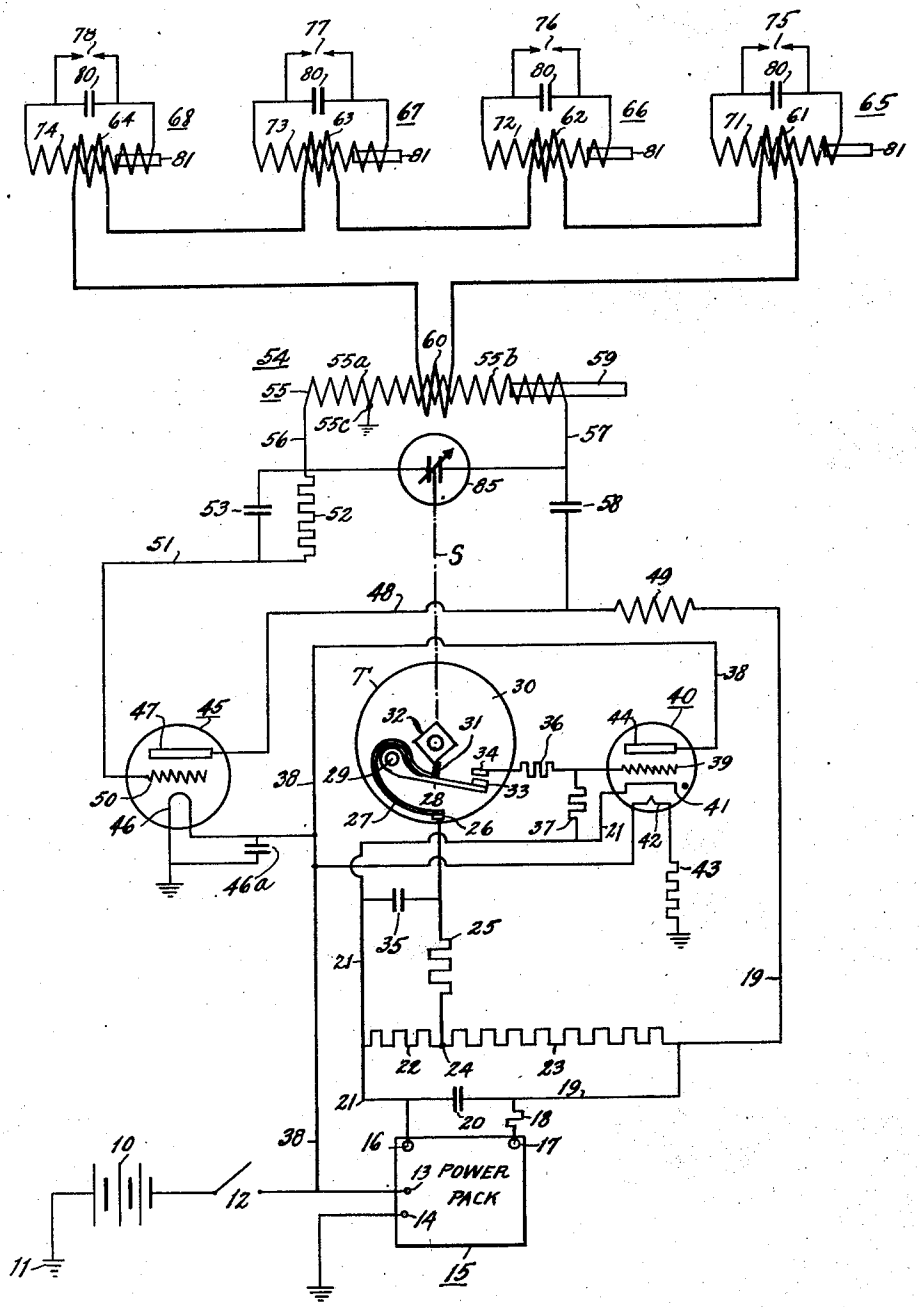
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IGNITION SYSTEM

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IGNITION SYSTEM

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This invention relates to a high frequency ignition system for an internal combustion engine and, more particularly, to a system having a resonator at each spark plug, the resonators of the different spark plugs being tuned to different frequencies, an oscillator having a variable condenser which can be adjusted to tune the oscillator successively with the various resonators at the spark plugs, a timer for controlling the operation of the oscillator and mechanically connected with its variable condenser whereby ignition is provided at the engine spark plugs in recurrent sequence. The system referred to is disclosed in my copending application, Serial No. 606,645, filed July 13, 1945, which discloses the supply of energy to the oscillator through a thyratron tube which is caused to be conducting by the closing of the contacts of the timer.

An object of the present invention is to provide a system of the type referred to in which the energy for operating the oscillator is supplied by discharging a condenser. In the disclosed embodiment of the invention, main and auxiliary condensers are charged by a power source, and closing of the timer contacts causes the auxiliary condenser to discharge through the grid of the thyratron to render it conducting whereupon the main condenser discharges through the oscillator to the thyratron, the thyratron becoming nonconducting when the main condenser is completely discharged whereupon the main condenser is recharged while the auxiliary condenser remains uncharged until after the timer contacts open.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred embodiment of the present invention is clearly shown.

The figure of the drawing is a wiring diagram of an embodiment of the present invention.

Referring to the drawing, a storage battery 10 grounded at 11 is connected by a switch 12 with the low voltage terminal 13 of a power pack 15 whose other low voltage terminal 14 is grounded. The high voltage terminals 16 and 17 of the power pack are connected by a main condenser 20 preferably one microfarad and a resistance 18 preferably 250 ohms. Condenser 20 is connected by wires 19 and 21 with voltage divider resistances 22 and 23 having a tap at 24. The element 22 has preferably .5 megohm resistance and the element 23 has 5 megohms resistance. The tap 24 is connected with resistance element 25, preferably .75 megohm, which is connected with terminal 26 of timer T. Terminal 26 is connected by leaf spring 27 with a circuit breaker lever 28 pivoted at 29 on a breaker plate 30 and having a non-conducting rubbing block 31 for engaging a timer cam 32. Lever 28 carries a contact 33 for making engagement with a contact 34. An auxiliary condenser 35, preferably .001 mf., is connected between wire 21 and the wire connecting resistance 25 with terminal 26.

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Timer contact 34 is connected through resistance 36, preferably 2500 ohms, which is connected by resistance element 37, preferably 25,000 ohms, connected with wire 21. Resistances 36 and 37 are connected with the grid 39 of thyratron 40 whose cathode 41 is connected with wire 21. Wire 38, leading from power pack low voltage terminal 13, is connected with cathode heater 42 connected with resistance 43 which is grounded. Thyratron plate 44 is connected with wire 38 which is connected with cathode 46 of oscillator tube 45. The terminals of cathode 46 are connected with a condenser 46a. The plate 47 of oscillator tube 45 is connected by wire 48 with high frequency choke 49 which is connected with the wire 19. The grid 50 of oscillator tube 45 is connected by wire 51 with condenser 53 and grid resistance 52 connected in parallel and both together with a wire 56 connected with primary 55 of oscillator coil 54. The primary 55 comprises sections 55a and 55b connected with a tap 55c which is grounded. Wire 57 connects primary section 55b with a condenser 58 connected with wire 48. Between wires 56 and 57, there is connected the terminals of a variable condenser 85, the movable plates of which are turned by a shaft S connected with the ignition timer cam 32. An adjustable core 59 extends within primary coil 55.

Associated with the primary is a secondary winding 60 of a few turns in which is induced a high frequency current of low voltage and high amperage. The secondary 60 is connected in series with primary coils 61, 62, 63 and 64 of resonators 65, 66, 67 and 68, respectively, having secondary windings 71, 72, 73 and 74, respectively, connected with the spark gaps of spark plugs 75, 76, 77 and 78, respectively, and each with a condenser 80. The natural frequencies of the resonators are substantially different and are determined by iron rods 81 which can be so adjusted as to project different distances within the secondary windings of the resonators.

When switch 12 is closed current is supplied from the battery for heating the cathode 46 of oscillator tube 45 and for heating the cathode heater 42 of thyratron 40, and the power pack 15

operates to produce high voltage across its terminals 16 and 17 for the purpose of charging the main condenser 20 at a high voltage and the auxiliary condenser 35 at a lower voltage. When the timer contacts close, condenser 35 discharges through the grid 39 of thyratron 40, causing the latter to become conducting whereupon the main condenser 20 discharges through the thyratron 40 and the oscillator 45 through the following circuit: Wire 21, cathode 41, plate 44 of thyratron 40, wire 38, cathode 46 and plate 47 of oscillator tube 45, wire 48, choke 49, wire 19. Condenser 20 supplies energy to the oscillator during the discharge period. When condenser 20 is completely discharged, the thyratron 40 becomes non-conducting and allows condensers 20 and 35 to recharge. However, the condenser 35 cannot be recharged until after the contact 33 separates from the contact 34.

As stated before, the instant the contact 33 engages contact 34, condenser 35 discharges and thyratron 40 becomes conducting, thereby impressing a high voltage upon the plate 47 of tube 45. Tube 45 then becomes conducting and condenser 20 discharges through it. During this discharge, high frequency oscillations are produced in the oscillator primary coil 55. In the secondary 60 of relatively few turns, there is induced a high frequency current of low voltage and high amperage. The frequency of the oscillator is determined by the adjustment or position of the movable plates of the condenser 85 which is driven by the engine concurrently with the timer cam 32. When the time arrives for the firing of a certain engine cylinder, the timer contacts close and at that instant the movable plates of the variable condenser 85 are so positioned that the oscillator 54 is tuned only to the resonator associated with that spark plug which is in the cylinder to be fired. For that reason, a spark of high voltage and frequency will occur only at the gap of that spark plug. Sparking does not occur at the other gaps of the resonators not in tune with the oscillator at the time of discharge of coil 54 because the resonator which is in tune with the oscillator receives a very large portion of the total wattage. Hence the resonators of the spark plugs not to be fired receive a voltage which is too low to jump the spark gap.

Whenever a sufficient voltage is impressed on the plate 47 of tube 45, the oscillator tube 45 permits current to flow to charge the condenser 85. The condenser charging circuit includes power pack terminal 17, wire 19, choke 49, condenser 58, condenser 85, resistance 52, wire 51, grid 50, cathode 46, wire 38, plate 44, cathode 41, wire 21 and power pack terminal 16. During the charge of condenser 85, the voltage impressed on the grid 50 becomes increasingly positive. As grid 50 becomes more positive, tube 45 passes more current and the voltage drop across the tube decreases. As the voltage drop decreases across tube 45, the condenser 85 starts discharging and produces a negative voltage on the grid 50 due to the operation of two inductively related circuits. One of these circuits is condenser 85, wire 57, all of the oscillator primary coil 55 and wire 56; and the other circuit includes the grounded tap 55c of primary 55, the primary section 55a, wire 56, resistance 52, wire 51, grid 50, cathode 46 and ground connection back to 55c. The negative voltage impressed on grid 50 causes less current to flow from the plate 47, thereby raising the voltage drop across the tube 45 and allowing the condenser 85 to be charged again. In this way, an oscillation through the primary 55 is sustained. This oscillation increases rapidly in amplitude until the maximum amplitude is reached; and the oscillation is sustained so long as sufficient voltage is impressed on the plate 47 of oscillator tube 45. In other words, the oscillator tube 45 operates in a manner analogous to a variable resistance in shunt with the condenser 85. As condenser charge increases, the variable resistance decreases automatically; and, when the decrease of resistance is such that the condenser is robbed of charging current, the condenser discharges. The discharge of the condenser automatically causes the variable resistance to increase whereby the condenser is permitted to receive a charging current; and the cycle is repeated so long as sufficient voltage is being impressed on the plate 47 of tube 45.

As the current oscillation through the oscillator primary coil 55 increases in magnitude that resonator with which the condenser 85 is tuned will have, in its condenser-coil circuit, a corresponding oscillation increasing in magnitude until voltage impressed upon the spark plug is sufficient to cause the current to jump the gap. As stated before, only the resonator which is in tune with the oscillator receives the benefit of the alternating charge and discharge of the condenser 85.

The present system is particularly useful for supplying ignition to high speed engines. Since the time intervals between sparking are relatively short, it is desirable to use as much as possible of the time interval to recondition the system for the next sparking operation. Therefore, as soon as the main condenser has discharged, it starts charging again without waiting for the timer contacts to open. The main condenser cannot discharge again until after the interval during which the contacts separate and reclose. Therefore, the charging time of the main condenser is the time between the beginning of successive ignitions less the time of main condenser discharge before the thyratron becomes non-conducting. This charging time includes all of the time during which the timer contacts are open and may include part of the time during which the contacts remain closed after the thyratron becomes non-conducting.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. An ignition system comprising a resonator connected with a spark gap, an oscillator including a coil inductively coupled with the resonator, a variable condenser for tuning the oscillator to the resonator and a tube, a power source, main and auxiliary condensers charged by the source, a thyratron through which the main condenser will discharge to the oscillator tube when the thyratron becomes conducting, and means for causing the auxiliary condenser to discharge to the grid of the thyratron to render it conducting.

2. An ignition system for a multicylinder engine comprising resonators respectively connected with the spark plugs of the engine, said resonators having different frequencies, an oscillator including a coil inductively coupled with the resonators, a variable condenser by which the oscillator can be tuned with the several reso-

nators in recurrent sequence and an oscillator tube, a power source, main and auxiliary condensers charged by the source, a thyratron through which the main condenser will discharge to the oscillator tube when the thyratron becomes conducting, a timer for causing the auxiliary condenser to discharge to the grid of the thyratron to render it conducting, and means for mechanically connecting the timer with the variable condenser.

3. An ignition system comprising a resonator connected with a spark gap, an oscillator including a coil inductively coupled with the resonator,

a variable condenser for tuning the oscillator to the resonator and a tube, a power source, main and auxiliary condensers charged by the source, a device which normally withholds main condenser discharge to the oscillator tube and having means responsive to auxiliary condenser discharge to render the device conducting whereby the main condenser discharges through said device to the oscillator tube, and a timer for causing the auxiliary condenser to discharge to said means.

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