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SPARK IGNITION APPARATUS

Filed Sept. 13, 1966

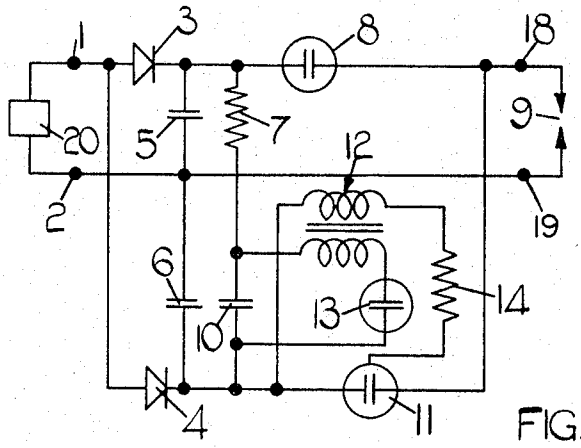


FIG. 1.

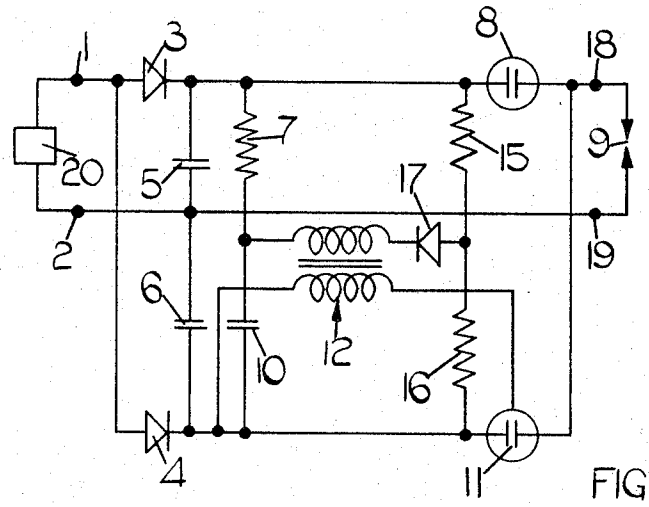


FIG. 2.

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SPARK IGNITION APPARATUS

Norman Arthur Parish, Hemel Hempstead, and Keith Douglas Collins, Watford, England, assignors to Rotax Limited, London, England

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7 Claims. (Cl. 315—183)

ABSTRACT OF THE DISCLOSURE

A spark ignition system wherein a first voltage pulse is applied to a spark plug through a barrier gap from a charged capacitor, after which a second voltage pulse is applied to the spark plug through a second barrier gap which has a higher break-down voltage than the first gap and which has a triggering circuit connected so as to cause breakdown of the second gap at a predetermined voltage to provide a desired discharge of the spark plug.

This invention relates to spark ignition apparatus for supplying high voltage pulses to an ignition plug and has for its object to provide an apparatus in a form in which a first voltage pulse is applied to the plug to condition same and then a second voltage pulse is applied to produce a discharge at the plug.

In the drawing,

FIG. 1 is a schematic circuit diagram of an ignition system embodying the present invention; and

FIG. 2 is a schematic circuit diagram illustrating another embodiment of an ignition system according to the present invention.

One example of a circuit in accordance with the invention will now be described with reference to FIGURE 1 of the accompanying circuit diagrams. In the example there are provided terminals **1** and **2** for connection to a high voltage A.C. source **20**. Terminal **1** is connected to the anodes of a pair of rectifiers **3**, **4**, the cathodes of which are connected to a pair of capacitors **5**, **6** respectively the other terminals of which are connected to terminal **2**. The cathode of rectifier **3** is further connected to one terminal of a resistor **7** and to one electrode of a barrier spark gap **8** the other electrode of which is connected to an output terminal **18** for connection to one electrode of a sparking plug **9** which has its other electrode connected to an output terminal **19** connected to terminal **2**. The sparking plug **9** is of the surface discharge type in which discharge takes place over the surface of a body of semi-conductor material.

The cathode of rectifier **4** is connected to the terminal of a capacitor **10**, the other terminal of which is connected to the other terminal of resistor **7**, and also to one electrode of a barrier spark gap **11** the other electrode of which is connected to the said other electrode of the spark gap **8**. Moreover, a point intermediate the resistor **7** and capacitor **10** is connected through the primary winding of a transformer **12** to one electrode of a further barrier spark gap **13** the other electrode of which is connected to the cathode of rectifier **4**. One end of the secondary winding of the transformer **12** is connected to the rectifier **4** cathode side of gap **11** whilst the other end thereof is connected through a limiting resistor **14** to an auxiliary electrode of the gap **11**.

In use, when the terminals **1** and **2** are connected to the A.C. source the capacitors **5** and **6** are charged through the rectifiers **3** and **4** respectively and the voltage across the capacitors increases at substantially the same

rate. When a predetermined voltage is attained barrier spark gap **8** breaks down, the breakdown voltage of this gap being arranged to be lower than the breakdown voltage of the gap **11**, and when this occurs capacitor **5** discharges through the spark plug **9**. When capacitor **5** has discharged capacitor **10** commences to charge through resistor **7** at a rate determined by the time constant of these two components, and when the voltage across capacitor **10** attains a predetermined value, barrier gap **13** breaks down and current flows in the primary winding of transformer **12**. The current flow in the primary winding induces a voltage across the secondary winding and this is applied to the trigger electrode of barrier spark gap **11** causing same to break down and to permit capacitor **6** to discharge through the spark plug **9**.

By this arrangement a first spark is produced at the plug which conditions its surface and the surrounding gases to create a more favourable condition for ignition by the subsequent second spark. The delay between the first and second sparks may be adjusted by varying the time constant of resistor **7** and capacitor **10** but it has been found that the desirable delay should be less than one millisecond.

If desired and as shown in the circuit diagram of FIGURE 2, spark gap **13** may be replaced by a diode **17** and a potential divider comprising resistor **15** and **16** in series connected between the cathode of the diode rectifiers **3** and **4** respectively. In a further modification not shown, the spark gap **13** is replaced by zener diode or an avalanche diode.

The particular circuits described above have a number of advantageous features and one of these is that the firing of the spark gap **11** is not influenced by the fact that the discharge of the capacitor **5** may have resulted in only a small spark at the plug. Moreover, the energy required to fire the spark gap **11** is derived from the capacitor **10** and not from the main capacitors **5** and **6**. The size of the capacitor **10** can therefore be chosen in accordance with the amount of energy required to fire the spark gap **11** satisfactorily. The spark gaps **8**, **11** and **13** are of the type comprising a pair of spaced plate like electrodes which are mounted within a glass envelope which is filled with an inert gas. The gaps break down when the voltage across them exceeds a predetermined value but in the case of the gap **11** a metal band is provided around the envelope or an additional electrode is sealed within the envelope and by applying a voltage to this band or electrode the gap can be made to break down at lower values of voltage than would otherwise be required.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. Spark ignition apparatus comprising in combination first and second capacitors, a pair of rectifier means through which said capacitors can be charged from a source of current, means for connecting said first capacitor to a pair of output terminals so that the capacitor can be discharged through a spark producing device connected across said terminals, when the voltage across said first capacitor attains a predetermined value, triggerable means for connecting said second capacitor to said pair of output terminals, a further capacitor, means through which said further capacitor is charged when said first capacitor has discharged, a transformer having a primary winding and a secondary winding, the secondary winding being connected to said triggerable means so that when a voltage is induced across said secondary winding said triggerable means will connect said second capacitor to said output terminals, and means responsive to the voltage across said further capacitor and arranged to cause a flow of current through said primary winding when the

voltage across the further capacitor exceeds a predetermined value.

2. Spark ignition apparatus as claimed in claim 1 in which one plate of each of the first and second capacitors is connected to a common terminal for connection to said source, the other plates of the capacitors being connected to a further terminal for connection to said source, through said pair of rectifier means respectively, so that the polarity of said other plates is the same and during the charging period rises at the same rate, and in which said further capacitor is connected in series with a resistor between said other plates of the first and second capacitors, so that said further capacitor is charged only when the first capacitor has been discharged.

3. Spark ignition apparatus as claimed in claim 2 in which said means responsive to the voltage across the further capacitor comprises a spark gap connected in series with the primary winding of the transformer across the further capacitor.

4. Spark ignition apparatus as claimed in claim 2 in which said means responsive to the voltage across the further capacitor comprise a Zener diode or an avalanche diode connected in series with the primary winding of the transformer across the further capacitor.

5. Spark ignition apparatus as claimed in claim 2 in which said means responsive to the voltage across said further capacitor comprises a potentiometer network connected between said other plates of the first and second capacitors and a diode connected in series with the primary winding of the transformer, the diode being connected to a tapping of the potentiometer and the other end of the primary winding being connected to a point intermediate the resistor and the further capacitor.

6. Spark ignition apparatus as claimed in claim 1 in which said means for connecting the first capacitor to the output terminals comprises a spark gap.

7. Spark ignition apparatus as claimed in claim 1 in which said triggerable means comprises a further spark gap having an auxiliary electrode to which one end of the secondary winding of the transformer is connected, the other end of the secondary winding being connected to one of the electrodes of the further spark gap through an A.C. path.

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RICHARD M. WOOD, *Primary Examiner.*

VOLODYMYR Y. MAYEWSKY, *Examiner.*