

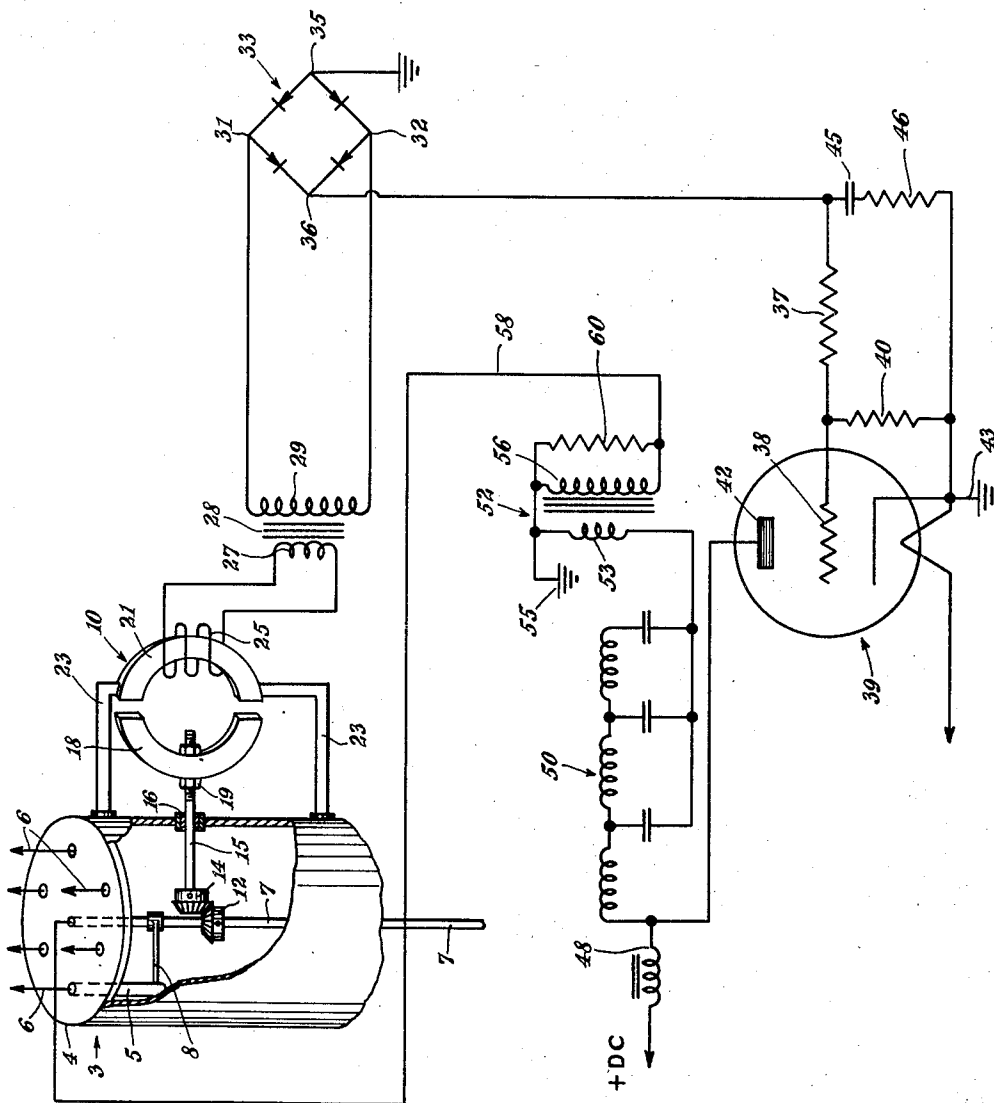
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W. G. MAYER

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ELECTRONIC IGNITION SYSTEM

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Inventor
William G. Mayer.

By his Attorney
William F. Nickel

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ELECTRONIC IGNITION SYSTEM

William G. Mayer, Asbury Park, N. J.

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1

This invention relates to an electronic ignition system for internal combustion engines.

My present invention provides a generally improved electronic ignition system which, among other features, embodies automatic electrical means for timing the ignition or advancing the spark, avoids misfiring, eliminates the usual troublesome contact points, provides more exact timing and more efficient ignition and has other important advantages, hereinafter set forth or appreciated by those skilled in the art, and furthermore provides a new and more efficient method for firing the explosive mixture in the cylinders of an internal combustion engine. Additionally, the invention may be readily applied to present day engine models.

The mentioned method for firing the explosive mixture in the cylinders of an internal combustion engine, which is not dependent on the apparatus shown for carrying out the method, comprises the transformation of electrical energy, by any suitable means, into the form of a pulse, and preferably a single pulse, which may be a square pulse, and then applying the pulse to effect a spark in the explosive mixture, whereby to secure more efficient ignition and consequently more powerful engine strokes.

To outline the apparatus to be described below as illustrating one embodiment of my invention, it may be said that I employ a switch, shown as an electric switch in the form of a tube adapted to be periodically triggered or fired, means for so actuating the switch, which said means may be of any suitable type, such for example as an A. C. generator operated in synchronism with, or by, the engine, said generator being desirably of the type which, in my ignition system, provides automatic control of the ignition timing, i. e., automatic spark advance. Additionally, I employ means adapted to be periodically charged and discharged, the charging being to a constant voltage regardless of the variable engine speed, and independent of the voltage of the mentioned generator or other source used to actuate the switch. The ignition voltage is thereby advantageously maintained constant at all engine speeds to secure the several advantages consequent thereupon. The means to be charged and discharged may be, and desirably is, a pulse-forming means, to provide efficient ignition, and may be, for example, a network adapted to form, on discharge, a single pulse, which may be, especially, a substantially square pulse. The pulse forming means is charged when the mentioned switch is open, and to a constant voltage regard-

2

less of engine speed, and discharges when the switch is closed. The discharge pulses are preferably transmitted to the distributor and from there communicated to the spark plugs to fire the same. In combination with the mentioned components, I may use a pulse transformer, to duplicate, at a higher voltage, the discharge pulses mentioned, which pass, after their formation, through the primary of the pulse transformer. Said transformer is desirably a low turns-ratio transformer so that, regardless of certain adverse conditions in the distributor, spark plugs and cables, as to be mentioned, the substantially constant voltage of the pulse-forming means may be transmitted to the spark plugs, whereby, among other advantages, misfiring is avoided. It may be here added that a pulse is defined as a sudden change of voltage or current of short duration; which duration is usually measured in microseconds. By using a pulse as aforesaid, I concentrate all the available energy in one intense burst of power, to secure a more effective spark. The spark resulting from the pulse is more reliable in exploding the charge within a cylinder, and also effects a quicker and therefore a more powerful explosion, which means greater engine power and fuel efficiency.

The accompanying drawing illustrates one embodiment of my invention.

Referring to the drawing for a more detailed description, the numeral 3 indicates a known type of distributor, modified as presently to be explained. The distributor comprises a housing 4, conductor terminal 5 (one shown) of conductors 6 which lead to the several spark plugs (not shown). The distributor shaft 7 rotates a known and used type of distributor arm 8, which extends to within sparking distance of the conductor terminals 5. In accordance with my invention, I provide means for driving a generator 10 from the drive shaft 7 of the distributor. The latter, as stated, is of known design, modified to provide means for driving the generator. The driving means shown comprises a bevel gear 12 fixedly mounted on the distributor shaft 7. Meshing with the gear 12 is a bevel gear 14 mounted on a horizontal shaft 15 which rotates in a bearing 16 set in the wall of the distributor housing. The gears 12 and 14 have the required ratio.

The generator 10 may be an A. C. generator, so that its voltage may be stepped-up by means of a transformer. The generator is shown as comprising a semi-circular permanent magnet 18 mounted on the shaft 15, to be rotated thereby to provide a rotating field. Said magnet is

3

arcuately or angularly adjustable on the shaft, and is fixed in adjusted position by stop nuts 19 and 20 which threadedly engage the shaft and abut against the magnet. This adjustability is provided for the purpose of changing the timing, the magnet being so set, in relation to the armature, that the generator develops an instantaneous voltage sufficient to fire an electric switch, mentioned below, when the distributor arm is in desired sparking relation to the terminals 5 which lead to the spark plugs. It will readily be appreciated that the adjustment mentioned for changing the timing is much simpler than that necessary in currently used systems. The mentioned generator also comprises a stationary, semi-circular armature core 21 which is opposed to and spaced from the magnet 18, and is supported by a frame 23 attached to the distributor housing. The core 21 carries the armature winding 25. The armature being stationary, no brushes are needed. It is to be understood that the generator shown and described is illustrative only.

The terminals of the armature winding 25 are connected, as shown, to the primary winding 27 of a transformer 28, the secondary of which is designated by the numeral 29. The voltage of the generator may thus be stepped up to any desired value.

The terminals of the secondary of the transformer are connected to the input points 31 and 32 of a bridge type full wave selenium rectifier 33. One of the output terminals, 35, of the rectifier, is grounded, while the other terminal, 36, leads, through a current-limiting resistor 37, to the control element or grid 38 of a tube 39, said grid having a grid leak 40. Said tube, which acts as a switch, is shown as being a thermionic, gas discharge tube, specifically a hydrogen-filled thyatron, which comprises an anode 42 and a grounded, indirectly heated cathode 43, but it is to be understood that any suitable type of tube switch may be employed, preferably one having a high current carrying capacity, to provide a hot spark in the plugs. It is to be noted, that, in the system disclosed, only one such tube is necessary.

The voltage of the generator 10, stepped up and rectified, is employed to trigger or fire the tube, the voltage being adequate for that purpose. If the voltage developed by the generator itself is high enough to trigger the tube, the transformer 28 may be dispensed with.

The rectifier 35 is shown to be a full wave rectifier, and desirably so, as the generator speed may thus be only half that necessary with half wave or no rectification, since the tube is fired only when the grid is positive. The generator speed may thus be kept at a comparatively low value, but if it is desired to run the generator at the higher speed, either a half wave rectifier may be used, or the rectifier may be dispensed with.

The mentioned generator is preferably such that increase in speed increases the voltage developed, at least for the usual engine speeds. This is a valuable advantage of my present invention, as providing an inherently automatic spark advance or control feature. That this is true may be appreciated by considering that the spark is to be advanced as the engine speed increases. Increased speed of the engine increases the speed and therefore the voltage and frequency of the generator output. The triggering voltage of the tube is therefore reached earlier in each cycle at a higher than at a lower speed,

4

which means that the spark, or ignition timing, is automatically advanced. Previous systems of spark control may therefore be dispensed with.

If the generator voltage should reach too high a value at high speeds, means for reducing the voltage may be employed. One such means is illustrated in the drawing, and comprises a condenser 45 and a resistance 46, in series, one terminal of the condenser being connected to the grid, through the current-limiting resistor 37, and one terminal of the resistance 46 being connected to the cathode 43 of the mentioned tube. Since the frequency of the generator current increases with speed, and since the impedance of the condenser 45 diminishes with frequency, more current passes through the mentioned condenser-resistance combination at the higher generator speeds and thus diminishes the terminal voltage of the generator due to the greater internal voltage drop caused by the higher current. It will thus be seen that I provide means for controlling the generator voltage.

My present disclosure further includes the feature of using a relatively high voltage D. C. source of power, of about 500 volts, for example, from which to fire the spark plugs, after transformation as explained below. The desired voltage may be obtained from a dynamotor, vibrator pack or motor generator, for example, run from a 6 volt battery. This stepped-up voltage may be used directly through a resistor, but in order to double the D. C. voltage, I employ the combination of a charging choke 48, and either a condenser (not shown) or, preferably, a pulse-forming network 50, so related respectively as to inductance and capacity that a doubling of the voltage is secured. In order to have the mentioned condenser, or the network 50 fully charged, i. e., reach maximum voltage when the thyatron fires, regardless of the repetition rate of the latter, which is dependent on the engine speed, the L of the choke and the C of the network are resonated for the lowest engine speed. A substantially constant discharge voltage is thus obtained for all engine speeds. These facts are known and used in other circumstances, but not heretofore taken advantage of, so far as I am aware, in electronic ignition systems, where the value of employing a relatively high voltage D. C. source, especially with the voltage doubler, lies in the fact that such source enables me to use a low turns-ratio transformer about 1 to 15, for example, as presently to be described. Such a low turns ratio transformer has a relatively low impedance ratio, as against the high impedance ratio of ignition coils used in conventional ignition systems. The importance of using a transformer having a low turns-ratio, and therefore a low impedance ratio, is in the fact that ignition coils having a high turns ratio, usually 1 to 60, have a high impedance ratio, viz., 1 to 3600, resulting, under certain conditions, in a drop in voltage to a point insufficient to fire the spark plugs, i. e., misfiring occurs. Such conditions occur when there is carbonization of the inside of the ceramic insulators of the plugs, or by deposits of dust or dirt on the outside of the same, or by moisture, dust or dirt collecting on the high tension cables, or on the distributor housing or spark plugs. The mentioned misfiring is avoided by my invention, which provides regular firing under the adverse conditions stated. A transformer having such low turns ratio and therefore relatively low matching impedance in the secondary, is

designated in the drawing by the numeral 52, and its output impedance is only about $\frac{1}{5}$ as much as that of the currently used transformers. This transformer is preferably a pulse transformer and its use as part of the system is a feature of my invention. The importance and value of this feature will be appreciated below. Said pulse transformer comprises a primary 53 having one terminal connected to the pulse-forming network 50 and the other terminal grounded at 55. The secondary 56 of this transformer has one terminal grounded and the other connected to the mentioned distributor arm 8 through a cable 58. A load resistor 60 is connected across the secondary and has such value that it matches the characteristic impedance of the pulse-forming network.

A still further feature of my invention provides a single pulse for firing a plug, instead of producing the usual series of damped oscillations given by ignition coils. Further, the comparatively slow rising waves of such oscillations do not immediately develop a firing voltage at the beginning of a cycle, and therefore result, not only in wasted power, but also in a time lag which retards the spark timing as the engine is operated at higher speeds. With my invention, however, the use of the pulse-forming network avoids such a condition, and all the developed power is put into a single pulse, which effects more efficient firing of the spark plugs. Any one of the several types of pulse-forming networks may be employed, the one shown being what is known as type E, and is shown as comprising three sections, each consisting of an inductance and capacitance. The values of the latter control the pulse width, as known, and that width may be varied in accordance with the type of fuel used, the compression of the engine, etc. Such a pulse network may be designed, as known, to produce a pulse having the desired steepness of wave front, and preferably is made to produce a wave which is represented graphically by a substantially perpendicular wave front, such as a square wave, whereby the firing voltage is practically instantaneously developed. This is an advantageous distinction and advance over the use of an ignition coil, with which, at high engine speeds, the primary current does not have time to develop to its maximum, due to the high inductance, resulting in lower secondary voltages at the higher speeds, so that the firing voltage is different for different engine speeds, with a consequent undesirable non-uniformity or irregularity of ignition, as contrasted with the uniformity provided by the presently disclosed system.

It will be appreciated from the foregoing that I provide a new and more efficient method for firing the explosive mixture in an internal combustion engine, comprising the formation of what is technically called a pulse, and preferably a single pulse, which may be square or substantially so, and then effecting a spark within the mixture by means of the pulse.

The mentioned pulse-forming means and pulse

transformer are valuable features of my invention, for the reasons stated, and while known and used in the art of object detection, have long been overlooked as having significant advantages in the present art.

In operation, the pulse-forming network is charged through the primary of the pulse transformer to ground, the thyatron being open. When the thyatron fires, the pulse-forming network, which is connected to the anode of the thyatron, discharges through the thyatron to ground, the current return being through the primary of the pulse transformer. The pulses formed in the primary of the transformer are duplicated in form, at a higher potential, in the secondary thereof, and are transmitted to the spark plugs to fire the same with the efficiency and advantages aforesaid.

I claim:

1. In an ignition system of an internal combustion engine, means for periodically forming a single substantially square pulse only, means for periodically charging said pulse-forming means, a pulse transformer having a primary and a secondary, a distributor and means adapted to be synchronized with the engine to periodically allow said pulse forming means to discharge through said primary of the pulse-forming transformer, the secondary of the transformer being operatively connected to said distributor.

2. In an ignition system of an internal combustion engine, the combination of a switch tube, a distributor driven by the engine and having a shaft, an A. C. generator driven by said shaft and adapted to open and close said switch tube, a full wave rectifier adapted to rectify the voltage of said generator, said generator being characterized by an increase of voltage with speed, to automatically advance the ignition, a pulse transformer, means connected to said transformer and adapted to be periodically charged and discharged, said means being adapted to discharge periodically, through said transformer, to said distributor, a single substantially square pulse only, when said switch tube is closed, said generator comprising a field magnet and an armature core, one of which is rotatable and angularly adjustable to facilitate the proper timing of the ignition system, and a condenser-resistance combination for regulating the voltage of said generator.

WILLIAM G. MAYER.

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