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SUPPRESSOR FOR HIGH-FREQUENCY IGNITION SYSTEMS

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Fig. 1

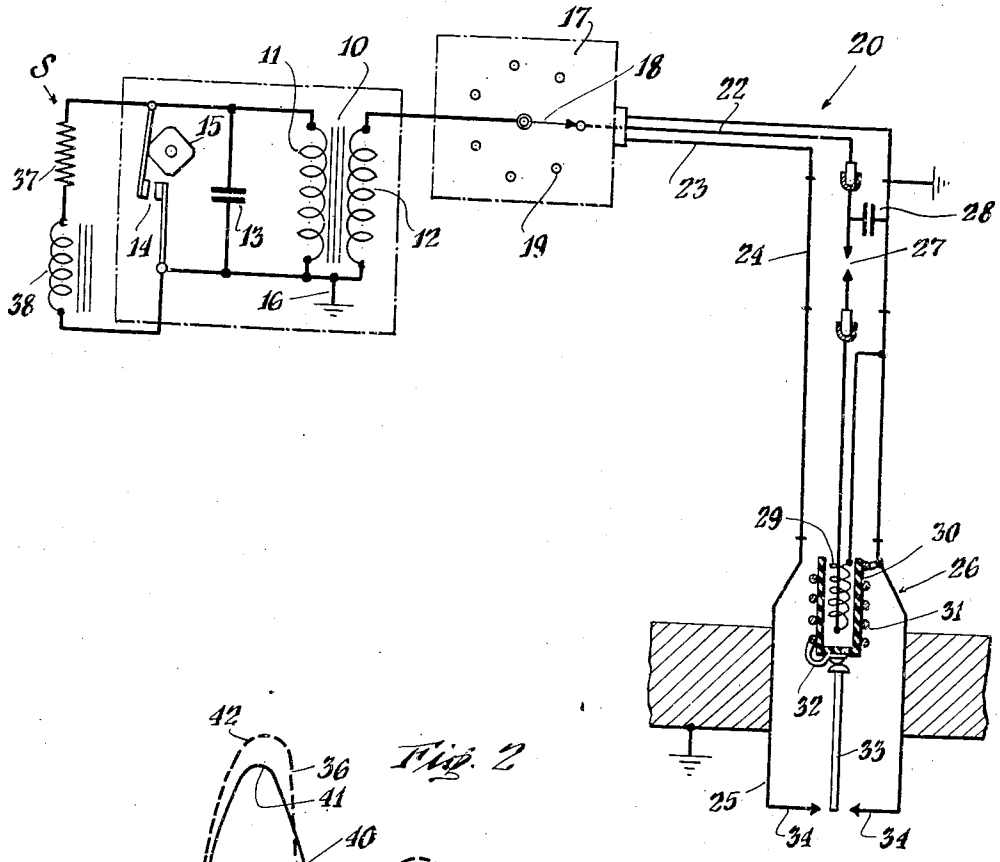


Fig. 2

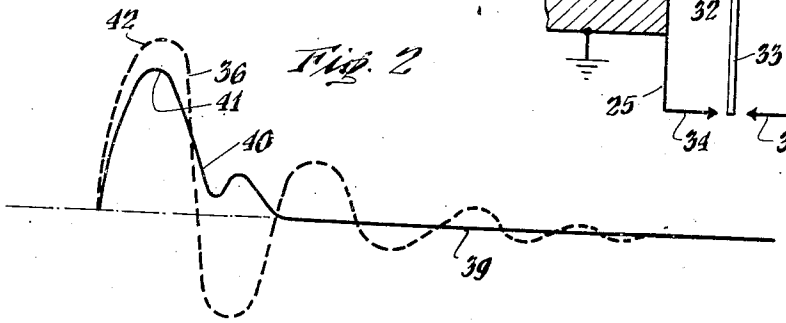
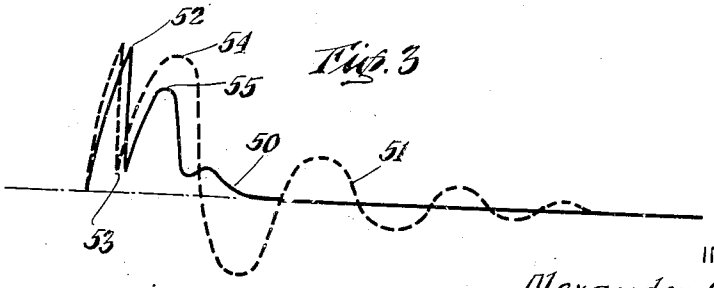


Fig. 3



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SUPPRESSOR FOR HIGH-FREQUENCY IGNITION SYSTEMS

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11 Claims. (Cl. 315—218)

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This invention relates to ignition systems such as those adapted for use in internal combustion engines and, more particularly, to such a system for producing fuel charge ignition sparks of high frequency and voltage.

It is an object of the invention to disclose a suppressor for such an ignition system to eliminate interference between the successive energizing impulses for the respective spark plug circuits.

Other objects of the invention will be apparent from the following description and accompanying drawings taken in connection with the appended claims.

The invention accordingly comprises the features of construction, combination of elements, arrangement of parts, and methods of manufacture referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawings, the scope of the invention being indicated in the appended claims.

In the drawings:

Figure 1 is a schematic circuit diagram showing the suppressor in combination with a high frequency ignition system; and

Figures 2 and 3 are graphs showing the effect of the suppressor.

In high frequency ignition systems, impulses for exciting the spark plug circuits may be produced by a magneto, the primary winding of which is normally short circuited by a breaker switch. The primary circuit includes a condenser connected across the magneto winding, this primary circuit being shock excited when the breaker switch is opened to provide a train of impulses which are stepped up by the magneto transformer and distributed successively to the separate oscillatory circuits for firing the respective spark plugs. With such a system, the train of impulses initiated by the opening of the breaker switch is oftentimes not sufficiently damped so as to die away before the next opening of the breaker switch. This results in overlapping of succeeding trains of impulses or interference therebetween which may cause misfiring or faulty operation of the spark plugs. Such faulty operation is particularly serious in aircraft engines which have a relatively large number of cylinders and a comparatively high speed of operation with the result that there is a very short interval between succeeding trains of impulses.

According to this invention, a suppressor is provided for the primary magneto circuit which causes rapid damping of the train of oscillations initiated by the opening of the breaker switch.

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In this manner, the energy of the magneto circuits is rapidly dissipated after the first impulse is produced thus substantially eliminating the overlapping of succeeding trains of impulses or interference therebetween and decreasing the possibility of multiple firing of the spark plug. In a preferred embodiment of the invention, the first impulse of each train is used to shock excite a high frequency oscillatory circuit, the components of which are located within or adjacent the spark plug to be fired. The suppressor, when used with such a circuit, reduces the maximum amplitude of this first impulse and prevents an excessively rapid voltage rise, thus promoting stability of the ignition circuit and improving the low speed operation of the magneto.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring now to the drawings in detail, a typical high frequency circuit adapted for use with the suppressor of this invention is shown in Figure 1. This circuit may comprise a magneto 10 having a primary winding 11 and a secondary winding 12. A condenser 13 and a breaker switch 14 which is operated by a cam 15, are each connected across the primary winding 11, one terminal of which may be grounded as at 16. When the breaker switch 14 is closed and the magneto 10 is rotated by the engine, a magnetic field is established in the primary winding. The breaker switch periodically opens to shock excite the primary circuit and produce a train of impulses which are stepped up by the magneto and appear across the secondary winding 12. A suppressor S is also connected across the primary winding for a purpose to be hereinafter explained.

The impulses appearing across the secondary winding upon the opening of the breaker switch are distributed successively to a plurality of spark plug exciting circuits by a distributor 17 which may comprise a rotatable contactor 18 and a plurality of contacts 19, one for each spark plug circuit. As the latter circuits are similar in structure and operation, only one such circuit will be described. The current from the distributor may pass to an oscillatory circuit 20 through a shielded cable having an inner conductor 22 and a

grounded outer conductor 23, the latter communicating with a casing 24 which, in turn, is connected to the shell 25 of a spark plug unit 26. The components of the oscillatory circuit are mounted within the casing 24 and these components may include an impulse gap 27 and a condenser 28 together with the primary winding 29 of a transformer 30 which may be conveniently located within the spark plug unit 26. The secondary circuit of the transformer 30 may include a secondary winding 31, one terminal of which is connected to the shell 25, the other terminal leading to a contact member 32 which is connected to a spark plug electrode 33. A plurality of electrodes 34 may be connected to the shell 25 to thereby define a gap across which the ignition spark is produced. The construction and operation of the aforementioned circuits are described in my copending application S. N. 549,278, entitled "Ignition system and apparatus thereof."

When a train of impulses is produced by opening of the breaker switch 14, these impulses are stepped up by the magneto 10 and pass through distributor 17 to excite the oscillatory circuit 20 and thereby energize the primary winding 29. In this manner, a high frequency current is induced in the secondary winding 31 which produces a spark between the electrodes 33, 34 to ignite a fuel charge in the adjacent cylinder. It will be noted that the primary winding 11 and condenser 13 comprise an oscillatory circuit with the result that a train of oscillations 36 is produced when the primary circuit is shock excited by opening of the breaker switch and the suppressor is not connected in the circuit. Although these oscillations are somewhat damped, there is a tendency for succeeding trains of impulses to overlap and interfere with each other which may cause misfiring or faulty operation of the spark plug. Moreover, the initial voltage rise is quite rapid which tends to cause instability of the impulse gap 27. These difficulties are eliminated or substantially minimized by the suppressor S which comprises a resistor 37 and a saturable reactor 38 connected in series across the primary terminals 11. It will be understood that the resistance 37 may be represented, partially or wholly, by the resistance of the reactor 38. When the suppressor is used, the inductance 38 is unsaturated as the voltage builds up to the value necessary to operate oscillatory circuit 20 and fire the associated spark plug. At this time, the reactor presents a high impedance across the primary winding 11 and little or no current flows through the suppressor. As the voltage continues to build up, the inductance 38 becomes saturated and the impedance thereof is decreased to a very small value with the result that the resistor 37 is effectively connected across the primary magneto winding, this occurring at the time or shortly after the voltage builds up to sufficient value for firing the spark plug. Thereupon, the energy of the magneto circuits is rapidly dissipated in the resistance, the oscillations produced by the primary winding 11 and the condenser 13 being rapidly damped so that the train of impulses resulting from one opening of the breaker switch does not interfere with the train of impulses produced by the next opening of the breaker switch.

A typical voltage curve for the magneto circuit embodying the suppressor S is indicated at 39 in Figure 2, this curve showing the wave produced by the magneto circuit without taking into account the effect of the spark discharge. It will be understood that the first pulse 40 is alone effective to fire the spark plug after which the oscillations are rapidly damped so that interference between succeeding trains of impulses is eliminated. The rapid damping of the impulses produced by opening of the breaker switch 14 is also advantageous in preventing burning of the distributor contacts which may be caused by the relatively undamped oscillations set up when no suppressor is used. Furthermore the maximum amplitude or peak voltage of the curve 39 is less than that produced when no suppressor is utilized. That is, the maximum amplitude 41 of curve 39 is less than the maximum voltage 42 of the curve 36 and the voltage rise is less abrupt. This has been found to be an advantage in improving the low speed operation of the magneto and obtaining stable operation of the impulse gap 27.

The effect of the spark discharge is shown by the curves of Figure 3. The curve 50 represents the voltage when the suppressor is used while the curve 51 shows the voltage wave when no suppressor is utilized. It will be noted that the voltage rises rapidly to the value 52 necessary to excite oscillatory circuit 20 and fire the associated plug. Thereupon, the voltage falls rapidly to a minimum value 53 after which a damped train of oscillations is produced, the oscillations shown by curve 50 being much more rapidly damped than the oscillations shown by curve 51. It will be further noted that the voltage of curve 50 approaches the firing voltage 52 after the spark plug has been fired, as indicated at 54. When no suppressor is used, the firing voltage may again be reached after the initial firing of the spark plug with the result that two or more sparks may be produced by one opening of the breaker switch. This may result in energy losses and in excessive deterioration of the circuit components and spark plugs. It will be apparent that this undesirable effect is eliminated or greatly minimized by the use of the suppressor since the energy of the circuit is rapidly dissipated whereby the maximum voltage produced after the firing, as indicated at 55, does not approach the value necessary to produce a spark at the plug electrodes.

The proper values for the resistor 37 and the impedance 38 are somewhat critical and depend on the inductance-resistance characteristics of the magneto primary. Suitable values of the suppressor components for a particular Army Navy type SF142N-3 fourteen cylinder aircraft magneto included a 10 ohm resistor and a saturable reactor consisting of 110 turns of #21 wire upon an E1-75 lamination with 6 leaves each .025 inch thick. These values are given purely by way of example, since different types of magnetos ordinarily require different values for the suppressor components and these values are best determined empirically with the aid of oscillographic observation.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

Thus, although the invention has been described in connection with an ignition system utilizing a magneto and a particular primary circuit therefor, other circuits may be utilized. For example, a battery, a breaker switch and the primary of a transformer may be utilized for the primary circuit, a condenser and the suppressor being shunted across the breaker switch. In this

case, the respective spark plug circuits may be energized from the secondary winding. Alternatively, a vacuum breaker switch and the suppressor may each be shunted across a generator winding which is coupled directly to the spark plug firing circuits. It is also within the scope of the invention to use coupling transformers in the primary or secondary circuits or to utilize the distributor in the primary circuit in which case a separate breaker switch and suppressor might be provided for each spark plug.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an ignition system, a winding, means associated with the winding constituting a source of energy for activating an ignition system for energizing a spark plug, and a breaker switch, a condenser, and a suppressor, each connected across said winding, said suppressor including a saturable reactor.

2. In an ignition system, a winding constituting a source of energy for activating an ignition system, means associated with the winding for energizing a spark plug, and a breaker switch, a condenser, and a suppressor, each connected across said winding, said suppressor including a saturable reactor in series with a resistor.

3. In an ignition system, a magneto having primary and secondary windings, means associated with said secondary winding for successively energizing a plurality of spark plug ignition circuits, and a primary circuit for said magneto including a breaker switch, a condenser, a suppressor, each connected across the primary winding of the magneto, said suppressor comprising a saturable reactor in series with a resistor.

4. In an ignition system, a magneto having primary and secondary windings, means for successively energizing a plurality of spark plug ignition circuits from said secondary winding, a primary circuit for said magneto, means for periodically exciting said primary circuit to provide a train of impulses for firing a spark plug, and a suppressor comprising a saturable reactor connected in shunt with the primary winding of said magneto, said reactor becoming saturated as the voltage exceeds the value necessary for firing a spark plug whereby the energy in the magneto circuits is rapidly dissipated after the spark plug has been fired.

5. In an ignition system, a magneto having primary and secondary windings, means associated with said secondary winding for successively energizing a plurality of spark plug ignition circuits, and a primary circuit for said magneto including a breaker switch, a condenser, a suppressor, each connected across the primary winding of the magneto, said breaker switch opening periodically to shock excite the primary circuit and provide a train of impulses for firing a spark plug, said suppressor comprising a reactor which becomes saturated as the voltage exceeds the value necessary for firing a spark plug whereby the energy in the magneto circuits is rapidly dissipated after the spark plug has been fired.

6. In an ignition system, a magneto having primary and secondary windings, means associated with said secondary winding for successively energizing a plurality of spark plug ignition circuits, and a breaker switch, a condenser, and a suppressor each connected across said primary winding, said breaker switch opening periodically to shock excite the primary circuit and provide a train of impulses for firing a spark plug, said suppressor comprising a saturable reactor in series with a resistor, the reactor becoming saturated as the voltage exceeds the value necessary for firing a spark plug whereby the resistor is effectively connected across the primary winding to rapidly dissipate the energy in the magneto circuits and prevent interference between the impulses produced by the successive openings of the breaker switch.

7. In an ignition system, a plurality of oscillatory circuits, a spark plug firing circuit coupled to each oscillatory circuit, a magneto having primary and secondary windings, a distributor for successively energizing said oscillatory circuit and the associated firing circuits from said secondary winding, a primary circuit for said magneto, means for periodically exciting said primary circuit to provide a train of impulses for firing a spark plug, and a suppressor comprising a saturable reactor connected in parallel with the primary circuit of said magneto, said reactor becoming saturated as the voltage exceeds the value necessary for firing a spark plug whereby the energy in the magneto circuits is rapidly dissipated and interference between succeeding trains of impulses is prevented.

8. In a high frequency ignition system, a plurality of oscillatory circuits each comprising an impulse gap, a spark plug firing circuit coupled to each oscillatory circuit, a magneto having primary and secondary windings, a distributor for successively energizing said oscillatory circuits and the associated firing circuits from said secondary winding, and a breaker switch, a condenser, a suppressor, each connected in parallel with said primary winding, said suppressor comprising a saturable reactor in series with a resistor.

9. In a high frequency ignition system, a plurality of oscillatory circuits, a spark plug firing circuit coupled to each oscillatory circuit, a magneto having primary and secondary windings, a distributor for successively energizing said oscillatory circuits and the associated firing circuits from said secondary windings, and a breaker switch, a condenser and a suppressor each connected across said primary winding, said breaker switch opening periodically to shock excite the primary circuit and provide an impulse for firing a spark plug, said suppressor comprising a saturable reactor in series with a resistor, the reactor becoming saturated as the voltage exceeds the value necessary for firing a spark plug whereby the resistor is effectively connected across the primary winding to rapidly dissipate the energy in the magneto circuits and prevent interference between the impulses produced by the successive openings of the breaker switch.

10. In an ignition system, a winding constituting a source of energy for actuating a spark plug, a circuit including a breaker switch for periodically releasing the energy stored in said winding, and a saturable reactor connected in shunt with said winding, said reactor becoming saturated a short interval after the operation of the breaker switch whereby the energy in said winding is rapidly dissipated in the reactor at the end of said interval.

11. In an ignition system, a winding constituting a source of energy for actuating a spark plug, a circuit including a breaker switch and a condenser for periodically releasing the energy stored in said winding, and a suppressor comprising a saturable reactor connected in series with a resistor, said suppressor being connected in shunt with said winding whereby the reactor

becomes saturated a short interval after the operation of said breaker switch, the energy in said winding being rapidly dissipated in the resistive portions of said suppressor at the end of said interval.

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