Sept. 9, 1947. K. J. R. WILKINSON ET AL 2,427,247

IGNITION SYSTEM

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Fig. 1.

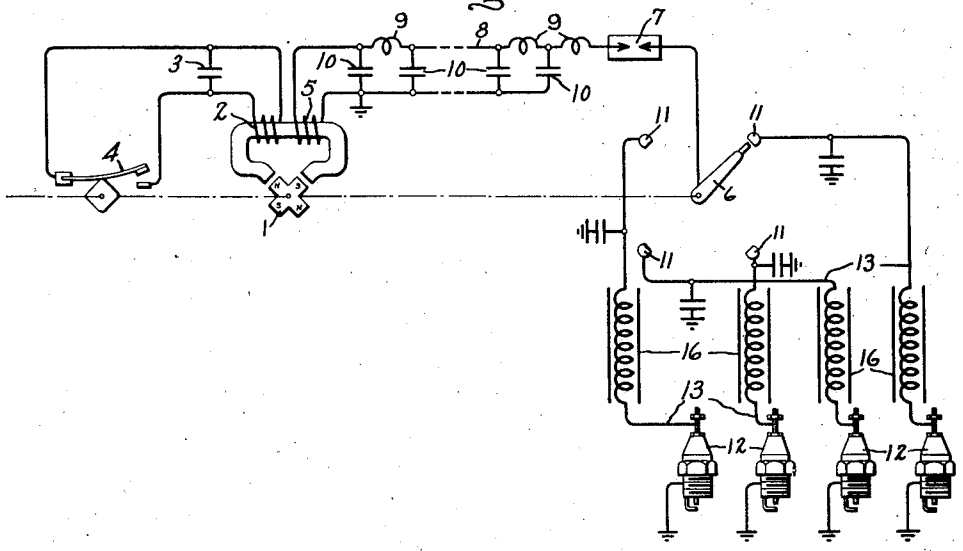
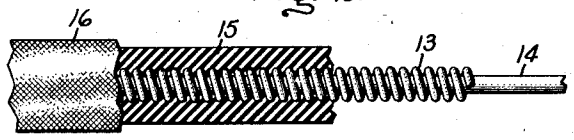


Fig. 2.



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2,427,247

IGNITION SYSTEM

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3 Claims. (Cl. 315—211)

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This invention relates to ignition systems and particularly to the high tension type for internal combustion engines which utilize a high tension magneto for charging a reservoir capacitance which is discharged through a spark gap and distributor to a series of spark plugs.

An object of our invention is to provide an improved ignition system by a special relationship of the capacitances and inductances of the circuit.

Another object of our invention is to provide an improved ignition system which will have sufficient voltage to cause the breakdown of spark plugs by the utilization of an improved conductor lead between the spark plugs and the distributor.

Further objects and advantages of our invention will become apparent and our invention will be better understood from the following description referring to the accompanying drawing, and the features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawing, Fig. 1 is a schematic representation of an ignition system provided with an embodiment of our invention; and Fig. 2 is a fragmentary view, partly in section, illustrating an embodiment of an improved conductor for use with our ignition system.

In high tension electric ignition systems for internal combustion engines of the kind in which the high tension voltage generated by a magneto coil is utilized to charge a reservoir condenser to be discharged through a spark gap and a distributor in series with the spark plug, a voltage can be obtained to cause breakdown at the spark plug by providing less energy than is represented by the product $\frac{1}{2}CV^2$, where C is the total capacitance of the cable between the distributor and spark plug and V the voltage at which breakdown of the spark plug occurs, by providing the desired distributed capacitance and inductance in the ignition circuit. In one embodiment of our invention, this may be obtained by providing a high tension lead between the distributor and the spark plug which is constructed so that the time taken for a wave to travel through it is made large compared with the time taken to build up current in the spark gap.

The physical length of lead between the distributor and spark plug is controlled by engine requirements, and in order to increase the transit time in accordance with this invention, the velocity of a traveling wave is reduced by increasing the inductance per unit length of conductor. It

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is known that the inductance per unit length of a concentric cable may be increased by placing ferromagnetic material within the dielectric space of a coaxial cable, or by replacing the central conductor by a coaxial helical conductor within the outer cable sheath. In view of the short periods of time involved in the ignition processes, the helical central conductor is generally to be preferred to a ferromagnetic insert.

Referring to the drawing, we have shown an ignition system in which a conventional magneto having a rotatable magnet 1 is arranged to excite a primary coil 2 of the magneto which is connected across a condenser 3 in circuit with a conventional breaker 4. The magneto also is provided with a secondary coil 5 which is connected to a distribution arm 6 of a distributor through a series spark gap 7, preferably of the quenched sealed type, through suitable conductor 8 having a distributed inductance 9 and capacitance 10 which acts as a reservoir capacitance for the network. In carrying out the invention, it is possible to restrict the value of the reservoir capacitance to a value comparable with an even less than the distributor spark plug cable capacitance. The minimum value permissible for the reservoir capacitance is controlled by the need to insure that the time duration of the traveling wave is sufficient to be unaffected by the finite time of build-up of current in a spark gap and to cause breakdown of the ignition spark plug without undue increase in voltage. In practice, both of these requirements are found to be met by traveling waves having a duration which exceeds 0.05 microsecond. The traveling wave has a time shape which is of the form

$$V(1-e^{-t/ZC_0})$$

where Z is the surge impedance of the high tension lead to the plug, and C_0 the capacitance of the reservoir condenser. At the spark plug, this traveling wave, in the absence of breakdown, tends to double by reflection to the value:

$$2V(1-e^{-t/ZC_0})$$

As shown in the drawing, the reservoir condenser may be replaced by a capacitance inductance network, and the network is made to represent electrically a cable of surge impedance Z_0 and transit time t_1. On discharging Z_0 charged to a voltage V through the spark gap and distributor into a conductor lead impedance Z, a traveling wave is set up in the conductor lead of value:

$$V\left(\frac{Z}{Z_0+Z}\right)$$

and of time duration $2t_1$. On reaching the spark plug, this voltage tends to double in value in the absence of breakdown, thereby providing the desired discharge voltage which makes it possible to obtain the desired ignition with a relatively lower total energy in the system. This is made possible in a practical embodiment of our system by utilizing the distributor arm 6 to distribute ignition current sequentially to distributor electrodes 11 which are connected to spark plugs 12 by conductor leads 13 of our improved type. These leads may be formed, as stated above, with ferromagnetic material in the dielectric space of the insulation about the lead or may be preferably formed as shown in Fig. 2, in which the conductor is formed as a high inductance coaxial cable in which the conductor 13 connected to the spark plug is wound as a helix about a central nonextensible core element 14, and is insulated by any suitable insulating material 15 arranged within a suitable shielding member 16, such as a metal braided covering. With such an arrangement, the conductor leads 13 between the distributor and the spark plugs 12 have a capacitance to ground that is greater than the reservoir capacitance 10 and the surge impedance of these leads should be made such that the transit time thereof is greater than 0.05 microsecond.

While we have described particular embodiments of our invention, modifications thereof will occur to those skilled in the art. We desire it to be understood, therefore, that our invention is not to be limited to the particular arrangements disclosed, and we intend in the appended claims to cover all modifications which do not depart from the spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An ignition system including a source of electric power, a spark gap and a reservoir capacitance connected in circuit with said source of electric power, and means including a conductor for connecting said spark gap to said spark plug, said conductor having a surge impedance such that transit time thereof is greater than 0.05 microsecond.

2. An ignition system including a magneto source of electric power, a plurality of spark plugs, a distributor for sequentially distributing ignition current to said spark plugs, a spark gap and a reservoir capacitance connected in circuit with said distributor and said source of electric power, and means including a conductor for connecting said distributor to said spark plugs having a capacitance to ground greater than said reservoir capacitance and a surge impedance such that the transit time of said conductor is greater than 0.05 microsecond.

3. An ignition system including a magneto source of electric power, a plurality of spark plugs, a distributor for sequentially distributing ignition current to said spark plugs, a spark gap connected between said distributor and said source of electric power, a reservoir capacitance connected between said spark gap and said source of electric power, and means including a high inductance coaxial helical cable conductor for connecting said distributor to said spark plugs, said cable having a capacitance to ground greater than said reservoir capacitance and a surge impedance such that the transit time thereof is greater than 0.05 microsecond.

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