Nov. 19, 1940. W. A. BYCHINSKY 2,222,498

IGNITION SYSTEM

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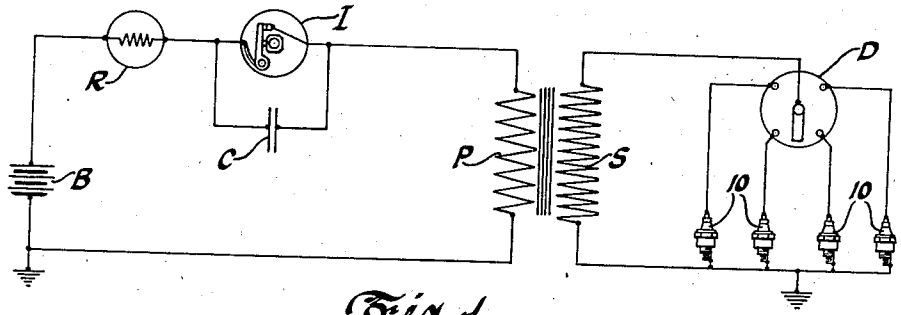


Fig. 1

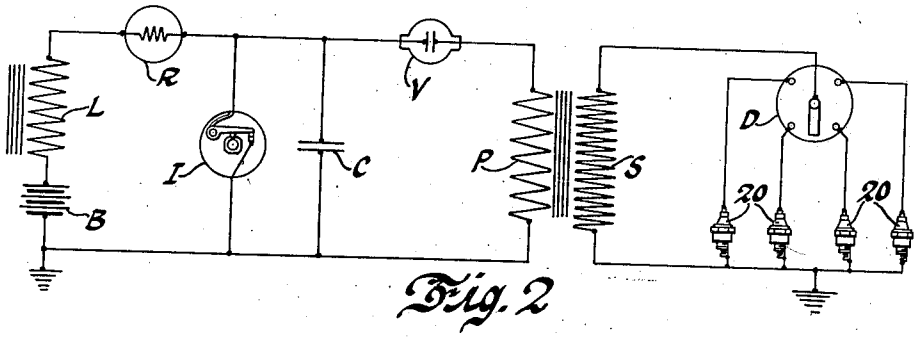


Fig. 2

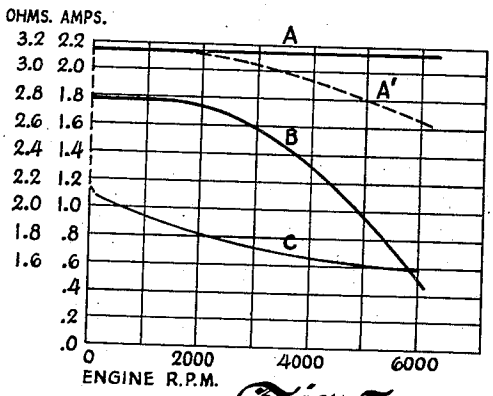


Fig. 3

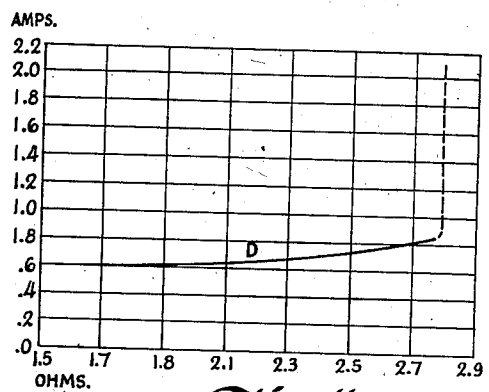


Fig. 4

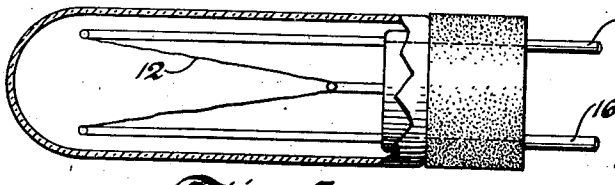


Fig. 5

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IGNITION SYSTEM

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1 Claim. (Cl. 123—148)

This invention has to do with an improvement in ignition systems for internal combustion engines and the like of the type in which the current flowing through an inductance is suddenly broken to obtain a sudden discharge of electrical energy for use in producing the spark. Such systems are commonly employed on present day automobile engines, the inductance taking the form of a transformer, commonly called a spark coil, the primary circuit of which is interrupted to provide energy for the spark. The voltage of the discharge is stepped up by the transformer to enable it to jump the gap at the spark plug.

In another type of system, current through an inductance is interrupted and a condenser is arranged to store the discharge of energy following the break, the condenser being provided with a discharge circuit containing an electrical valve which breaks down upon application of sufficient voltage. In series with the valve is the primary of a step-up transformer which increases the voltage of the discharge. This type of circuit is characterized by the fact that the discharge is of high frequency as well as high voltage.

In both of the above described ignition systems the inductances are fed with energy from a suitable source such as the conventional battery. A definite time is required for the current passing through the inductance to reach any particular percentage of its steady value. The energy stored in the inductance and released when the current is interrupted depends on the value of the current at the time of break. Hence, in such systems, as the speed of the engine increases and hence the length of time of the circuit closing-opening cycle becomes shorter, the current builds up to lower and lower values and the energy available becomes less and less. As a consequence the high tension voltage available at the spark plugs may become so reduced in value at high speeds as to seriously limit ignition performance. Conversely as the engine speed is reduced the current in the primary circuit increases and at low speeds may be large enough to produce destructive arcing at the contact points of the interrupter.

Another difficulty encountered with such systems is that under certain conditions when the engine is not running but the ignition switch remains closed there is a considerable discharge of current through the inductance and this, especially in the case of the high frequency system described above, may be sufficient to cause serious injury to the insulation of the inductance, sometimes disabling it.

The ideal ignition system of this type would be one in which the current through the inductance would build up to the same value regardless of engine speed. Such a system would produce a substantially constant energy output and would not produce excessive arcing at the interrupter points.

I have discovered that this result may be substantially achieved by providing an automatically varying resistance in series with the inductance in such a manner that the current always builds up to substantially the same value. Thus at top engine speeds low resistance is provided and when the engine is not running but the ignition switch is on, maximum resistance is provided. The resistance must also be capable of rapidly changing in value since the changes in engine speed which must be accommodated often take place very rapidly.

The resistance preferably takes the form of a fine wire in a gaseous atmosphere, for example a filament of substantially pure iron in an atmosphere of hydrogen. The ohmic resistance of such a unit varies directly with the current flowing through it. Owing to the fineness of the wire its temperature changes very quickly with changes in current passing through it. Such resistances may be readily designed to hold the current within the desired limits insuring satisfactory ignition at all engine speeds.

In the drawing:

Figure 1 is a wiring diagram showing the application of my invention to a conventional battery ignition system.

Figure 2 is a wiring diagram showing the application of my invention to the above described high frequency ignition system.

Figures 3 and 4 are graphs showing performance characteristics of a typical example of my improved system.

Figure 5 is a view, partly broken away, showing a suitable form of ballast resistance tube.

Referring to Figure 1, B indicates a battery supplying current to the primary P of a conventional spark coil through interrupter I, the points of which may be protected by a small condenser C as shown. R indicates a ballast resistance arranged in series in the circuit. S indicates the usual secondary of the spark coil supplying energy through distributor D to spark plugs 10.

The ballast resistance R preferably consists of a fine wire of substantially pure iron contained in a sealed tube having an atmosphere of hydrogen. The tube may take the form shown in

Figure 5, 12 indicating the resistance wire and 14—16 the terminals to which it is connected.

The system operates as follows: Upon the closing of the contacts of the interrupter I, current flows through the primary circuit attaining a value depending upon the length of time the circuit is closed and this in turn depends upon the speed of the engine, the interrupter being driven at one-half engine speed in the case of a four cycle engine. Should the speed of the engine be reduced the current in the primary circuit will tend to rise to a higher maximum value because the circuit remains closed for a longer period but this tendency toward increase in current will be largely offset by the increase in voltage drop through the resistance R due to the fact that, as indicated by curve D of Figure 4, the resistance through R increases materially with increase in current. Should the engine speed increase, the current in the primary will tend to reach a low maximum value because of the reduced time that the contacts of the interrupter I are closed. This tendency is, however, offset by the fact that the resistance of R decreases with decrease in current thereby reducing the drop in voltage across the terminals of R and permitting the current to attain its former value.

Figures 3 and 4 give certain of the design data for an ignition system such as shown in Figure 1, employing a six-volt battery, a four lobed single breaker cam with contacts open 50% of the time, and a primary coil, the inductance of which is 4.89 millihenries. 2.15 amperes has been selected as a suitable value of current at the time of opening of the contacts. The values shown on the graphs may be readily calculated by those skilled in the art. Curve A, Figure 3, shows the value of current at break, this being maintained constant at substantially 2.15 amperes as above stated. This condition is to be contrasted with that indicated by curve A' showing the current at break in the same ignition system without the ballast tube. It will be noted from A' that the current falls off as the speed increases and at top speed is more than one-half an ampere below the value at low speed.

Curve B shows the total resistance of the primary circuit required to give the constant value of 2.15 amperes at break. The total resistance is the sum of the fixed resistance of the circuit plus the variable resistance of the ballast tube, the latter giving the curve its drooping characteristic.

Curve C shows the variations in average current through the primary circuit with changes in speed.

Curve D, Figure 4, shows the relation of the average current through the primary to the total resistance of the primary circuit including the ballast tube. The increase in resistance with increase in current is produced by the action of the ballast tube.

There is shown in Figure 2 the application of my invention to an ignition system such as is described and claimed in prior Patent 2,030,228 granted February 11, 1936 to Randolph, Duffendack and Wolfe. Here L indicates an inductance supplied with current from battery B through interrupter I, with the ballast resistance R arranged in series as indicated. Across the interrupter is provided condenser C which is adapted to receive the energy stored in inductance L when the interrupter is open. When the charge on condenser C reaches the break-down voltage of the gap in the two electrode electric valve V current flows through the primary P of a transformer of which the secondary is indicated at S, the latter supplying high frequency current through distributor D to spark plugs 20.

The ballast resistance operates in this circuit in the same manner as in the circuit of Figure 1 to assist in the attaining of substantially the same maximum current in the inductance L under all operating conditions so as to give satisfactory and uniform ignition throughout the range of speed of the engine.

While I have described a ballast resistor consisting of a fine iron wire in hydrogen, many other types of constant current resistors may be employed. For example, a fine tungsten filament operating in vacuum will be found to be satisfactory when designed to have the proper operating characteristics.

I claim:

In an ignition system, the combination of a source of current, an inductance, a circuit breaker and a resistance in series, said resistance increasing in value with increase in the amount of current flowing through it, a condenser connected to said circuit so as to receive and store electrical energy from said inductance upon opening of said circuit breaker, a gaseous discharge tube and the primary of a transformer in series with said condenser, an ignition device connected to the secondary of said transformer, said tube being adapted to break down when the charge on the condenser reaches a predetermined value, thereby producing a high frequency discharge at the ignition device, means for driving the circuit breaker at variable speed, said resistance serving to maintain the current substantially constant at the time of opening of the interrupter throughout the range of speed of operation of the interrupter.

WILFRED A. BYCHINSKY.