

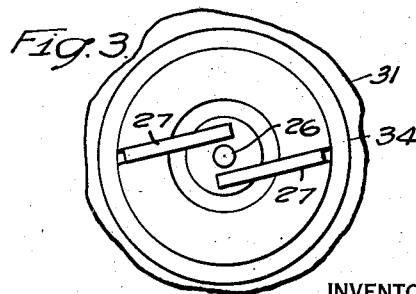
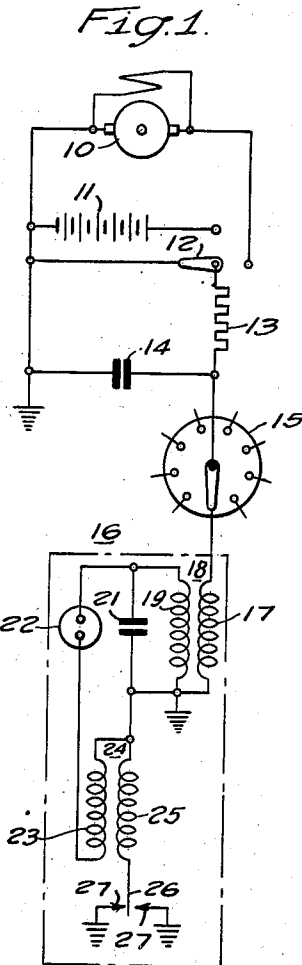
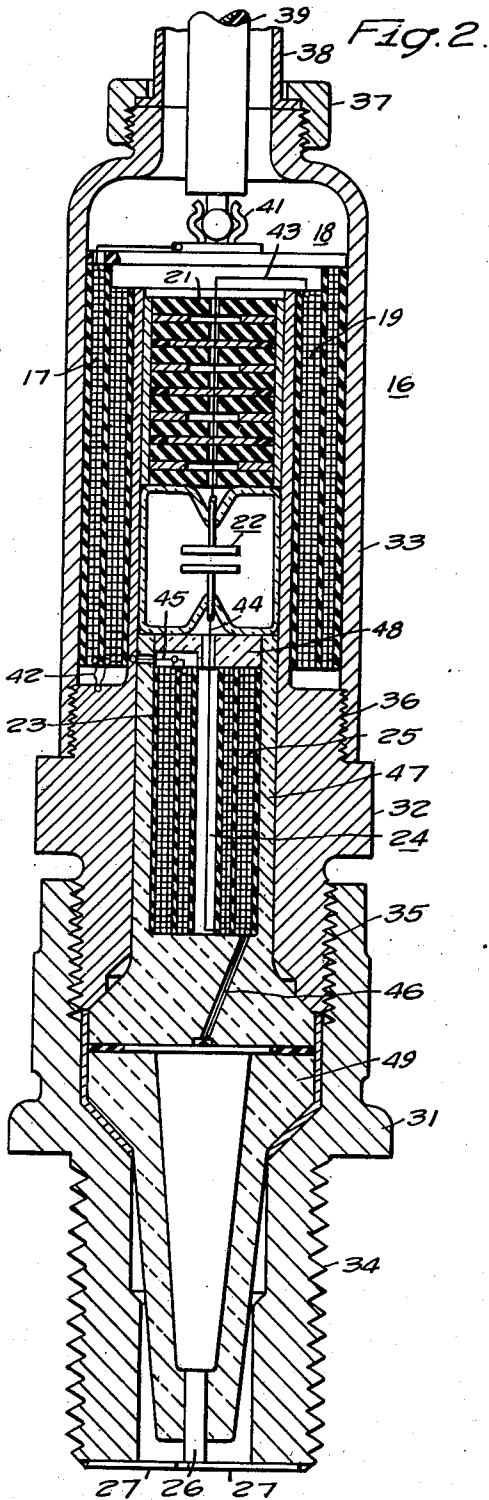
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2,467,725

IGNITION SYSTEM

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IGNITION SYSTEM

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Our invention relates, generally, to ignition systems for internal combustion engines and, more particularly, to ignition systems for aircraft engines.

The reliability and performance of present aircraft magnetos and ignition distribution systems do not equal that of aircraft engines now in production or under development. This is true particularly with regard to performance at high altitudes, life of the system between overhauls, susceptibility to contamination and moisture, and to spark plug performance.

An object of our invention, generally stated, is to overcome the foregoing disadvantages of present aircraft ignition systems.

A more specific object of our invention is to so increase the reliability of an ignition system that it may be utilized with aircraft engines for higher altitude flying.

Another object of our invention is to simplify the timing of the system to the engine.

A further object of our invention is to prevent production of excess energy in the ignition system at high speeds.

Still another object of our invention is to provide a high frequency spark plug suitable for use in our improved ignition system.

Other objects of our invention will be explained fully hereinafter or will be apparent to those skilled in the art.

In accordance with one embodiment of our invention, current from either a low voltage generator or a battery charges a large capacitor until the distributor arm makes contact with one of the spark plug leads. The capacitor then discharges through the distributor and the primary winding of a transformer coil located in the spark plug. The current in the secondary winding of this coil charges a second capacitor located in the plug until the voltage reached is sufficient to break down a sealed gap built into the plug. The discharge current from the second capacitor flows through the primary winding of a second transformer coil, also located in the plug, and the secondary winding of this coil develops sufficient voltage to break down the ignition gap of the plug in the cylinder and fire the engine.

For a better understanding of the nature and objects of our invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawing, in which:

Figure 1 is a diagrammatic view of an ignition system embodying the principal features of our invention;

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Fig. 2 is an enlarged view, in vertical section, of a spark plug suitable for use in the system shown in Fig. 1, and

Fig. 3 is a view, in bottom plan, of the plug shown in Fig. 2.

Referring to Fig. 1 of the drawing, the system shown therein comprises a direct-current generator 10, a battery 11, a selector switch 12, a resistor 13, a capacitor 14, a distributor 15 and a spark plug 16. The generator 10 is of a relatively low voltage, for example, 24 volts, and is preferably of a type which will generate a substantially constant voltage over a relatively wide range of speed. The generator may be driven by an aircraft engine (not shown). The battery 11 may be of the type usually utilized on airplanes for supplying direct-current energy.

As shown, the switch 12 may be utilized to connect the ignition system to either the battery 11 or the generator 10. Thus, the battery may be utilized as the source of energy for the ignition system during starting when the engine is operating at a low speed. The battery also may be utilized to supply energy for the ignition system in case the generator 10 breaks down.

The current from either the generator 10 or the battery 11 charges the capacitor 14 through the resistor 13 and keeps the capacitor 14 charged until the arm of the distributor 15 makes contact with one of the spark plug conductors. When the distributor arm engages a contact member connected to a spark plug conductor, the capacitor 14 discharges through the distributor and a primary winding 17 of a transformer coil 18 which is disposed within the spark plug 16. The flow of current through the primary winding 17 induces a voltage in a secondary winding 19. This charges a second capacitor 21 with a voltage sufficient to break down a sealed spark gap 22 which is disposed within the plug 16. The discharge current from the second capacitor 21 flows through a primary winding 23 of a second transformer coil 24. The flow of current through the primary winding 23 induces a voltage in a secondary winding 25. When the potential of the secondary winding 25 becomes sufficient to break down the ignition gap between a central electrode 26 and outer electrodes 27 of the spark plug, the engine is fired.

Each contact member of the distributor 15 may be connected to a plug 16, similar to the one illustrated. Thus, the cylinders of the engine may be fired consecutively. By selecting favorable circuit components, it is possible to make and break the circuits through the distributor at a

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small current and low voltage without objectionable arcing at the distributor.

Since the voltage at the distributor is relatively low, for example, 24 volts, no complicated insulation problems arise. All timing and compensating may be done at the distributor by properly spacing the contact members engaged by the distributor arm. Thus, the advancement or retarding of the spark may be done at the distributor.

As illustrated in Fig. 2, the spark plug 16 utilized in connection with the present system is of a special construction. It contains the two transformer coils 18 and 24, the capacitor 21 and the sealed spark gap 22.

The plug 16 comprises a metal casing which is preferably divided into three sections 31, 32 and 33. As shown, the lower end of the section 31 is provided with a threaded portion 34 for insertion into the engine cylinder in the usual manner. The lower end of the section 32 is threaded into the upper end of the section 31 by means of threads 35. The lower end of the section 33 is threaded onto the upper end of the section 32 by means of threads 36. A flanged metal sleeve 37 is threaded onto the upper end of the section 33 to retain a metal sheath 38 which encloses a conductor 39. The conductor 39 may be connected to one of the contact members on the distributor 15.

As shown, the conductor 39 is connected to a terminal 41, which, in turn, is connected to one terminal of the primary winding 17 of the transformer coil 18. The other terminal of the primary winding 17 and one terminal of the secondary winding 19 are connected to the casing 32 by conductors 42. The other terminal of the secondary winding 19 is connected to part of the plates of the capacitor 21 and to one terminal of the spark gap 22 by a conductor 43. The capacitor 21 and the spark gap 22 are disposed within the transformer 18. The other plates of the capacitor 21 are connected to the casing 32 and hence to ground through the engine frame.

As shown, the other terminal of the spark gap 22 is connected to one terminal of the primary winding 23 by a conductor 44. The other terminal of the primary winding 23 and one terminal of the secondary winding 25 are connected to the casing 32 by a conductor 45. The other terminal of the secondary winding 25 is connected to the central electrode 26 by a conductor 46.

The transformer coil 24 is disposed within an insulating sleeve 47 which, in turn, is disposed inside of the section 32 of the casing. An insulating cap 48 is disposed between the transformer coil 24 and the enclosed spark gap 22. The electrode 26 is substantially embedded in an insulating member 49. The insulating members 47 and 49 may be composed of porcelain or other suitable ceramic material.

The windings of the transformer coils and the plates of the capacitor may be insulated from each other by any suitable insulating material. Furthermore, certain of the electrical connections between the various members of the spark plug may be made by brushes, thereby facilitating the assembly of the parts of the plug. The capacitor 21 and the spark gap 22 may be removed from the plug for inspection, and, if necessary, they may be replaced by new parts.

From the foregoing description, it is apparent that we have provided an ignition system which has numerous advantages over previously known systems. Thus, the present system will function

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properly at very high altitudes, since the transformer coils are built into the spark plug. The life of the system has been greatly increased, since the energy source consists of a low tension direct-current generator with a battery as an auxiliary source. Because of the low distribution voltage, all causes of disintegration of the insulating materials have been eliminated.

Furthermore, failures due to moisture and contamination have been eliminated because of the low voltage used for distribution. The life of the spark plug electrodes is improved by unipolarity sparks, by the absence of large capacitance in the distribution system and by the reduction of excess energy at high speeds.

The firing characteristics of fouled spark plugs are also improved because of the steep discharge wave form produced in the system. Also, the timing of the system to the engine is greatly simplified over present systems, and utilizing the standard battery of an airplane eliminates any additional booster or vibrator circuit which is, at present, required for starting.

Since numerous changes may be made in the above-described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. In an ignition system for an internal combustion engine, in combination, a source of direct current, a condenser charged by said source, a transformer, a distributor for discharging said condenser through said transformer, a second condenser charged by said transformer, a second transformer, a spark gap for discharging said second condenser through said second transformer, and a spark plug having an electrode connected to the second transformer.

2. In an ignition system for an internal combustion engine, in combination, a source of direct current, a resistor, a condenser charged by said source through said resistor, a transformer, a distributor for discharging said condenser through said transformer, a second condenser charged by said transformer, a second transformer, a spark gap for discharging said second condenser through said second transformer, and a spark plug having an electrode connected to the second transformer.

3. In an ignition system for an internal combustion engine, in combination, a direct current generator, a battery, a condenser, a switch for selectively connecting the condenser to either the battery or the generator to charge the condenser, a transformer, a distributor for discharging said condenser through said transformer, a second condenser charged by said transformer, a second transformer, a spark gap for discharging said second condenser through said second transformer, and a spark plug having an electrode connected to the second transformer.

4. In an ignition system for an internal combustion engine, in combination, a direct current generator, a battery, a resistor, a condenser, a switch for selectively connecting the condenser across either the battery or the generator to charge the condenser through the resistor, a transformer, a distributor for discharging said condenser through said transformer, a second condenser charged by said transformer, a second transformer, a spark gap for discharging said

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second condenser through said second transformer, and a spark plug having an electrode connected to the second transformer.

5. In an ignition system for an internal combustion engine, in combination, a direct current generator, a battery, a resistor, a condenser, a switch for selectively connecting the condenser across either the battery or the generator to charge the condenser through the resistor, a transformer, a distributor for discharging said condenser through said transformer, a second condenser charged by said transformer, a second transformer, a spark gap for discharging said second condenser through said second transformer, and a spark plug having an electrode connected to the second transformer, both of said transformers, said spark gap and one of said condensers being disposed with said spark plug.

6. In an ignition system for an internal combustion engine, in combination, a source of direct current, a condenser charged by said source, a transformer having a primary winding and a secondary winding, a distributor for discharging said condenser through said primary winding, a second condenser charged by said secondary winding, a second transformer having a primary winding and a secondary winding, a spark gap for discharging said second condenser through the primary winding of said second transformer, and a spark plug having an electrode connected to the secondary winding of the second transformer.

7. In an ignition system for an internal combustion engine, in combination, a source of direct current, a condenser charged by said source, a transformer having a primary winding and a secondary winding, a distributor for discharging said condenser through said primary winding, a second condenser charged by said secondary winding, a second transformer having a primary winding and a secondary winding, a spark gap for discharging said second condenser through the primary winding of said second transformer, and a spark plug having an electrode connected

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to the secondary winding of the second transformer, both of said transformers, said spark gap and said second condenser being disposed within said spark plug.

8. A spark plug having a casing and an electrode insulated from the casing, a condenser, a spark gap, and two transformers all disposed within the casing, said condenser being charged by one of said transformers and discharged by said spark gap through the other transformer, said electrode being connected to said other transformer.

9. A spark plug having a casing and an electrode insulated from the casing, a condenser, a spark gap, and two transformers all disposed within the casing, each one of said transformers having a primary winding and a secondary winding, said condenser being charged by the secondary winding of one transformer and discharged by said spark gap through the primary winding of the other transformer, said electrode being connected to the secondary winding of said other transformer.

10. A spark plug having a casing and an electrode insulated from the casing, a condenser, a spark gap, and two transformers all disposed within the casing, one of said transformers surrounding said condenser and said spark gap, said condenser being charged by said one transformer and discharged by said spark gap through the other transformer, said electrode being connected to said other transformer.

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