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IGNITION SYSTEM

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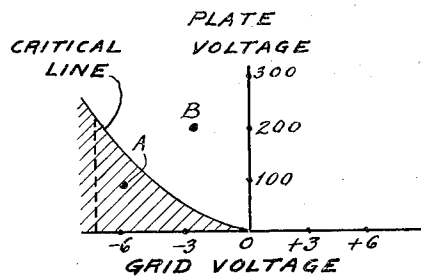


Fig. 2

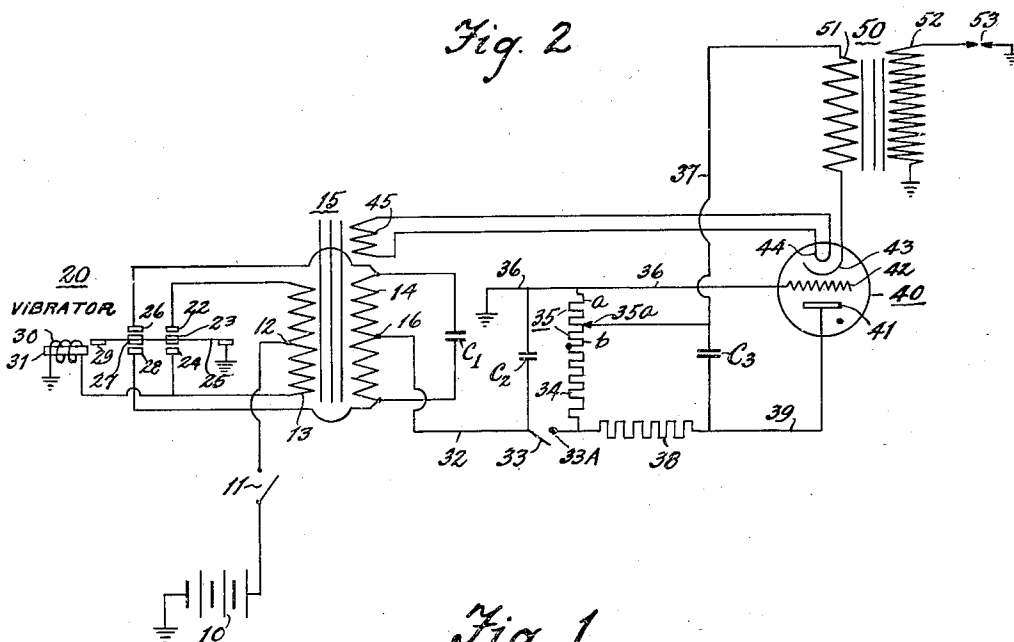


Fig. 1

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UNITED STATES PATENT OFFICE

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IGNITION SYSTEM

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1 Claim. (Cl. 315—238)

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This invention relates to ignition apparatus for igniting liquid fuel, for example, a gasoline burner.

An object of the invention is to provide ignition apparatus which operates without the use of contact circuit-make-and-break devices to provide a rapid succession of ignition sparks. In the disclosed embodiment of the invention, this object is accomplished by an ignition coil having a secondary winding connected with a spark gap and having a primary winding, a capacitor to be intermittently discharged through the primary winding, a thyatron tube operative to establish a circuit between the capacitor and primary winding when, corresponding to a certain negative bias on the tube grid, the tube plate voltage grows to a certain value whereby the condenser is discharged through the primary winding and the tube becomes non-conducting, a current source or power supply for plate and grid voltages and for capacitor charging, and circuit connections between the power supply and the tube and capacitor providing for a predetermined negative grid bias and for the concurrent growth of voltage at the capacitor and tube plate.

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.

In the drawing:

Fig. 1 is a diagram of the embodiment of the invention.

Fig. 2 is a chart showing the characteristics of a thyatron used in the system.

Referring to Fig. 1, a storage battery or other current source 10 which is grounded is connected by a switch 11 with the center tap 12 of a primary 13 of a transformer 15 having a secondary 14 provided with a center tap 16 and having its end leads connected with a capacitor C1. The end leads of primary 13 are connected with contacts 22 and 24 of a vibratory rectifier 20 having a vibratory reed 25 carrying a contact 23 which vibrates between contacts 22 and 24 and alternately engages them. The end leads of transformer secondary 14 are connected with vibratory contacts 26 and 28 between which there vibrates a contact 27 carried by the reed 25. Contact 27 alternately engages contacts 26 and 28 concurrently with the alternate engagement of contact 23 with contacts 22 and 24. The reed 25 is maintained in a state of vibration due to the operation of an electromagnet having a coil 30 surrounding a core 31 which effects the downward attraction of the armature 29 attached to the reed 25 when switch 11 is closed. Upon the engagement of contact 23 with contact 24 the coil 30 is short circuited, whereupon the reed is released and its movement upwardly causes con-

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tacts 23 and 24 to engage contacts 22 and 26. When contact 23 separates from contact 24 the short circuit around the coil 30 is interrupted so that the magnetism begins to build up. By the time contacts 23 and 27 have engaged contacts 22 and 26, the magnetism in the coil 31 is again sufficient to effect the downward movement of the armature 29 so as to bring contacts 23 and 27 into engagement with contacts 24 and 28 again. Thus vibration is maintained so long as switch 11 is closed. The operation of the vibrator is to cause current to flow intermittently through the two halves of the primary 13, thereby causing higher voltages to be induced alternately in the two halves of the secondary 14. Thus the vibrations of the reed alternately connect the two halves of the secondary with ground and the direction of current flow in the wire 32 connected with the center tap is always the same.

Wire 32 is connected by switch 33 with a terminal 33A connected with a fixed potentiometer resistance 34 and with an adjustable potentiometer resistance 35 connected with wire 36 which is grounded at one end. A capacitor C2 is connected between wire 32 and wire 36. Potentiometer 35 has a slider 35a connected with a wire 37. A resistance 38 is connected with resistance 34 and with a wire 39 connected with the plate 41 of a thyatron tube 40. A capacitor C3 is connected between wire 37 and wire 39. The wire 36 is connected with the grid 42 of tube 40. The cathode 43 of tube 40 is connected with primary winding 51 of ignition coil 50, and the other end of said winding is connected with wire 37. The secondary 52 which is grounded at one end is connected at the other with a grounded spark plug 53 for maintaining the combustion of fuel vapor. The cathode heater 44 of thyatron 40 is connected with a transformer secondary 45.

The following electrical dimensions have been found satisfactory:

Primary winding 13—44 turns #16 gauge wire
Secondary winding 14—4000 turns #38 gauge wire
Secondary 45—35 turns #22 gauge wire
Capacitor C1—.0025 m. f. d., 2000 v.
Capacitor C2—.10 m. f. d., 450 v.
Capacitor C3—.25 m. f. d., 600 v.
Resistance 35—3000 ohms, wire wound
Resistance 34—50,000 ohms, 2-watt
Resistance 38—75,000 ohms, 2-watt
Thyatron 40—type 2051 electron tube
Transformer 50—a conventional automobile ignition coil

Theory of operation

All components up to and including C2 make up a power supply. This power supply provides 250 volts of direct current at terminal 33A and 6.3 volts of alternating current. The 250 volts D. C. at terminal 33A provides plate and grid voltages

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for the thyatron tube 40; and the 6.3 volts A. C. supplies the cathode heater 44.

The characteristics of a thyatron of the type used in this device are best shown in the curve of Fig. 2. Any combination of potentials that fall to the left of the critical line will not render the tube conducting. This region is indicated by shading. Any combination falling to the right of the line will cause the tube to become conducting. For example 100 plate volts, and -6 grid 10 volts will not cause conduction (point A). 200 volts plate and -3 volts grid will cause ionization and result in conduction (point B).

In this system, the negative bias voltage is determined by the setting of the potentiometer 35. 15 Assuming that a represents the resistance between the upper end of 35 and the slider 35a, and that b represents the resistance from the slider to the lower end, the grid potential E_g is equal to 250 volts (potential at 33A) times the ratio of resistance a to the total resistances between 33A and ground (resistance 34 plus resistance 35).

Let it be assumed that the slider 35a is set to give a grid potential E_g of -5 volts with respect to the cathode 43. That is, the grid 42 is 5 volts 25 more negative than the cathode 43. With -5 volts on the grid, the tube 40 will become conducting whenever the plate potential becomes 190 volts. Since plate 41 is directly connected to capacitor C3 by wire 39, plate voltage grows with the growth of voltage on capacitor C3. The time of growth of voltage upon capacitor C3 is dependent upon the potential between terminal 33A and wire 37 connected with slider 35A, and upon the time constant of the circuit including resistance 38 and capacitor C3. According to their electrical dimensions given heretofore as an example, this time constant is $75,000 \text{ (ohms)} \times .25 \text{ (m. f. d.)} \times 10^{-6} = .01875 \text{ seconds}$. The voltage upon capacitor C3 will grow exponentially until 30 190 volts is reached. At that point, the critical line is crossed, making the thyatron tube 40 conducting. When such ionization takes place within the tube, the energy stored in the capacitor C3 is discharged through the thyatron, and the ignition coil primary 51. This discharge sets up flux in the coil core, which in turn produces the high voltage output in the coil secondary 52. When C3 has been discharged, the tube 40 becomes de-

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ionized, and the capacitor C3 again begins to charge and the cycle is repeated so long as switches 33 and 11 remain closed.

Switch 11 should be closed before switch 33 5 is closed to allow time for heating the tube 40 before beginning to build up voltage at the capacitor C3 and at the plate 41.

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 claim which follows.

What is claimed is as follows:

An ignition system for providing a rapid succession of sparking impulses comprising an ignition coil having a secondary winding for connection with a spark gap and having a primary winding, a capacitor to be intermittently discharged through the primary winding, a thyatron tube operative to establish a circuit between the capacitor and the primary winding when, corresponding to a certain negative bias on the tube grid, the tube plate voltage grows to a certain value whereby the condenser is discharged 20 through the tube and the primary winding and the tube becomes non-conducting, a current source or power supply for plate and grid voltages and for capacitor charging, and circuit connections between the power supply and the tube and capacitor providing for a predetermined negative grid bias and for the concurrent growth of voltage at the capacitor and tube plate, whereby the frequency of sparking impulses is determined by rate of charge and discharge of the 35 capacitor.

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