Sept. 27, 1949. T. TOGNOLA ET AL 2,482,884

IGNITION APPARATUS

Filed July 1, 1944

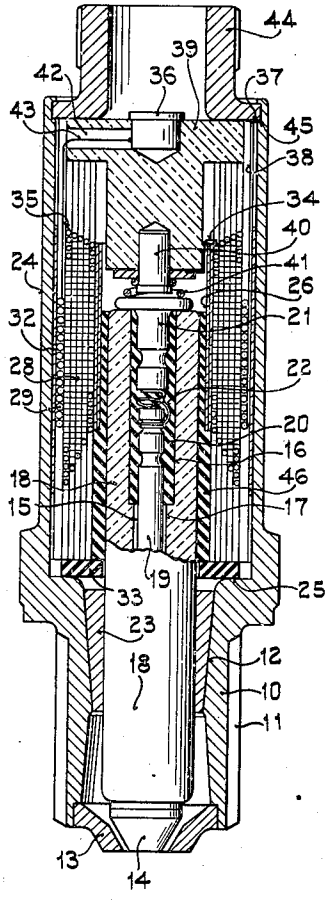


Fig. 1

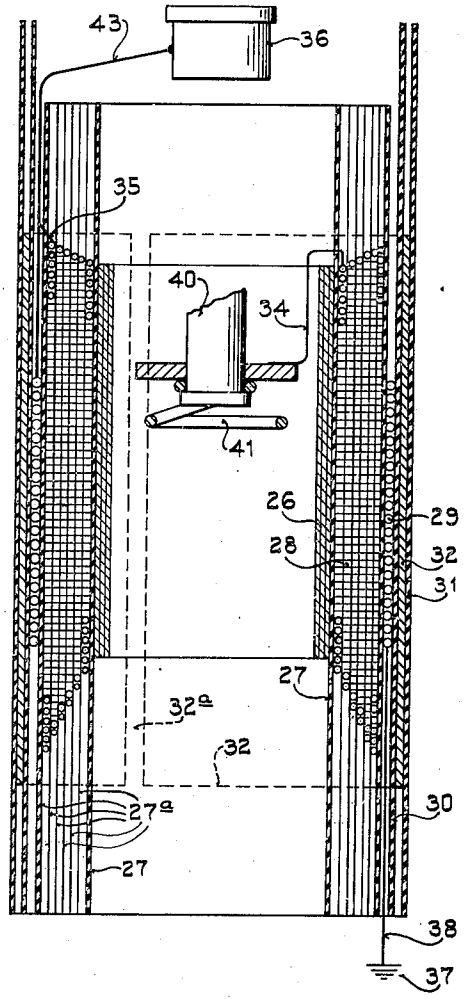


Fig. 2

INVENTORS.
Tullio Tognola
Maurice S. Thorn

BY F. Bascom Smith
ATTORNEY

Patented Sept. 27, 1949 2,482,884

UNITED STATES PATENT OFFICE

2,482,884

IGNITION APPARATUS

Tullio Tognola, Sidney, and Maurice S. Thorn, Oneonta, N. Y., assignors to Bendix Aviation Corporation, New York, N. Y., a corporation of Delaware

Application July 1, 1944, Serial No. 543,136

13 Claims. (Cl. 315—57)

1

This invention relates to ignition apparatus and more particularly to a combined spark plug and coil unit adapted for use in the ignition system of an internal combustion engine.

One of the objects of the present invention is to provide a novel simplified ignition unit comprising a transformer and a spark plug.

Another object is to provide a unit of the above character which is small and compact, and yet durable and reliable in operation.

Still another object is to provide a novel ignition coil of small size which may be incorporated in a standard shielded spark plug by making a minimum number of alterations in the latter.

A further object is to provide novel means for connecting a low voltage supply lead to the terminal of a spark plug through the medium of a high frequency transformer coil.

A still further object is to incorporate a transformer coil in a shielded spark plug in a novel manner so as to minimize danger of flashovers.

Another object is to provide a novel ignition coil which will withstand the high temperatures to which it is subjected in a shielded spark plug.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended to define the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a half sectional elevation view of one form of ignition unit embodying the present invention; and,

Fig. 2 is an enlarged scale detail view, partly diagrammatic, showing the coil of the unit of Fig. 1.

The invention is illustrated in the drawings, by way of example only, as embodying a radio shielded spark plug of the type now in common use on aircraft and similar engines and more particularly of the type disclosed in the copending application of Tullio Tognola, Serial No. 494,516, filed July 13, 1943, now Patent No. 2,453,049. In the embodiment shown, the spark plug comprises a tubular metallic shell 10 which is externally threaded at 11 for cooperation with a threaded opening in an engine cylinder (not shown). The bore through shell 10 is provided with a tapered wall portion 12 for a purpose to hereinafter appear. A ground electrode 13 which may be of any suitable known construction is secured in the

2

lower end of shell 10 by means of silver solder or any other suitable means.

Ground electrode 13 is in cooperative spark gap relation with the enlarged head portion 14 of a center electrode 15 which constitutes part of the conducting means mounted in the differential bore 16, 17 of a ceramic or like insulator 18 for conducting high tension electrical current therethrough. The upper end of spindle 19 of the center electrode is provided with one or more annular grooves or equivalent deformations which are engaged by a solid insulating compound or cement 20, whereby the center electrode is held in place. Embedded in filling compound 20 and held thereby in a like manner is a terminal plug 21. The center electrode and plug 21 are preferably electrically connected by a fine wire conductor 22.

The center electrode assembly is preferably mounted in shell 10 in such a manner as to prevent any gas leakage between insulator 18 and said shell. The mounting is effected by wedging a sleeve 23 of relatively soft metal, such as copper, between a surface of insulator 18, that may be coated with a thin layer of powdered graphite or the like, and tapered wall 12 in shell 10. The wall of the insulator may also be provided with a slight taper. Extending upwardly from shell 10 beyond the end of insulator 18 is a metallic shielding barrel 24 which may be integral with or otherwise operatively secured to the shell. The inner diameter of said barrel is preferably larger than the inner diameter of shell 10, thereby forming a shoulder 25.

A novelly constructed transformer coil is mounted in barrel 24 in a novel manner and provision is made for connecting a shielded supply lead thereto without materially increasing the dimensions and size of standard shielded aircraft spark plug now in common use. In the form shown, the transformer coil unit comprises a tubular core 26 of magnetic metal. This core preferably but not necessarily consists of a few spiral turns of sheet metal, such as magnetic steel, forming a laminated tube which will extend over the upper end of insulator 18 into the annular space between the insulator and barrel 24.

In order to guard against flashovers of high tension current, the ends of core 26 should be kept a safe distance from grounded parts of the spark plug. Additionally, the metal of said core may be coated with a thin film of suitable electrical insulation, such as enamel.

One or more layers 27 of insulating material are placed or wound around core 26 and a secondary coil winding 28 is then applied thereto, the several layers of the coil winding being separated in a well known manner by layers of insulating sheet material 27a. A primary winding 29, which may consist of a single layer, is

wound around the last insulated layer of the secondary winding and is in turn surrounded by an insulating layer or sleeve **30**. Surrounding this latter layer and insulated from barrel **24** by a sleeve or layer **31** is a split sleeve **32** of magnetic metal which acts as a path for magnetic flux in conjunction with core **26**. Sleeve **32** is preferably split longitudinally, as at **32***a*, in order to avoid a short circuit path for eddy currents around the coil. If desired, insulating sheet **27***a* may be a continuation of insulating sleeve or layer **27**. This insulating sheet **27**, **27***a* is of substantially uniform width and the lower edge thereof engages an insulating washer **33** resting on shoulder **25**. In the interest of clarity, all of the insulating layers are shown as single lines in Fig. 1 and some are so shown in the enlarged view of Fig. 2.

The high potential end of secondary winding **28** is connected, such as by a thin strip conductor **34**, to the spark plug terminal **21** in a manner to hereinafter appear. The inner or high potential layer of secondary winding **28** is kept relatively short so that it will be a safe distance from the grounded metallic parts of the structure and the length of the other layers are progressively increased. This novel construction makes it possible to incorporate the necessary number of turns in the winding while keeping the turns which are at the highest potential at a safe distance from grounded parts of the unit.

The end of the outer or low potential layer of the secondary winding **28** is connected to the adjacent end of primary winding **29**, as at **35**. Either end of primary winding **29** is connected to an input terminal **36** to be hereinafter described and the other end thereof is connected to ground by connecting it to the barrel **24**, as at **37**, through a conductor **38**. The spaces between the insulating layers **27**, **27***a*, **30** and **31** and preferably the entire coil structure are impregnated or filled with a suitable insulating compound such as polymerized cashew-nut-shell oil or the like. In the interest of clarity, this filling compound is not shown in the drawings. The filling or impregnation of the coil unit may be done under vacuum or by pressure and vacuum means well known in the art. The insulating layers **27**, **27***a* are preferably of a high heat resisting flexible sheet material, such as woven glass fibre cloth impregnated with a suitable insulating compound, such as silicon. Insulating layers **30** and **31** may be of the same material or any other suitable high heat resisting insulating material.

Projecting into the upper end of the coil unit **28**, **29** is an insulating block **39** which has a flange which rests upon the upper end of insulating sheet **27**, **27***a*. Molded or cemented into the inner end of block **39** is a terminal **40** to which connector **34** may be permanently connected. A spring **41** or other suitable means may be provided for connecting terminal **40** to terminal **21** of the spark plug. The input terminal **36** is mounted in the outer end of block **39** and is connected through a radial passage **42** by lead **43** to the ungrounded end of primary winding **29**.

The coil assembly may be held in place in barrel **24** by a flanged tubular member **44**. The flange of said member rests on shoulder **45** in barrel **24** and the end of the latter peened or rolled inwardly over the flange. The joint is then soldered or made weather tight in some other suitable manner. The outer end of member **44** is externally threaded for receiving a shielding conduit for an incoming supply lead

(not shown) which may be of standard size and known construction.

Either before or after adapter member **44** is secured in place the space within barrel **24** around and inside the coil unit may be filled with a suitable insulating compound, such a polymerized cashew-nut-shell oil and a drying agent as disclosed in Tognola U. S. Patent No. 2,348,427. The compound should be so treated as to set from a liquid to a solid mass of a resilient, non-moldable mixture. In its liquid form, the compound may be inserted by pressure after evacuating the spark plug barrel. Some of the proposed filling compound is illustrated at **46** but the entire space is not shown in filled condition since it would tend to obscure the remaining structure. In any event, the filling compound is not essential.

There is thus provided a novel ignition unit which is simple and compact—a novel unit which, when incorporated in a low voltage distribution ignition system, will eliminate all high tension leads, thereby materially reducing the possibilities of ignition failures and the radio shielding requirements. A novelly wound transformer coil is also provided whereby the danger of flashovers within such a unit is minimized. Additionally, the novel unit provided is not appreciably larger than standard radio shielded spark plugs and may be used in lieu thereof on engines already designed and built.

Although only a single embodiment of the invention is illustrated and described it is to be expressly understood that the same is not limited thereto. For example, differently constructed spark plugs, such as those having mica insulation instead of ceramic, may be used. Various other changes not heretofore mentioned may also be made, particularly in the design and arrangement of parts illustrated and in the materials mentioned without departing from the spirit and scope of the invention as will now be clear to those skilled in the art.

For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. In apparatus of the class described, a tubular metallic shell, an insulated center electrode assembly mounted in said shell, a metallic shielding barrel extending from said shell around and beyond the projecting end of said assembly, an ignition coil in said barrel and surrounding the outer end of said assembly, and means operatively electrically connecting said coil and the electrode of said assembly.

2. In apparatus of the class described, a tubular metallic shell, an insulated center electrode assembly mounted in said shell, a metallic shielding barrel extending from said shell around and beyond the projecting end of said assembly, a transformer coil comprising primary and secondary windings in said barrel, said coil extending into the annular space around said assembly, and means for electrically connecting said secondary winding to the electrode of said assembly.

3. In apparatus of the class described, a tubular metallic shell, an insulated center electrode assembly mounted in said shell, a metallic shielding barrel extending from said shell around and beyond the projecting end of said assembly, a transformer coil in said barrel, said coil comprising a tubular metallic core surrounding the outer end of said assembly, and means for operatively connecting said coil to the electrode of said assembly.

4. In apparatus of the class described, a tubular metallic shell, an insulated center electrode assembly mounted in said shell, a metallic shielding barrel extending from said shell around and beyond the projecting end of said assembly, an ignition coil comprising primary and secondary windings in said barrel, a tubular metallic core for said coil surrounding the outer end of said assembly, and a split sleeve of magnetic metal surrounding said coil.

5. In apparatus of the class described, a tubular metallic shell, an insulated center electrode assembly mounted in said shell, a metallic shielding barrel extending from said shell around and beyond the projecting end of said assembly, a transformer coil in said barrel surrounding the outer end of said assembly, said coil comprising a tubular core of magnetic metal, a secondary winding on said core and a primary winding around said secondary winding, and means for connecting the high potential end of said secondary winding to the electrode of said assembly.

6. A combined spark plug and coil unit comprising a tubular body member, an insulated electrode assembly mounted in said member and projecting therefrom, a shielding tube extending from said member around and beyond said assembly, an ignition coil having primary and secondary windings extending into the annular space between said assembly and tube, said secondary winding comprising a plurality of layers which progressively increase in length from the inner layer to the outer layer, and means for electrically connecting said inner layer to the electrode of said assembly.

7. A combined spark plug and coil unit comprising a tubular body member, an insulated electrode assembly mounted in said member and projecting therefrom, a shielding tube extending from said member around and beyond said assembly, a transformer coil comprising primary and secondary windings slidably extending into the annular space between said assembly and tube, the number of turns in each layer of said secondary winding increasing progressively from the inner layer to the outer layer of said secondary winding, a magnetic flux path comprising a tubular metallic core within said secondary winding and a split metallic sleeve surrounding said primary winding, and means for electrically connecting said secondary winding to the electrode of said assembly.

8. A combined spark plug and coil unit comprising a tubular body member, an insulated electrode assembly mounted in said member and projecting therefrom, a shielding tube extending from said member around and beyond said assembly, an ignition coil in said tube, insulating means between successive layers of said coil and extending beyond the ends of said layers for spacing said coil from opposite ends of said tube, and means for closing the ends of said barrel.

9. A combined spark plug and coil unit comprising a tubular body member, an insulated electrode assembly mounted in said member and projecting therefrom, a shielding tube extending from said member around and beyond said assembly, a tubular coil unit including a secondary winding, a primary winding on said secondary winding, insulating sheets between adjacent layers of said windings and extending substantially

beyond the ends of said layers for spacing said windings from the ends of said barrel, an insulating block in one end of said coil unit and terminals in opposed ends of said block, one of said terminals being connected to said primary winding and the other of said terminals being connected to said secondary winding, and means for connecting said other terminal to the electrode of said assembly.

10. A combined spark plug and coil unit comprising a tubular body member, an insulated electrode assembly mounted in said member and projecting therefrom, a shielding tube extending from said member around and beyond said assembly, a tubular coil unit slidably extending into said tube around said assembly, said coil unit including primary and secondary windings and insulating sleeves between adjacent layers of said windings and extending beyond the ends of said layers, insulating means extending transversely across the ends of said coil unit, and means secured in the open end of said tube for holding said coil unit in place and for receiving a shielded supply cable.

11. An ignition unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond an insulated center electrode, a tubular transformer coil unit slidably extending into the annular space in said barrel around the end of said insulated electrode, and means connecting the secondary winding of said coil unit to said electrode.

12. An ignition unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond an insulated center electrode, a tubular ignition coil unit comprising primary and secondary windings, insulating means disposed between the layers of the coil and extended for spacing said windings from opposite ends of said barrel, and means for connecting the high potential end of said secondary winding to said electrode.

13. An ignition unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond an insulated center electrode, a tubular ignition coil unit slidably extending into said barrel, insulating means disposed between the layers of said coil unit and extended for spacing the windings of said coil unit from the ends of said barrel, an insulating block having terminals in opposite ends thereof, means for connecting one of said terminals to the primary winding of said coil unit, means for connecting the other of said terminals to the secondary winding of said coil unit, and means for connecting said other terminal to said electrode when said coil unit is inserted in said barrel.

TULLIO TOGNOLA.
MAURICE S. THORN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,081,979	Bentley	June 1, 1937
2,180,358	Hooven	Nov. 21, 1939
2,236,316	Helgason	Mar. 25, 1941
2,266,614	Robinson	Dec. 16, 1941
2,378,893	Berkey	June 26, 1946

Certificate of Correction

Patent No. 2,482,884 September 27, 1949

TULLIO TOGNOLA ET AL.

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

Column 1, line 52, for "Patent No. 2,453,049" read *Patent No. 2,453,048;*

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 7th day of February, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.