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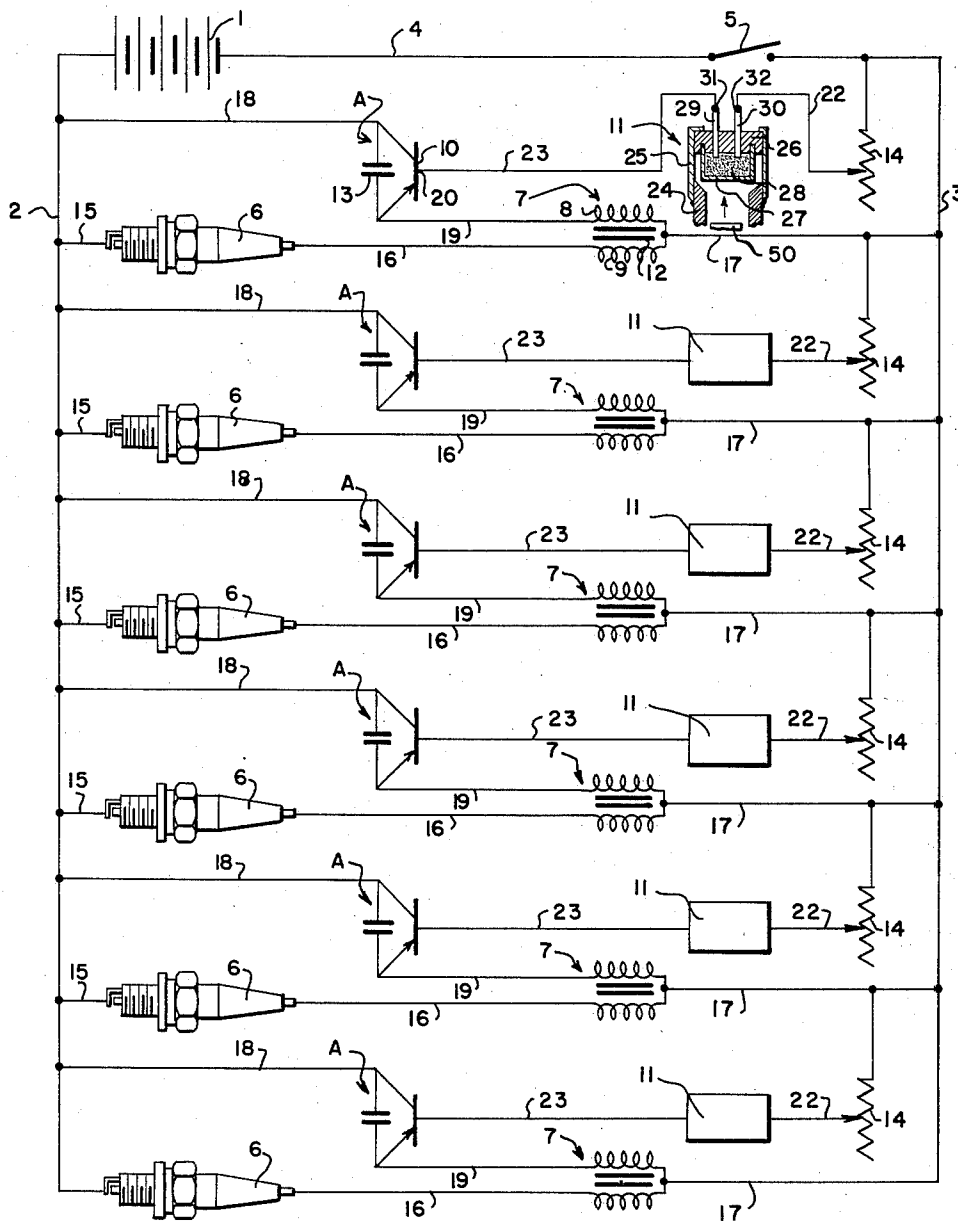
C. L. WOOD

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IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINE

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2 Sheets-Sheet 1



III.1.

INVENTOR

CARL L. WOOD

BY

BY James E. Toney ATTORNEY

ATTORNEY

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C. L. WOOD

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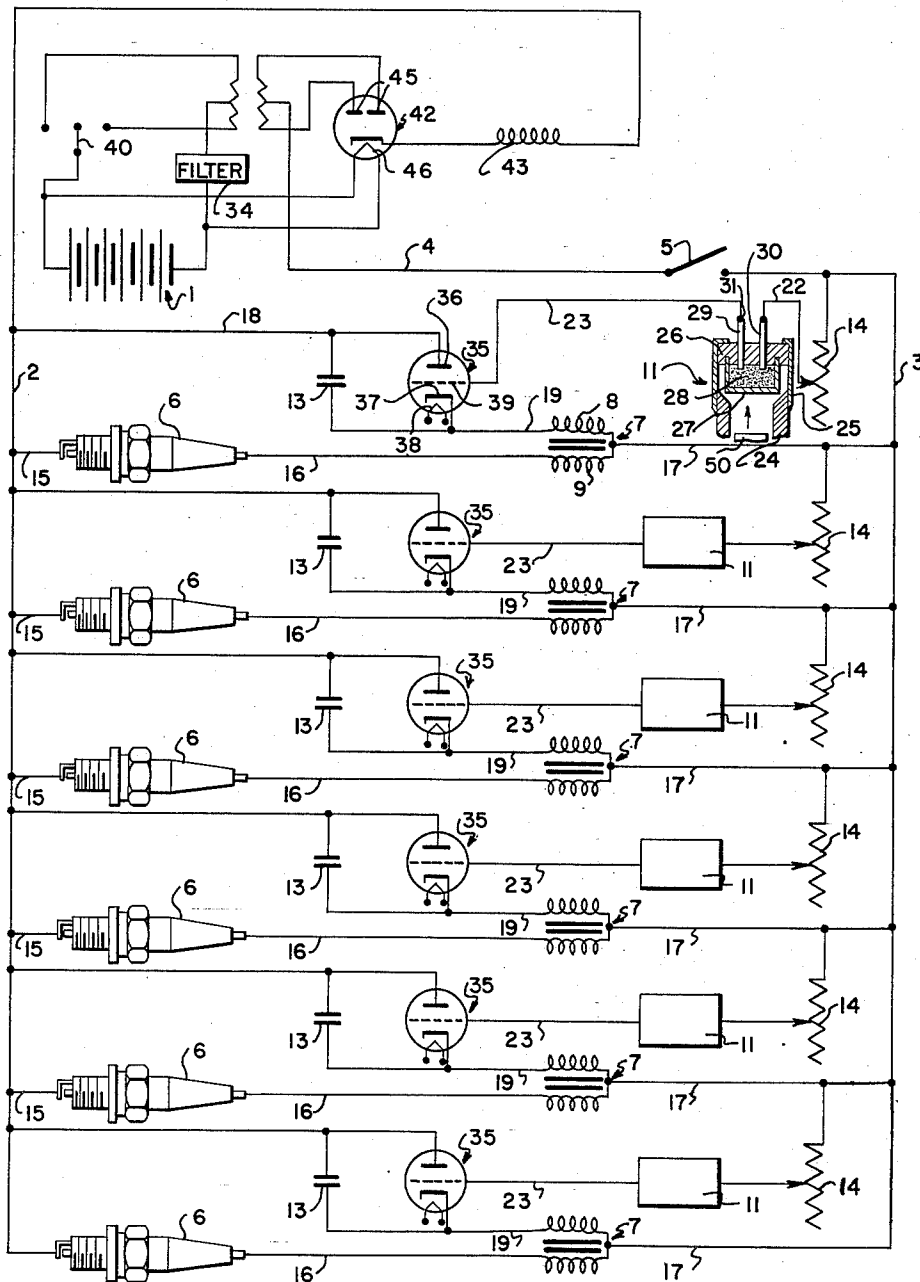


FIG. 2.

INVENTOR
CARL L. WOOD

BY

James E. Edmeyer
ATTORNEY

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IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINE

Carl L. Wood, Los Altos, Calif., assignor to Henry J. Kaiser Company, Oakland, Calif., a corporation of Nevada

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This invention relates to an electrical ignition system for an internal combustion engine.

According to prior art practice, electrical ignition systems for internal combustion engines have generally relied on a battery energized ignition coil which employed mechanical switching devices to energize the ignition coil and supply a high potential to a spark plug for igniting the fuel mixture. With multi-cylinder engines, it is the conventional practice to employ a single ignition coil along with a mechanical distributor switch whereby the voltages built up in the ignition coil are applied to the spark plug of each cylinder in sequence. Such prior art practice possesses certain inherent disadvantages with regard to mechanical wear of the many moving parts, imperfect timing and incomplete combustion.

The fuel mixture in the cylinder of an internal combustion engine must be ignited early enough to insure effective burning throughout the entire combustible mixture at the point of maximum compression or power will be needlessly lost. With the prior art mechanical devices, timing whereby the spark is ignited at exactly the right point is achieved only approximately. With multi-cylinder engines employing a single ignition coil and a distributor switch, the very short duration of time between the firing of one cylinder and the firing of the next succeeding cylinder is often insufficient for complete saturation or build-up of the ignition coil and, accordingly, a relatively weak spark is produced. Further, arcing between mechanical breaker points and distributor points dissipates some of the energy stored in the induction coil whereby it is lost for use in the spark plug.

These factors result in decreased power, throttle response, efficiency, and gas mileage. Further, such incomplete combustion in automobile engines adds to the smog problem present in many of our large cities today due to the fact that part of the fuel is not converted to useful energy.

Accordingly, it is a primary purpose of the instant invention to provide an improved electrical ignition system for internal combustion engines wherein mechanical switching devices, including a mechanical distributor, and their substantial number of moving parts are eliminated or substantially reduced and wherein ignition of the fuel mixture in each cylinder is accomplished at the optimum time with a hotter spark.

Other objects and advantages of the instant invention will become more apparent from a review of the following detailed description when taken in conjunction with the appended drawings wherein:

FIG. 1 diagrammatically illustrates an ignition circuit in one embodiment of this invention for application to a multi-cylinder, internal combustion engine wherein the electronic valves employed therein are transistors; and

FIG. 2 diagrammatically illustrates an ignition circuit in a further embodiment of this invention for application to a multi-cylinder, internal combustion engine wherein the electronic valves employed therein are triode tubes.

Referring now to the drawings and in particular to FIG. 1, it will be seen that the apparatus of the present invention includes a source of suitable potential, such as a conventional automobile storage battery 1. Storage battery 1 is connected to lines 2 and 3 used to supply

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current to the spark plugs 6 and accompanying ignition circuits for each cylinder of the engine. The connection to line 3 is through line 4 and a conventional automobile ignition switch 5.

Although FIG. 1 illustrates the application of the invention to six-cylinder engines, it is to be understood that this invention may be applied to engines having more or less than six cylinders. The ignition circuit A for each spark plug 6 is identical and thus a description of one will suffice for all.

Each ignition circuit A comprises a spark plug 6, a transformer 7, an electronic valve or transistor 10, a pressure sensitive cell 11 and a potentiometer 14.

Spark plug 6 is connected to line 2 through line 15 and to line 3 through line 16, secondary winding 9 of transformer 7 and line 17. The high voltage required to cause spark plug 6 to spark is supplied by inducing a high voltage pulse in the secondary winding 9 of transformer 7. The high voltage pulse is brought about by interrupting or cutting off a current which normally flows through the primary winding 8 of transformer 7 by means of the electronic valve or transistor 10. Current is supplied to primary winding 8 of transformer 7 from line 2 through line 18, transistor 10 and line 19 and from line 3 through line 17. The capacitor 13 is connected across or in parallel with transistor 10 to prevent damage to transistor 10 when the circuit is interrupted. The current supplied to primary winding 8 is controlled by means of a negative bias voltage applied to a conventional control connection 20 of transistor 10 and the current supplied to primary winding 8 is cut off by raising the bias voltage applied to control connection 20 above the cut-off point. The bias is supplied to control connection 20 of transistor 10 from line 3 through such lines as line 4 or 17, as the case may be, potentiometer 14, line 22, pressure sensitive cell 11 and line 23.

Means are provided for transmitting pressure from an engine cylinder to its associated pressure sensitive cell 11 in a manner to be described more fully hereinafter whereby high pressure in the cylinder head causes the resistance in pressure sensitive cell 11 to decrease, thus increasing the bias voltage on transistor 10. Potentiometer 14 is provided in the circuit to adjust the level of the bias to the point whereby bias voltage will reach cut-off at the exact time the cylinder piston 50 of the engine, and shown somewhat schematically in the drawings, reaches the point in its upward movement where a spark is needed.

One type of suitable pressure sensitive cell 11 is illustrated cross-sectionally in FIG. 1 of the drawing. This device can comprise a metal tube 24 which leads to the combustion chamber of a cylinder and a metal sleeve 25 affixed to the upper part of tube 24. A cap 26 of suitable ceramic material is fixedly mounted in sleeve 25 and a small metal receptacle 27 containing carbon particles 28 is dependently affixed to cap 26. Electrodes 29 and 30 extend through cap 26 and contact the particles 28. The electrode 29 is connected through terminal 31 to line 23 and to control connection 20 of transistor 10. The electrode 30 is connected through terminal 32 to line 22 and potentiometer 14. The pressure sensitive cell 11 is constructed of materials having a coefficient of expansion that will compensate for the change in resistance of the carbon particles in the cell as the temperature is varied from hot to cold. The resistance of the cell 11 is advantageously varied by pressure. At maximum compression of the cylinder to which a tube 24 is connected, the carbon particles will be most compactly arranged, thereby lowering the resistance in the part of the circuit containing these particles.

With reference again to FIG. 1, operation of the electrical ignition system of this invention will be de-

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scribed. When the ignition switch 5 is closed, current flows from the battery 1 through lines 4, 3 and 17 to the primary winding 8 of transformer 7 and from the primary winding 8 through line 19, transistor 10 and lines 18 and 2 to battery 1. The current which is flowing increases in the primary winding 8 of transformer 7 and reaches a maximum in a few thousandths of a second. During this short interval, a magnetic field is induced in the primary winding 8. When the piston 50 of the internal combustion engine reaches the upper end of its stroke, the resistance in the pressure sensitive cell 11 is reduced to such an extent, due to the high pressure, that there is an increase in current flow through cell 11. The negative bias on transistor 10 is also increased to the cut-off point, thereby causing the transistor 10 to stop conducting and the circuit to primary winding 8 of transformer 7 to be opened. The iron core 12 in the transformer 7 is demagnetized, causing the magnetic field to collapse. This sudden collapse induces voltage in both the primary winding 8 and secondary winding 9 of transformer 7. The many thousands of turns of wire in the secondary winding 9 cause sufficiently high voltage to be induced in the secondary winding 9 to force the current to jump across the gap in the spark plug 6. The explosion resulting from the sparking of plug 6 forces the piston 50 down. This relieves the pressure on pressure sensitive cell 11 and, at the same time, effects an increase in its resistance and a reduction in the negative bias on transistor 10 whereby current again flows through primary winding 8 in a normal fashion. This operation, of course, takes place in each spark plug 6 for each engine cylinder, as described above, as the piston in each cylinder produces a predetermined pressure on the cell 11 associated therewith.

Potentiometer 14 provides a means of adjusting the negative bias voltage applied to transistor 10 through pressure sensitive cell 11 whereby current flow through the transistor 10 can be cut off exactly at the point where the piston reaches the top of its stroke or a few degrees before if this is required for maximum efficiency.

In another embodiment of the invention, a vacuum tube-type electronic valve is used in lieu of a transistor. The circuit wherein the vacuum tube-type electronic valve is used is illustrated in FIG. 2. From a review of FIG. 2, it will be observed that all the other components of the individual ignition circuits for the spark plugs 6 are basically the same as for the embodiment employing transistors and, accordingly, a detailed description of these circuits is not believed necessary. In the embodiment shown in FIG. 2, the vacuum tube-type electronic valve advantageously comprises a triode 35 provided with an anode 36, a cathode 37, a cathode heater 38, and a control grid 39. Grid 39 is connected to the cell 11, cathode 37 is connected to the primary winding 8 of the transformer 7, and anode 36 is connected to the line 2. The cathode heater 38 can be supplied with a low voltage by direct connection across battery 1.

While the individual ignition circuits of FIG. 2 are the same as for FIG. 1 in general, triodes require a higher voltage for operation than can be obtained from a conventional automobile storage battery and, accordingly, a step-up power supply as shown in FIG. 2 to supply lines 2 and 3 would generally be employed. This power supply is a conventional power supply such as is employed for powering automobile radio receivers and, accordingly, it is not described in detail. In general, it comprises storage battery 1', filter 34, vibrator 40, transformer 41, rectifier 42 and an inductance coil 43. In the embodiment shown in FIG. 2, the rectifier 42 is a vacuum tube-type rectifier having a cathode 44, two anodes 45 and a cathode heater 46. The operation of such power supplies is well known and has been employed many times to power automotive radio receivers and, accordingly, such operation need not be described here. The operation of the circuit employing the triode 35 is the same as the operation of the circuit of FIG. 1 as de-

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scribed above, the control grid 39 of the triode 35 being controlled by a negative bias applied through lines 4 or 17 as the case may be, potentiometer 14, line 22, pressure sensitive cell 11 and line 23. Thus, when the carbon particles 28 of any cell 11 are compressed due to the upward movement of the engine piston associated therewith, there will be an increase in current in the part of the circuit containing cell 11. This in turn increases the negative bias placed on grid 39 of the triode. When tube 35 stops conducting as a result of the increase in the negative bias placed on grid 39, the circuit for the primary winding 8 is opened. The magnetic field in transformer 7 builds up and collapses, thereby inducing current in secondary winding 9. The induction of current in winding 9 produces a spark across the spark plug 6 associated therewith, all in the manner previously described.

It will be understood that various changes and modifications may be made to this invention without departing from the spirit and scope thereof as defined in the appended claims, wherein

What is claimed is:

1. An ignition system for an internal combustion engine having at least one cylinder, said system comprising a source of potential, a spark plug for said cylinder, means including an electronic valve and a transformer for supplying a high potential to said spark plug, the secondary winding of said transformer being directly connected to said spark plug and the primary winding of said transformer being directly connected to said electronic valve, pressure sensitive means electrically connected to said source of potential and electrically connected directly to said electronic valve for controlling said electronic valve, and engine operated means for transmitting pressure to said pressure sensitive means so as to actuate said electronic valve and produce a flow of current in the secondary winding of the transformer and a high potential to said spark plug, said pressure sensitive means being the only engine operated means employed to actuate said electronic valve.

2. The ignition system of claim 1 wherein said electronic valve comprises a vacuum tube.

3. The ignition system of claim 2 wherein said vacuum tube is a triode.

4. An ignition system as set forth in claim 1 including a capacitor connected in parallel with said electronic valve.

5. The ignition system of claim 1 wherein said electronic valve comprises a transistor.

6. The ignition system of claim 1 wherein said internal combustion engine has a plurality of cylinders and a separate spark plug, electronic valve, transformer and pressure sensitive means for each cylinder.

7. An ignition system for an internal combustion engine having at least one cylinder, said system comprising a source of potential, a spark plug for said cylinder, transformer means having primary and secondary windings for supplying a high voltage pulse from said source of potential to said spark plug, the secondary winding of said transformer means being connected to said spark plug, electronic valve means connected to the primary winding of said transformer means and adapted to control the flow of current from said source of potential to the primary winding of said transformer means, pressure sensitive cell means electrically connected to said source of potential and electrically connected directly to said electronic valve means for supplying and controlling a bias voltage on said electronic valve means, engine operated means for transmitting pressure from said cylinder to said pressure sensitive cell means whereby a predetermined pressure in the cylinder will cause said pressure sensitive cell means to increase the bias voltage on said electronic valve means, and means connecting said electronic valve means to the pressure sensitive cell means whereby current flow through said electronic valve means to the primary winding of the transformer means is cut off at the time an ignition

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spark is needed and the consequent cutting off of current in the primary winding of the transformer means induces a high voltage pulse in the secondary winding of said transformer means and causes said spark plug to spark said pressure sensitive cell means being the only engine operated means employed to increase the bias voltage on said electronic valve.

8. The ignition system of claim 7 wherein said electronic valve means comprises a vacuum tube.

9. The ignition system of claim 8 wherein said vacuum tube comprises a triode.

10. The ignition system of claim 7 wherein said electronic valve means comprises a transistor.

11. An ignition system for an internal combustion engine having at least one cylinder and a piston, said system comprising a source of potential, a spark plug for said cylinder, a transformer having primary and secondary windings for supplying a high voltage pulse from said source of potential to said spark plug, the secondary winding of said transformer being connected to said spark plug, electronic valve means connected to the primary winding of said transformer and adapted to control the flow of current from said source of potential to the primary winding of said transformer, capacitor means connected in parallel with said electronic valve means, pressure sensitive cell means electrically connected to said source of potential and electrically connected directly to said electronic valve means for supplying and controlling a bias voltage on said electronic valve means, engine operated means including said piston for transmitting pressure

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from the cylinder to said pressure sensitive cell means whereby a predetermined pressure in the cylinder causes said pressure sensitive cell means to increase the bias voltage on said electronic valve means and cut off the flow of current through said electronic valve means to the primary winding of the transformer at the time an ignition spark is needed, the cutting off of the flow of current to said primary winding in turn inducing a high voltage pulse in said secondary winding and a sparking of said spark plug, and means for adjusting said bias voltage whereby said electronic valve means will be cut off at the time said piston reaches the point in the cylinder where the spark is needed said pressure sensitive cell means being the only engine operated means employed to increase the bias voltage on said electronic valve.

12. The ignition system as set forth in claim 11 wherein said electronic valve means comprises a vacuum tube.

13. The ignition system as set forth in claim 12 wherein said vacuum tube is a triode.

14. The ignition system as set forth in claim 11 wherein said electronic valve means comprises a transistor.

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