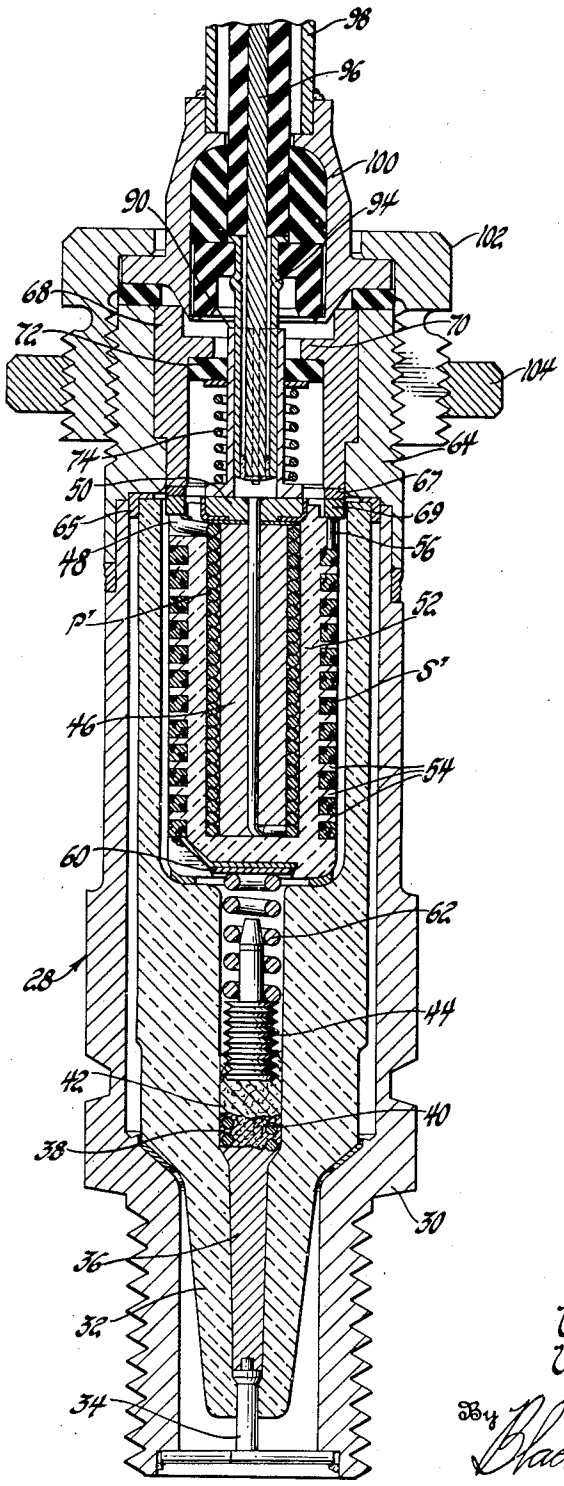
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SPARK PLUG

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SPARK PLUG

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9 Claims. (Cl. 315—57)

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This invention has to do with spark plugs incorporating an ignition coil or transformer. Such plugs have been found to be particularly desirable in ignition systems used on internal combustion engines employed in aircraft. The plug here disclosed is especially designed for use in the high frequency ignition system described and claimed in the Patent 2,459,297 of Lucian B. Smith, dated January 18, 1949, and filed concurrently herewith, said system being characterized by distribution of current to the plugs at low voltage where it is stepped up to the high voltage required for ignition by transformers associated with each of the spark plugs. The difficult problems arising from high voltage distribution, such as flashover at high altitude, deterioration of the wiring harness by corona discharge and leakage of current through the capacitance of the ignition cable, are thereby avoided. The arrangement also makes it possible to shield the circuit much more easily so as not to interfere with radio communication.

An important feature of the invention is the compact but efficient high tension transformer built into the plug. The transformer is of such construction as to withstand the relatively high temperatures encountered at the plugs. The spark plug and its shield are especially designed to receive the coil and form a compact unit assembly which may be as readily replaced as a conventional plug.

Various other features of the invention will be disclosed in the following description with the aid of the accompanying drawing which is a sectional view through the spark plug and associated parts.

Referring to the drawing, **30** indicates the spark plug shell in which is mounted insulator **32**, preferably of an aluminum oxide base composition. The insulator **32** is provided with a central bore increasing in diameter by stages from the electrode and upwardly. In the lowermost portion of the bore there is provided a platinum tip **34** having its upper flanged end supported on a shoulder formed in the insulator bore as shown. The bore above the tip is filled with silver **36** which is cast in place and holds the platinum tip in position. Above the silver is a conducting glass seal **38** fused in place. Embedded in both glass seal **38** and silver core **36** and acting to make metallic contact between the two is coiled wire, preferably nickel, **40**. Above seal **38** is seal **42** which may be of a composition similar to seal **38**. Seal **42** surrounds and grips the upper electrode element **44**. Parts **34**, **36**, **38**, **40**, **42** and **44** together constitute the center electrode of the spark plug.

Within the uppermost portion of the bore is

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arranged the transformer P'—S' comprising a core **46** of powdered iron, the particles being held together but electrically insulated from each other by a suitable insulating varnish or other compound so as to minimize eddy current losses. Around the core is wound the primary P', the upper end of which is grounded as at **48** to the shell of the spark plug through metal gasket **69**, lock washer **67**, annular member **68** and sleeve **64**, secured to the shell. The lower end of primary P' extends upwardly through the central aperture in the core and is connected as by welding to metal contact **50**. The core and the primary winding are housed within insulator **52** preferably of heat resistant material such as a steatite provided with spaced circumferential ribs **54**. Secondary S' is wound in a series of connected pancake coils, each of which is housed in one of the grooves formed by the ribs of the insulator. The purpose of this is, of course, to reduce the distributed capacity thereby providing higher voltage output with a smaller coil and reducing the possibility of short-circuiting of turns without employing bulky insulation between the layers. The upper end of the secondary S' is grounded as indicated at **56** while the lower end is connected to metal contact disc **60**. The wire of the secondary coil S' is preferably insulated by glass yarn impregnated with silicone resin. The impregnation is accomplished under vacuum and is followed by heat treatment. The coil spring **62** establishes electrical connection between the contact disc **62** and the upper end **44** of the center electrode.

The transformer described is assembled as a unit and inserted in the upper end of the bore of the insulator **32**. The insulator **32** is secured within the shell **28** by means of a sleeve **64**, the lower end of which telescopes over the upper end of the shell and is permanently secured thereto as by silver soldering. If preferred, the parts may have a threaded connection. A suitable gasket **65** of soft metal such as aluminum may be provided between the sleeve **64** and the upper end of the insulator. Within the sleeve **64** is secured by threaded engagement or by staking, annular member **68** the lower end of which bears upon spring-like lock washer **67** resting on soft metal gasket **69** engaging the upper end of the insulator **52** of the transformer as shown. It is to gasket **69** that the ground connections of the primary and secondary are made as previously described.

Member **68** is provided with inwardly extending flange **70** serving as an abutment for apertured insulator **72** which is held in position by spring **74** surrounding a split tubular metal jack **90** having

a flanged lower end engaged by the spring and held by it in engagement with the contact 50 of the primary P' of the transformer. Within the jack 90 there is engaged a plug 94 secured to the end of spark plug cable 96. Any suitable means may be provided to secure the cable and its plug or terminal 94 in position in the jack and to insulate it from surrounding conductors and as this constitutes no part of the present invention it will not be described in detail. The cable may be provided with conventional radio shielding consisting of tube 98 carrying the fitting 100 which may be clamped to the upper end of the sleeve 64 by means of an apertured nut 102 as shown. In the arrangement illustrated the threaded portion of nut 102 may be split as shown and may be provided with a nut 104 adapted to be turned down on external threads on the nut 102 to lock it in position.

The spark plug and coil form a permanent assembly which is replaceable as a unit just like a conventional plug. By housing the transformer within the insulator 32 it is insured that there will be no short-circuiting, particularly at high altitudes by discharge between the secondary S' and the surrounding spark plug shell.

The spark plug is susceptible of considerable modification. For example, if desired, the center electrode of the plug may embody a built in resistance as described and claimed in prior application Serial No. 488,114, filed May 24, 1943, by Taine G. McDougal et al., now Patent No. 2,459,282.

We claim:

1. A spark plug comprising a cylindrical shell, an integral insulator within the shell having a central bore therein, an electrode sealed within the lower end of the insulator, said shell being provided at its lower end with an electrode cooperating therewith, and a transformer within the upper end of the bore of said insulator comprising a core composed of insulated magnetic particles, a primary winding about the core, one end of said winding being grounded to the shell and the other end being in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding having axially spaced annular ribs formed thereon, and a secondary winding comprising connected coils occupying the spaces between said ribs, one end of said secondary being in conducting relation with the central electrode and the other end with the said shell.

2. A spark plug comprising a cylindrical shell, an integral insulator within the shell having a central bore therein, an electrode sealed within the lower end of the insulator, said shell being provided at its lower end with an electrode cooperating therewith and a transformer within the upper end of the bore of said insulator comprising a core composed of magnetic particles, a primary winding about the core, one end of said winding being grounded to the shell and the other end being in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding having axially spaced annular ribs formed thereon and a secondary winding comprising connected coils occupying the spaces between said ribs to form a pancake winding thereon, one end of said secondary winding being in conducting relation with the central electrode and the other end with said shell.

3. A spark plug comprising a cylindrical shell, an integral insulator within the shell having a central bore therein, an electrode sealed within the lower end of the insulator, said shell being provided at its lower end with an electrode cooperating therewith and a transformer within the upper end of the bore of said insulator comprising a core composed of magnetic particles, a primary winding about the core, one end of said winding being grounded to the shell and the other being in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding having axially spaced annular ribs formed thereon and a secondary winding comprising connected coils occupying the spaces between said ribs, one end of said secondary winding being connected to a metallic disk recessed in the end of said cup-shaped member in conducting relation with the central electrode and the other end connected to said shell.

4. A spark plug comprising a cylindrical shell, an integral insulator within the shell having a central bore therein, an electrode sealed within the lower end of the insulator, said shell being provided at its lower end with an electrode cooperating therewith and a transformer within the upper end of the bore comprising a core composed of insulated metallic particles, a primary winding about the core, one end of said winding being in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding having axially spaced annular ribs formed thereon and a secondary winding comprising connected coils occupying the spaces between said ribs, one end of said secondary winding being connected to a metallic disk of substantial thickness recessed in the end of said cup-shaped member in conducting relation with the central electrode and the other end connected to said shell.

5. A spark plug comprising a tubular shell having a ground electrode in the lower end thereof, an integral insulator housed within the shell having a central bore, the upper end of which is enlarged, a central electrode sealed in the lower end of the bore and cooperating with the ground electrode to form a spark gap, a transformer housed within the upper enlarged portion of the bore in said insulator comprising a metallic core composed of insulated metal particles, a primary winding surrounding the core and having one end in conducting relation with the shell and the other end in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding, said insulator having axially spaced annular ribs formed thereon and a secondary winding comprising connecting coils occupying the spaces between said ribs, said secondary winding being connected at one end to a metallic disk of substantial thickness recessed in the end of said cup-shaped member and in conducting relation with the said central electrode and at the other end with said shell.

6. A spark plug comprising a tubular shell having a ground electrode in the lower end thereof, an integral insulator housed within the shell having a central bore, the upper end of which is enlarged, a central electrode sealed in the lower end of the bore and cooperating with the ground electrode to form a spark gap, a transformer housed within the upper enlarged portion of the bore in said insulator comprising a core of adhering metal particles insulated from each other, a primary winding surrounding said core and having one end in conducting relation with the shell and the

other end connected to a conductor centrally disposed in said core and in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding, said insulator having axially spaced annular ribs formed thereon and a secondary winding comprising connected coils occupying the spaces between said ribs, said secondary winding being connected at one end to a metallic disk of substantial thickness recessed in the end of said cup-shaped member and in conducting relation with the central electrode and at the other end with said shell.

7. A spark plug comprising a tubular shell having a ground electrode in the lower end thereof, an integral insulator housed within the shell having a central bore, the upper end of which is enlarged, a central electrode sealed in the lower end of the bore and cooperating with the ground electrode to form a spark gap, a transformer housed within the upper enlarged portion of the bore in said insulator comprising a core of adhering metallic particles insulated from each other, a primary winding surrounding said core and having one end in conducting relation with the shell and the other end connected to a conductor centrally disposed in said bore and in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding, said insulator having axially spaced annular ribs formed thereon and a secondary winding comprising connected coils occupying the spaces between said ribs and forming a pancake winding, said secondary winding being connected at one end to a metallic disk of substantial thickness recessed in the end of said cup-shaped member and in conducting relation with the central electrode and at the other end with said shell.

8. A spark plug comprising a tubular shell having an integral insulator housed therein, said insulator having a central bore the upper end of which is enlarged, a central electrode sealed in the lower end of the bore, a transformer housed within the upper enlarged end of the bore comprising a metallic core, a primary winding surrounding said core, having one end grounded to said shell and the other end in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator within which said primary winding and core are disposed, said cup-shaped insulator having axially spaced annular ribs formed thereon, a secondary winding comprising connected coils occupying the spaces between said ribs, one end of said secondary winding being in conducting relation

with the central electrode and the other end with the shell, an annular member recessed in the upper end of said shell for sealing said secondary within the upper enlarged end of the bore of said insulator and means cooperating with the upper end of said shell for clamping said annular member in said shell and connecting an insulated and shielded lead to the primary of said transformer.

9. A spark plug comprising a tubular shell having an integral insulator housed therein and a ground electrode in the lower end thereof, said insulator having a central bore the upper end of which is enlarged, a central electrode sealed in the lower end of the bore and cooperating with said ground electrode to form a spark gap, a transformer housed within the upper enlarged portion of the bore in said insulator comprising a core of adhering metal particles insulated from each other, a primary winding surrounding said core and having one end in conducting relation with the shell and the other end connected to a conductor centrally disposed in said core and in conducting relation with a terminal adapted to make contact with the spark plug lead, a cup-shaped insulator surrounding the primary winding, said insulator having axially spaced annular ribs formed thereon, a secondary winding comprising connected coils occupying the spaces between said ribs and forming a pancake winding, said secondary winding being connected at one end to a metallic disk of substantial thickness recessed in the end of said cup-shaped member and in conducting relation with the central electrode and at the other end with said shell, an annular member recessed in the upper end of said shell for sealing said secondary within the upper enlarged end of the bore of said insulator and means cooperating with the upper end of said shell for clamping said annular member in said shell and connecting an insulated and shielded lead to the primary of said transformer.

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WALTER L. CHURCH.

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Certificate of Correction

Patent No. 2,478,087 August 2, 1949

WILFRED A. BYCHINSKY ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 5, line 27, claim 7, for the word "bore" read *core*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of December, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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