to cause the discharge in the spark plug (or ignition) 7.

Fig. 6 shows an application based on the principle of providing, by means of the discharge of a capacitor to the primary 26 of the transformer, the energy required to initiate the discharge in the spark plug and, through the overvoltage of opening of an inductive circuit coupled to the secondary, the energy for maintaining the discharge over a period of time.

The circuit 34 in Fig. 6 comprises the capacitive transformer 1 between whose terminals H and L the spark plug 7 is arranged. A continuous voltage generator 35 is connected to the terminals A and B, in parallel with a switch 36; a branch 37, comprising a resistor 38, a switch 39 and a continuous voltage generator 40 connected in series, is arranged between the terminals D and B.

The circuit 34 in Fig. 6 operates as follows. Initially, the switch 36 is open and the switch 39 is closed. When the circuit is switched on, the capacitor 5 is charged by the voltage generator 35 at a predetermined voltage, and a current i is induced in the primary 3 of the transformer through the branch 37. When the switch 36 is closed, the capacitor 5 discharges into the primary 3. Consequently a high voltage, capable of triggering the spark plug 7, is induced in the secondary 4 of the transformer. At the end of the discharge of the capacitor 5, or slightly before, the switch 39 is opened. This opening makes available the magnetic energy induced in the core 13 of the transformer by the current i ; this energy may then be used to maintain the discharge of the spark plug 7 for a certain period.

Figure 7 shows an embodiment using the equivalent circuit 22 shown in Fig. 4, in which a current is induced in the inductance 26 through the terminals B and D, and the capacitors 24 and 25 are charged through the terminals A and B.

The circuit 45 in Fig. 7 comprises the capacitive transformer 1, represented by its components 23-27; a generator 46 of a continuous voltage V_1 is connected to the terminal D of the capacitive transformer 1 through a resistor 47 and a diode 48. The cathode of the diode 48 is connected to the terminal D. The circuit 45 also comprises a switch 49 arranged in a bypass line 51 which connects the terminals A and B; the terminal B is also connected to earth through a switch 50. The terminal A forms a terminal for the application of a voltage V_2 obtained by means of a voltage generator which is not shown. In the circuit 45, the terminal H of the secondary 27 is connected to the terminal D and the terminal L is connected to one terminal of the spark plug 7, whose other terminal is connected to earth.

The circuit 45 in Fig. 7, described in detail in a preceding Patent Application No. TO91A000021 filed on 15.1.91 under the title "Control system for electronic ignition in an internal combustion engine of a vehicle", operates as follows. Initially, the switch 50 is closed while the switch 51 is kept open. The voltage generator 46 induces a current i in the inductor 26, while the voltage V_2 enables the capacitors 24 and 25 to be charged. When the switch 49 is closed, the capacitors 24 and 25 begin to discharge into the primary 26. A high voltage is therefore generated in the secondary 27, triggering the spark plug 7. At the end of the discharge of the capacitors 24, 25 or slightly before, the switch 50 is opened, causing the release of the magnetic energy accumulated in the primary 26. This release then enables the discharge of the spark plug 7 to be maintained.

By using the capacitive transformer 1 in the circuit 45 it is therefore possible to obtain an ignition circuit having lower costs than one made with discrete components, owing to the use of a single component for the formation of a plurality of elements. The circuit described also has improved efficiency, owing to the reduction of the losses due, in the known circuit, to the wiring of the components.

Finally, it is clear that the triggering circuit described and illustrated herein may be modified and varied without departure from the scope of protection of the present invention. In particular, it is pointed out that the plates of the capacitor or capacitors (leaves 15, 16) may be made of any conductive material and may be insulated by any dielectric material. The magnetic circuit may have any configuration and may be made of any material (including non-magnetic material), with the primary inside or outside the secondary. The terminal L of the secondary in the circuits 30 and 34 may be connected directly or indirectly to the earth of the spark plug 7; alternatively, each of the terminals L, H of the said circuits 30 and 34 may be connected to a terminal of a cor-

responding spark plug whose other terminal is connected to earth (lost discharge).

The triggering circuit may be used for the ignition of internal combustion engines of various types, including four- and two-stroke and Diesel engines, for motor propulsion, in motor vehicles, for aircraft, etc. or as the ignition in turbine engines and similar. It may also be used as an ignition for fuel burners (furnaces, ovens, heating systems); as a starting system for discharge lighting devices; and as a control and monitoring circuit incorporated (possibly only partially) in the component. Finally, it is possible to combine one or more primary or secondary windings of the leaf type shown or of the conventional type in the same magnetic circuit to decouple the functions of generation of the first triggering discharge and generation of the energy for maintaining the discharge. For example, it is possible to make the circuit 34 in such a way that the capacitive transformer 1 has three leaf windings around the same core, of which the innermost winding forms the capacitive winding (first primary) connected to the continuous voltage generator 35 and to the switch 36, the intermediate winding forms the second primary, connected to the maintenance branch 37, and the outermost winding forms the secondary.

Claims

1. Triggering circuit (21; 34; 45) for ignition devices, comprising at least a first and a second inductive element (3, 4; 26, 27) coupled magnetically together and to a magnetic core (13), and a capacitive element (5; 24, 25) connected to the said first inductive element, the said second inductive element being connected to an ignition device (7), characterized in that it comprises a capacitive transformer (1) including at least a first and a second sheet of conductive material (15, 16) wound around the said magnetic core (13) and coupled magnetically to a secondary winding (14) in such a way as to form the said first and second inductive elements and the said capacitive element.
2. Circuit according to Claim 1, characterized in that the said secondary winding (14) is a wire winding.
3. Circuit according to Claim 1, characterized in that the said secondary winding (14) is formed by a sheet of conductive material wound around the said magnetic core (13).
4. Circuit according to any of the preceding claims, characterized in that the said sheets of conductive material (15, 16) are wound in a spiral.
5. Circuit according to any of the preceding claims, characterized in that each of the said two sheets of conductive material (15, 16) has a first and a second end (A-D), the said first ends of the said two sheets of conductive material being adjacent to each other and forming a first and second terminal respectively (A, D), and the said second ends of the said two sheets of conducting material being adjacent to each other and forming a third and fourth terminal respectively (C, B); and in that it comprises switched voltage generation means (35, 36; V_2 , 49) connected between the said first terminal (A) and the said fourth terminal (B).
6. Circuit according to Claim 5, characterized in that the said switched voltage generation means comprise a continuous voltage generator (35) in parallel with a controlled switch (36).
7. Circuit according to Claim 5 or 6, characterized in that it comprises an energy accumulation control branch (37) arranged between the said first terminal (A) and the said fourth terminal (B).
8. Circuit according to Claim 7, characterized in that the said energy accumulation control branch (37) comprises the series connection of a continuous voltage generator (40), resistive means (38) and a switch (39).
9. Circuit according to Claim 5 or 6, characterized in that it comprises a voltage generation element (46) connected to the said first terminal (A), a bypass line (51) arranged between the said first terminal (A) and the said fourth terminal (B), a first switch element (49) interposed in the said bypass line and a second switch element (50) interposed between the said fourth terminal (B) and a reference potential line.
10. Circuit according to Claim 9, characterized in that the said second terminal (D) is connected to a first terminal (H) of the said secondary winding (14, 27), and in that the said secondary winding is connected to the said ignition device (7) through its second terminal (L).

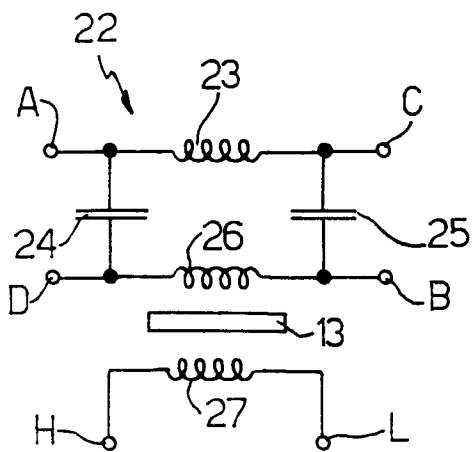
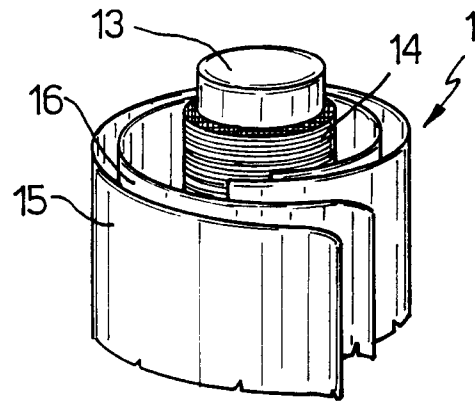
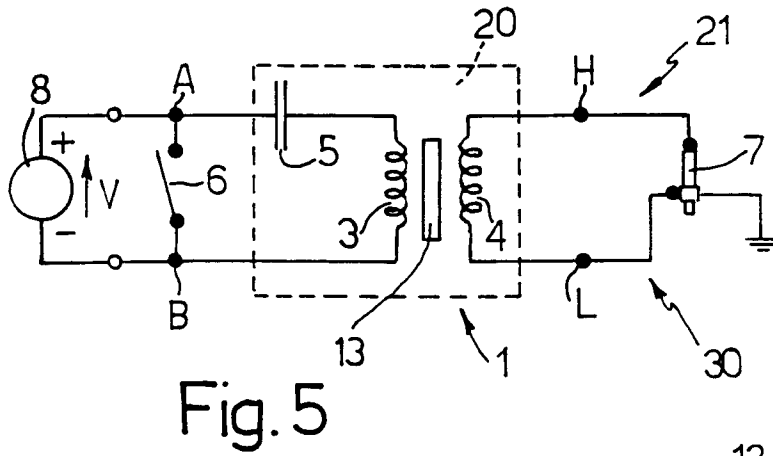
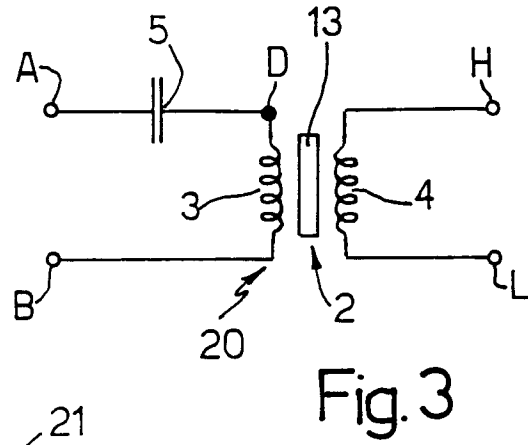
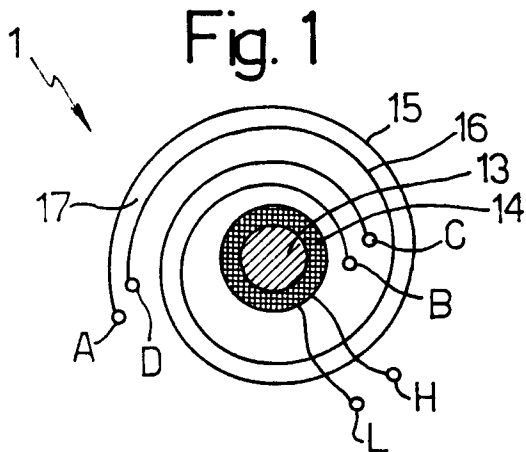


Fig. 4

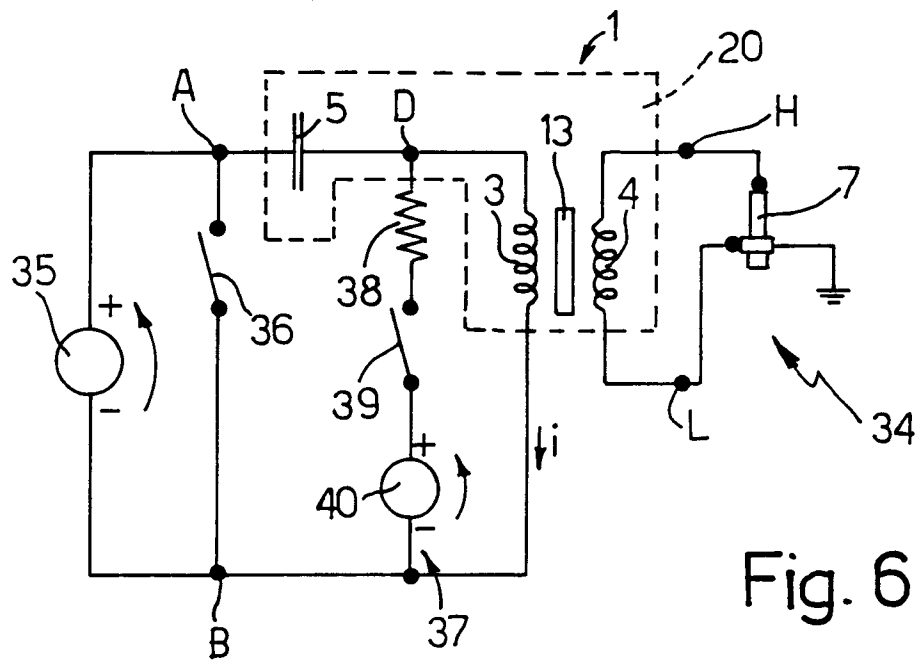


Fig. 6

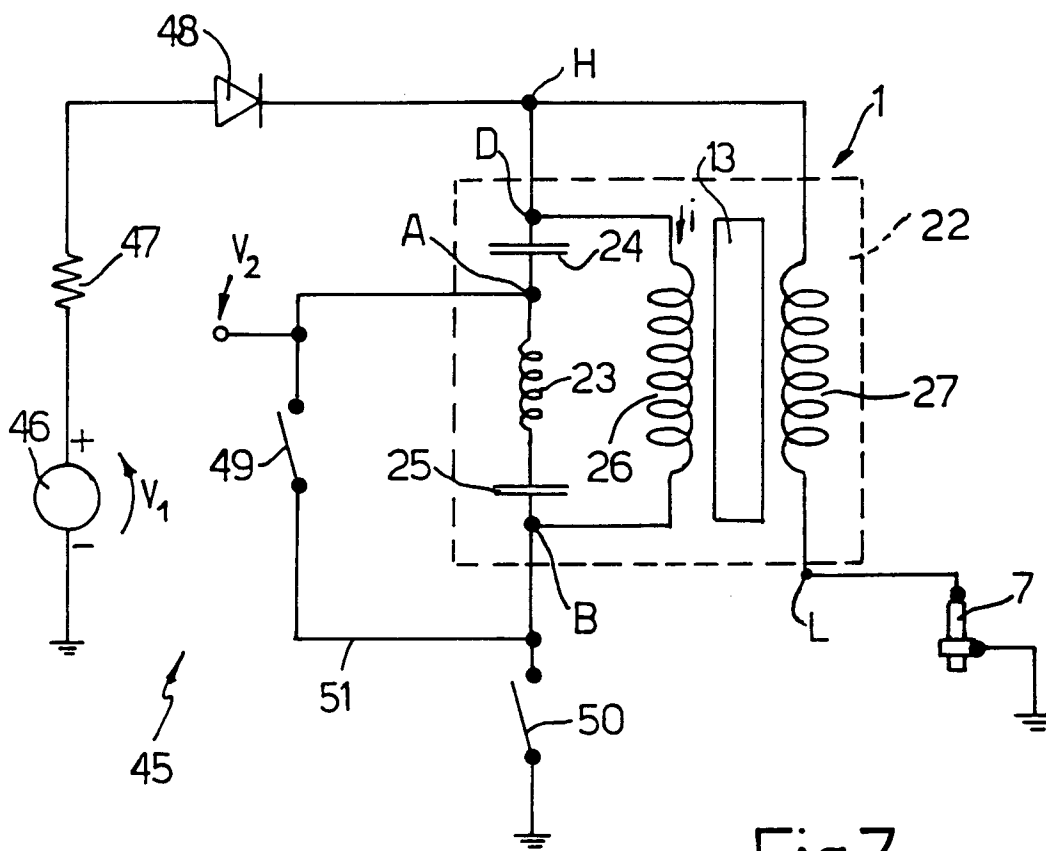


Fig.7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 7607

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.6)
X	WO-A-90 07056 (DUCATI ENERGIA SPA) 28 June 1990	1,2,4-6	F02P3/02 H01F38/12
Y	* the whole document * ---	3,7,8	
X	GB-A-2 137 427 (MCCULLOCH CORP) 3 October 1984	1,2,4	
A	* the whole document * ---	5,6	
Y	FR-A-2 642 892 (SIEMENS BENDIX AUTOMOTIVE ELEC) 10 August 1990	3	
A	* claims 1,10; figures * ---	1	
D,Y	EP-A-0 495 434 (WEBER SRL) 22 July 1992	7,8	
A	* figures 4-7 * ---	9,10	
A	US-A-3 704 390 (GRAHAME FREDERICK W) 28 November 1972 * abstract; figures * -----	3	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6) F02P H01F
Place of search THE HAGUE		Date of completion of the search 12 August 1996	Examiner Michels, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)