

May 19, 1953

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FUEL IGNITION CONTROL
Filed Nov. 12, 1949

2,639,408

Fig. 2

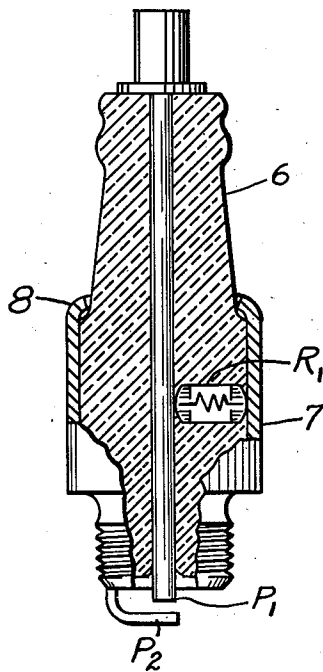
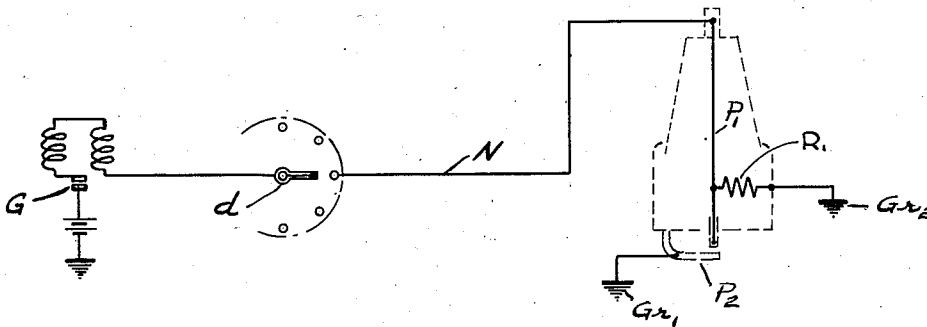


Fig. 1

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2,639,408

FUEL IGNITION CONTROL

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Application November 12, 1949, Serial No. 126,771

2 Claims. (Cl. 315—59)

1

This invention relates to fuel ignition, and particularly to the ignition of vaporized fuel in a combustion chamber, as for example, the cylinder, or cylinders, of an internal combustion engine.

In conventional high-tension ignition systems for multi-cylinder engines, an ignition current flow begins when the spark generator of the primary circuit develops a voltage of sufficient magnitude to induce in the secondary circuit a peak voltage of a value (hereinafter referred to as V_1) high enough to bridge the distributor gap. When this occurs, there is a flow of high-tension current in the ignition circuit; and this energy flow continues to increase until the voltage across the spark plug electrodes reaches a sufficient value (hereinafter referred to as V_2) to cause a spark plug gap. When this occurs, the current continues to oscillate until the dissipation of energy reduces the voltage to a point V_3 , that is not adequate to sustain the flow of current across the spark plug gap. When this cessation of flow occurs, however, there is still a substantial potential difference remaining between end points of the conductors, as for example, between the distributor end of the ignition cable, on the one hand, and the central (insulated) electrode of the spark plug, on the other. The magnitude of this remaining potential difference is substantial, whether the engine has been in constant operation for a period of time, or whether it is being "started" from a "cold" condition; but it is relatively much greater during the "starting" effort, as will be seen from the following analysis of the two extreme conditions:

I.—Normal operation

During normal operation, with the usual relatively small gap at the distributor, the breakdown voltage V_1 of the distributor gap may be of the order of 1500 to 2000 volts, and the spark discharge voltage V_2 will be correspondingly low; similarly, the healing voltage V_3 will be still lower because, during such normal operation, the spark discharge is occurring across a space enveloped by hot ionized gases, hence, the residual voltage on the secondary circuit, while not zero, is not great enough to interfere with normal functioning of the operating cycle.

II.—Starting

By "starting" is meant the period of time before sustained combustion occurs in the engine cylinders. At this time, the spark plug electrodes are cold, and the voltage V_2 to be de-

2

veloped before the electrodes will function is correspondingly high. For the same reasons the voltage V_3 at which "healing" of the gap will occur is also high. Hence, there will be an appreciable potential difference remaining on the ignition cable, particularly as the first spark discharge occurs without benefit of any noteworthy assistance from the surrounding gases in the cylinder, as the latter do not become hot, or ionized, until a later stage of operation. This inherent potential difference, from the cable to ground, is greatly augmented when accompanied by a condition of worn electrodes at the distributor and plug gaps. Moreover, if the charge remaining on the cable is of the same polarity, as it may well be, it may render the spark generator ineffective, as the maximum voltage capacity of the latter may be less than that required to bridge a worn distributor gap, against the residual voltage remaining on the cable, at the termination of the first abortive spark discharging cycle.

The present invention solves the difficulties just described by introducing a new step in the ignition control cycle, namely, the step of connecting the ignition cable to ground, over a path of calculated resistance value, which path, will remain permanently effective as a cable potential venting instrumentality, not only during normal engine operation but also in the intervals between successive uses of the engine. By introducing this step of constantly venting the cable to the ground, I provide a positive insurance against reversely loading the spark generator to a point where spark production becomes uncertain. At the same time, the resistance of the venting path can be kept high enough to prevent its seriously affecting the peak voltage capacity of the spark generator.

Accordingly, objects of the invention are:

1. To provide a novel method of controlling the behavior of a fuel ignition circuit, which novel method involves the continuous venting of each ignition cable to ground, over a venting path whose resistance is of a pre-established value that is sufficiently low to insure against maintenance of any substantial residual potential difference to ground in the cable during the engine starting period, yet sufficiently high to prevent any appreciable drop in the peak voltage at which spark discharge occurs.

2. To provide, in an ignition system, in combination with each ignition cable, a relatively high resistance element having one of its terminals connected to ground and the other of

its terminals continuously connected in circuit with said cable.

3. To provide, in an ignition system, in combination with each spark plug, a resistance element constituting shunt path by which the "locked-in" portion of the energy developed in the system will escape to ground, and thus, clear the spark plug circuits of all residual charges that might, if allowed to remain in storage in said circuits, interfere with proper functioning of the spark discharge electrodes of the plugs; and

4. To provide a spark plug of novel construction, including such a grounding resistor as an integral part of the plug.

These and other objects of the invention will be better understood upon reference to the accompanying drawing, wherein, Figure No. 1 is a sectional view of a spark plug embodying the invention; and, Figure No. 2 is a diagram of electrical connections to such a plug.

Referring first to Figure No. 2, there is illustrated, schematically, an ignition system including a spark generator *G*, a distributor *d*, a pair of spark plug electrodes *P*₁—*P*₂, a cable *N* connecting one of the contacts of distributor *d* with the first electrode *P*₁ of the spark plug, a ground connection *Gr*, leading from the second spark plug electrode *P*₂, and a resistor *R*, having one terminal connected directly to the electrode *P*₁, and its other terminal grounded at *Gr*₂. Figure No. 1 shows this resistor *R* (merely by way of indicating one of many suitable physical locations and arrangements), as disposed laterally of the central electrode *P*₁, in a hole drilled into the ceramic body 6 of the plug; the resistor having its inner capped end pressed against the electrode *P*, by the pressure of the shell 7 against the outer capped end of the resistor. Being in capsule form, the resistor is readily insertible into the body 6, prior to assembly of the body and shell; the body being retained in the shell by turning over the shell end 8, as usual in the art.

In operation, resistor *R* will serve as a constant

venting means between the cable *N* and the grounded shell 7, so that no residual potential difference will remain on the cable, to interfere with spark production, especially when the engine is cold. The value chosen for resistor *R* (the same will apply as to the resistors *R*, for the other spark plugs not shown) will be low enough to produce the desired cable venting, yet, high enough so that it will not appreciably affect the gap break-down voltage characteristics of the particular circuit employed in any given installation, as heretofore explained.

The invention, of course, embraces physical relationships deviating from those illustrated and, in fact, all embodiments based upon the teaching disclosed herein.

What I claim is:

1. In an ignition system, in combination with each individual ignition current supply circuit, a circuit venting path operable as an integral part of each successive cycle of operation of the system, during normal use of the system, at its normal operating voltage, said path including a relatively high resistance element having one of its terminals connected to ground and the other of its terminals continuously and permanently connected in series with said current supply circuit.

2. In a spark plug having an insulated electrode terminating in a point of spark discharge, the combination with said electrode of a permanently operating venting path including a relatively high resistance element permanently incorporated within the plug, and having one of its terminals connected to ground and the other of its terminals connected directly to said electrode.

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