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IGNITION SYSTEM

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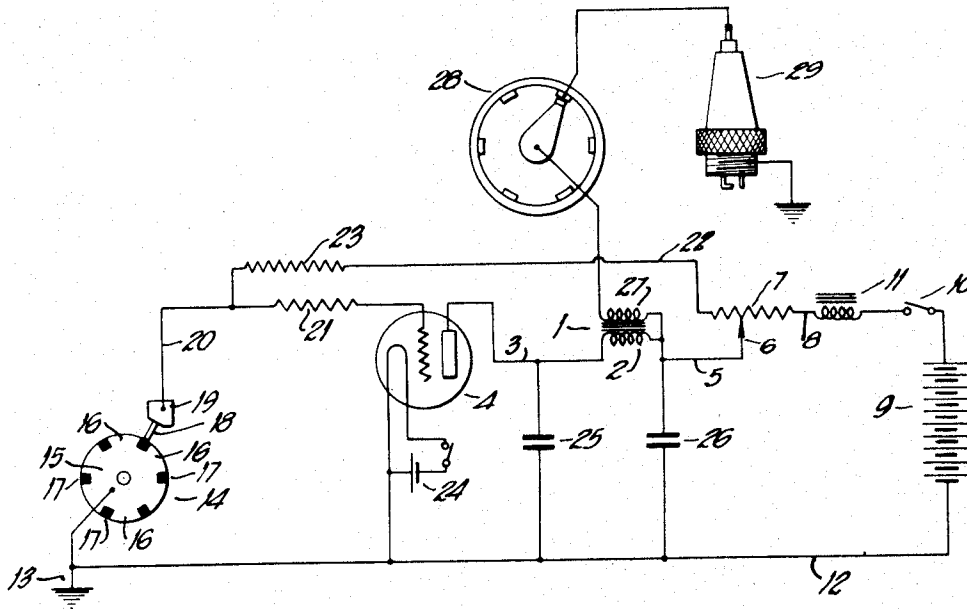


FIG. 1

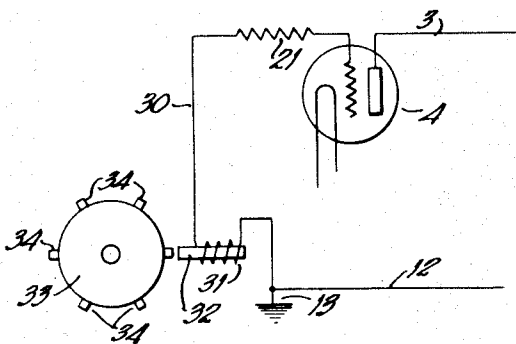


FIG. 2

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IGNITION SYSTEM

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3 Claims. (Cl. 171-119)

Our invention particularly relates to an ignition system for use with internal combustion engines which comprises in the circuit thereof an electron tube for controlling the operation of said system.

The type of ignition system which is now standard with most internal combustion engines is what may be termed a mechanical system, that is, it comprises, as essential elements, a coil, the primary winding of which is connected to a suitable source of electrical energy such as a battery and the secondary of which is connected through a distributor to the spark plugs of the engine, and a make and break switch which is operated by a cam synchronized with the distributor. The make and break switch directly controls the primary circuit of the coil. A mechanical ignition system of the foregoing character has some disadvantages. Wear both of a mechanical and electrical nature may occur in the make and break switch as, for example, wear of the cam or cam shaft, and corrosion and pitting of the contacts because of the relatively heavy current which passes therethrough.

It is important to note that in the mechanical type of ignition system quite accurate relative adjustment of the contacts of the make and break switch must be made in order to provide highly efficient engine performance. However, it will lose its close adjustment due to wear of both of the above mentioned natures and, therefore, the engine efficiency will decrease. Hence, it is desirable to provide an ignition system in which, among other things, the make and break switch or the means therein provided for controlling the operation of the system is of such character that it can not get out of adjustment or is subject to wear of either a mechanical or electrical nature which will affect the accuracy of its setting.

Furthermore, in the mechanical type of ignition system, the inertia of the make and break contacts becomes a limiting factor at high engine speeds. Also, the operation of the make and break switch is affected by atmospheric conditions.

It is an object of this invention to provide what may be called for comparison purposes an electronic ignition system which is principally characterized both in its nature of operation and the results produced thereby, in the following ways:

1. Extremely small currents are employed for controlling the energy developed in the system for spark emission purpose whereby make and

break contacts may be eliminated or, if used, wear and corrosion of these contacts is substantially eliminated;

2. High fidelity of operation;

3. Provides substantially uniform engine performance at all speeds;

4. Does not limit high speed operations of the engine;

5. Affords more accurate control of timing;

6. Continuously provides efficient motor performance;

7. The magnitude of the currents may be higher without detrimental effects than in the mechanical system whereby to increase or intensify the spark discharge at the spark plugs.

Another object lies in providing an ignition system which is of such character that a cam drive such as that used in the mechanical system is not necessarily employed.

More specifically, it is an object of our invention to provide an ignition system in which an electron tube or a thyatron tube is employed for controlling the circuit of the coil from which energy is derived for ignition purposes. Our invention also contemplates providing an ignition system of the above character in which a plurality of tubes may be employed which are so electrically connected in circuit that upon failure of the working tube, connected for operation in the circuit, another tube may be readily and operatively connected in the working circuit by means of a switch; and this may be accomplished automatically.

The foregoing objects of our invention may be accomplished by employing the systems described below and illustrated in the accompanying drawing in which preferred embodiments of our invention are shown, and in which—

Fig. 1 is a wiring diagram of our system; and

Fig. 2 is a fragmentary wiring diagram illustrating a modified form of device for controlling the grid bias of the electron tube.

The circuit of the electronic ignition system herein illustrated comprises the usual coil 1, one end of the primary 2 of which is connected through conductor 3 to the plate of an electron tube or thyatron tube 4. The other end of the primary 2 is connected through conductor 5 to the movable contact arm 6 of a resistance 7. One end of resistor 7 is connected through conductor 8 to the positive terminal of a battery 9. The battery 9 supplies a voltage preferably of the order of about 120 volts. A switch 10 may be interposed in the leg of the circuit comprising conductor 8, between resistor 7 and battery 9,

and we also prefer to interpose therein a choke coil 11 for protective purposes.

The negative terminal of battery 3 is connected through conductor 12 to ground, as indicated at 13, and to a make and break device or switch indicated generally at 14. The make and break device is interposed in the grid circuit of the tube and, in the embodiment illustrated, comprises a commutator 15, the conducting segments 16 of which are electrically connected with conductor 12. Electrical insulating segments 17, of course, are interposed between the segments 16. A brush 18 which is supported in a brush holder 19 and adapted to ride upon the surface of the commutator is electrically connected through conductor 20 and resistance 21 to the grid of the tube 4.

The grid voltage, in the embodiment illustrated, is obtained from the plate supply and for this purpose a conductor 22 is connected to the end of resistor 7, remote from that connected with the battery, and to a resistance 23 which in turn is connected with conductor 20.

The energy for the cathode may be derived from an alternating source of electrical energy or, as herein illustrated, may be derived from a battery 24 which is connected across the filament of the tube 4 and one side of which is connected to the conductor 12. A condenser 25 is connected to the conductor 3, between the plate of the tube 4 and the primary 2 of the coil 1, and to the conductor 12. A second condenser 26 is connected to conductor 5, between the primary coil 2 and the contact arm 6, and to the conductor 12. The condenser 25, which is in an oscillatory circuit including condenser 26, contributes little to the current which may flow through the primary of the coil. However, some capacitance, connected in the circuit like condenser 25 should be present in order to preserve the action of the tube.

Condenser 26, on the other hand, contributes to the current flow through the primary of the coil 1 and, as compared to condenser 25, may have a much greater capacitance and one sufficient materially to increase the current flow through the coil. For example, condenser 25 may have a rating of the order of about 6.0 microfarads while condenser 26 may be of about an 18.0 microfarad rating. With the oscillatory circuit, above referred to, arranged as illustrated in the drawing, the current through the primary of coil 2 comprises two components, one from the plate of the tube and the other from the condenser 26. Since condenser 26 functions in the foregoing manner, higher capacitances may be substituted therefor with consequent increases in available energy.

The secondary 27 of coil 1 is connected in the usual manner with one end of the primary 2 and conductor 5 and with the arm of a distributor 28, the contacts of said distributor being connected in the usual manner with the spark plugs of the internal combustion engine with which the system is associated. In the drawing, we have illustrated but one spark plug 29 and its connection between the ground and one of the contacts of the distributor. Of course, it will be understood that rotation of the arm of distributor 28 will be synchronized with the rotation of the make and break device 14.

The operation of the system hereinabove described is as follows. Assuming that the switch or switches of the circuit are closed and that an insulating segment of the commutator of the make and break device 14 is engaged by the brush 18, the grid of tube 4 will have a positive bias. Current will, therefore, flow in the plate

circuit of tube 4 and energy will be supplied to the primary of the coil or energy-transforming means 1 both from the plate of the tube and from condenser 26 thereby producing a spark discharge across the terminals of the spark plug. However, when the brush of the make and break device 14 passes from an insulating segment to a conducting segment, the grid of tube 4 is connected to ground and its potential drops substantially to zero potential whereupon no current passes through the tube and, of course, no current is supplied to the primary coil 2.

It will be noted that although a comparatively large current may flow through the primary coil 2, under all conditions only a very minute current will flow through the make and break device.

Furthermore, since the condenser 26 contributes to the magnitude of current flowing through the primary of the coil 1, the primary current will be increased thereby and, therefore, a spark of relatively longer duration will be produced across the terminals of the spark plugs.

Since only extremely small currents flow in the control circuit for the grid of the thyratron tube, any type of switch or make and break type of switch may be used and arcing, pitting and corrosion of the contacts thereof will not take place. We have illustrated and described a commutator type make and break switch mainly for exemplary purposes, and it will be understood that a make and break type of switch need not be employed but the grid of the tube may be biased in other ways and by means other than those embodying contacts. For example, magnetic means associated with the grid circuit may be employed to bias the grid of the tube as illustrated in Fig. 2.

In Fig. 2 we have illustrated in a generally schematic way an exemplary form of device for magnetically biasing the grid of the tube in the circuit of Fig. 1 and have shown only a part of the circuit, sufficient to indicate the way in which the device may be associated therewith. In the embodiment illustrated, the grid of tube 4 is connected through resistance 21 to conductor 30. Conductor 30 is also connected with one end of a coil 31, wound on a core 32, and the other end of coil 31 is connected to ground. A rotatable member 33 is provided with circumferentially, preferably equidistantly spaced, poles 34 and so mounted with relation to core 32 that the poles, upon rotation of the member, pass in close proximity thereto. The poles are all of the same polarity as north poles. It will be understood, of course, that member 33 is preferably synchronized with the distributor and that the number of its poles will preferably correspond to the number of contacts of the distributor or spark plugs served.

As a pole of the member 33 passes the core 32, the grid of tube 4 is biased to cause a current flow in the plate circuit thereof. However, after a pole leaves the core 32, the grid potential drops substantially to a zero value and no current will then flow through the tube.

Tests of our electronic ignition system indicate that the engine with which it was used had substantially no high speed limitation by virtue of the ignition and more uniform engine performance resulted at all speeds. Not only are the objects, hereinbefore enumerated, obtained with a system of the character herein described but, additionally, our ignition system has an added advantage in that it may include, as hereinbefore indicated, a second or extra tube which may be cut into operation should the working tube

in the circuit fail. The ability so to make rapid substitution is of great importance in airplane installations.

While we have described our invention in its preferred embodiments, it is to be understood that the words which we have used are words of description rather than of limitation. Hence, changes within the purview of the appended claims may be made without departing from the true scope and spirit of our invention in its broader aspects.

What we claim is:

1. In an ignition system of the character described, an electrical circuit including a source of electrical energy, means for transforming said energy to energy of comparatively higher voltage including a primary coil, a thyratron tube for controlling the flow of energy to said energy-transforming means, and capacitance, said primary coil and capacitance being connected in an oscillatory circuit and connected with the plate of said thyratron tube, and the grid of said tube being electrically connected with a source of electrical potential, and means for varying the potential of said grid whereby to control the flow of electrical energy to said energy-transforming means.

2. In an ignition system of the character described, an electrical circuit including a source of electrical energy, means for transforming said energy to energy of comparatively higher voltage, an electron discharge tube adapted to operate as a control valve for controlling the flow of energy to said energy-transforming means, and capacitance in said circuit for increasing the energy

supplied to said energy-transforming means, said tube including a grid, a grid circuit operatively connected in said electrical circuit and to said grid to supply operating potentials thereto, and said grid circuit including means for controlling the operating potentials on said grid to render said tube normally inoperative to pass current therethrough to said energy-transforming means but said control means being operable to vary the potential on said grid to a value permitting said tube to pass current therethrough.

3. In an ignition system of the character described, an electrical circuit including a source of electrical energy, capacitance, means for transforming said energy to energy of comparatively higher voltage including a primary coil, and an electron discharge tube; said capacitance and the primary coil of said transforming means being connected in an oscillatory circuit and connected with the plate of said electron tube, said tube being arranged to control the flow of energy to said transforming means and including a grid, a grid circuit operatively connected in said electrical circuit and to said grid to supply operating potentials thereto, and said grid circuit including means for controlling the operating potentials on said grid to render said tube normally inoperative to pass current therethrough to said energy-transforming means but said control means being operable to vary the potential on said grid to a value permitting said tube to pass current therethrough.

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