

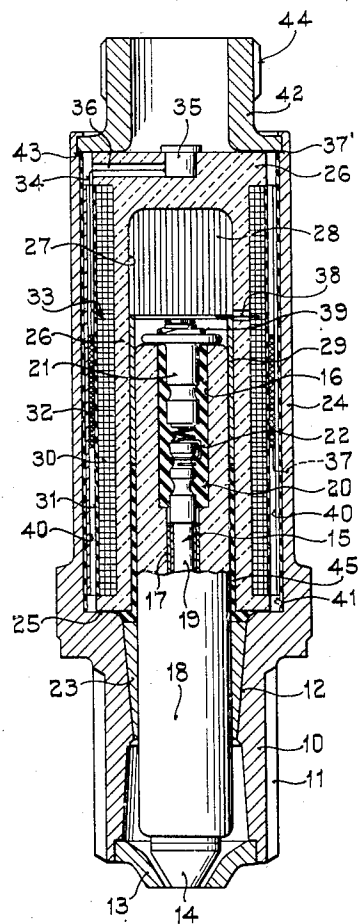
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M. G. WEATHERLY

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IGNITION APPARATUS

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INVENTOR.

BY *Morgan G. Weatherly*

F. Bascom Smith
ATTORNEY

UNITED STATES PATENT OFFICE

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IGNITION APPARATUS

Morgan G. Weatherly, Mount Upton, N. Y., assignor to Bendix Aviation Corporation, New York, N. Y., a corporation of Delaware

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This invention relates to ignition apparatus for internal combustion engines, or the like, and more particularly to a radio shielded spark plug and transformer coil unit adapted for use in an ignition system.

One of the objects of the present invention is to provide a novel simplified unit wherein a high frequency transformer coil is mounted in and electrically connected with a radio shielded spark plug.

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

Still another object is to provide a novel ignition coil which is adapted to withstand the high temperatures which exist in the shielding barrel of a radio shielded spark plug during engine operation.

A further object is to provide a novel ignition coil of small size which may be incorporated in a standard shielded spark plug without making material alterations in the structure of the spark plug.

A still further object is to provide a novel unit for use in an ignition system of an internal combustion engine whereby the necessity for radio shielding of high voltage conductors is reduced to a minimum.

Another object is to provide a novel spark plug-coil unit of the above character which is so constructed that the coil unit may be removed and renewed with comparative ease.

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 drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not intended to define the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

The single figure illustrated in the drawing is a longitudinal sectional view of one form of device embodying the present invention.

The single embodiment of the invention illustrated in the drawing, by way of example, includes a radio shielded spark plug of the ceramic insulated type now in common use on aircraft and similar engines throughout the world. The particular spark plug shown is more fully disclosed in the copending application of Tullio Tognola, Patent No. 2,453,048, filed July 13, 1943. In the form shown, the spark plug per se comprises a tubular metallic shell 10 which is ex-

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ternally threaded at 11 for cooperation with a threaded opening in an engine cylinder (not shown) in the manner well understood in the art. The internal wall of shell 10 is preferably provided with a tapered wall portion 12 for suitable cooperation with other parts in supporting the center electrode assembly in a manner which will more fully appear hereafter. A ground electrode 13, which may be of any suitable known construction, is secured in the lower or inner 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 there-through. The upper end of spindle 19 of the center electrode 15 may be provided with one or more annular grooves or equivalent deformations which are engaged by a rigid insulating compound or cement 20 whereby the center electrode is held within the bore of insulator 18. Embedded in filling material 20 and held thereby within the outer end of enlarged bore 16 of the insulator is a metallic terminal plug 21. For a purpose to hereinafter appear, plug 21 preferably consists of magnetic flux conducting metal and, if desired, may be of a laminated construction, although the same is not so shown. The inner adjacent ends of terminal plug 21 and spindle 19 are preferably electrically connected by a fine wire conductor 22 which is also embedded in filling compound 20 which serves to seal the bore of the insulator against the leakage of gases from the engine cylinder.

The above described center electrode assembly of the spark plug is mounted in shell 10 in any suitable known manner so as to prevent the leakage of gases from the engine cylinder between insulation 18 and the shell. In the form shown, the mounting of the center electrode assembly is effected by wedging a sleeve 23 of relatively soft metal such as copper between the insulator 18 and tapered wall 12 in shell 10. If desired, the outer wall of insulator 18 may also be provided with a slight taper which will tend to prevent movement thereof by the pressure of the gases within the engine cylinder. Extending upwardly from shell 10 is a metallic shielding barrel 24 which may be operatively secured to said shell in any suitable manner or integral therewith, as shown. The inner diameter of said barrel is

larger than the inner diameter of shell 10, thereby forming an internal shoulder 25.

A novel constructed coil unit is slidably mounted in barrel 24 around the above-described center electrode unit and is connected with the conducting means or center electrode 15, 21 in a novel manner without materially increasing the diameter and length of the shielding barrel as used today on standard shielded spark plugs. In the form shown, the coil unit comprises a rigid insulating member 26 which has a recess 27 in one end thereof for slidably receiving the upper end of the center electrode assembly. Tightly fitted or otherwise suitably secured within recess 27 is a core 28 of magnetic flux conducting material, such as magnetic steel. The core 28 is preferably a laminated structure. If desired, said laminated core may be supplemented by a tubular metallic core member 29 which, if desired, may be formed of several turns of magnetic sheet metal. The lower end of core member or sleeve 29 is terminated a safe distance from the grounded metallic parts of the spark plug to avoid danger of flashovers and, hence, spark plug failure. Additionally, it is desirable to coat core member 29 with a thin layer of insulation, such as enamel. As pointed out above, the terminal member 21 of the spark plug may be made of magnetic flux conducting material and, hence, may serve as a coil core or as a supplement to either or both of the core structures 28 and 29.

Rigid insulating member 26 is preferably provided with external flanges at opposite ends thereof and the secondary winding 30 of an ignition coil may be wound on said member between said flanges, the high potential layer of the winding being adjacent the surface of the insulating member or spool. The successive layers of the secondary winding may be insulated from one another and the outer layer may have an insulating covering 31 made of any suitable heat resisting insulating material. One suitable insulating material for forming these layers of the coil is a woven fabric made of fine glass fibers and impregnated with an insulating compound such as silicon.

Surrounding secondary winding 30 is a primary winding 32, one end of which may be connected as at 33 to the low potential end of secondary winding 30. The same end of the primary winding may be connected by means of a lead 34 to a terminal 35 suitably secured, such as by cement, in the upper end of insulating member 26, said lead extending through a radial passage 36 in said insulating member. The other end of the primary winding is grounded through the spark plug shell 10, 24 as shown diagrammatically at 37. In actual practice, it is preferable to attach the grounding wire to the spark plug shell at 37' when the closure member to be hereinafter described is inserted in barrel 24. The other or high potential end of secondary winding 30 is connected by means of a lead 38 to core 28 which is in turn connected by means of a resilient coil spring 39 to the center electrode conducting means 15, 21 within insulator 13. Conductor 38 preferably extends through an opening in the wall of insulating member 26 and is thereby kept a safe distance from any grounded part of the spark plug. When current from a suitable source is fed through primary winding 32, changes in said current will cause current to be induced in secondary winding 30 at relatively high voltage and, hence, create a spark between the electrodes

13 and 14 for a purpose well understood in the art.

Surrounding coil 30, 32 is a sleeve 40 of magnetic flux conducting material. Sleeve 40 is preferably split in the longitudinal direction on the line of the section of Fig. 1, thereby preventing the loss of energy in the form of eddy currents around the coil. Sleeve 40 serves as a path of magnetic flux around the coil windings, thereby supplementing the core structure 21, 28, 29. Sleeve 40 is preferably insulated from primary winding 30 by means of a thin layer of insulation which may be of the same character as that used in separating the layers of secondary winding 30. A similar layer of insulation 41 is interposed between sleeve 40 and the inner surface of barrel 24, this layer extending from one end of the barrel to the other.

The novel coil unit described above may be held in place within barrel 24 with spring 39 under compression by means of a tubular adaptor or closure member 42. This member is provided with an external flange which engages a shoulder 43 in barrel 24 and is held in place by spinning the upper edge of the barrel inwardly into overlapping relation with said flange. The joint between barrel 24 and member 42 may be made weather tight such as by soldering the same with silver solder. Threads 44 are provided on the outer surface of member 42 for receiving the shielding conduit of a supply cable which may, in turn, be provided with a terminal adapted to engage terminal 35. The shielded input or supply cable may be of standard well known construction.

Either before or after closure member 42 is secured in place, the space around and within the above-described coil unit is preferably, but not necessarily, filled with a suitable insulating compound, such as polymerized cashew-nut-shell oil, and a drying agent as disclosed in Tognola U. S. Patent No. 2,348,427. This compound, or other similar compounds, may be injected into the space within barrel 24 in liquid form and caused to set as a solid mass of resilient non-moldable material. In its liquid form, the compound may be inserted under pressure after evacuating the spark plug barrel. Some of the filling compound is illustrated in the drawing at 45 but all of the spaces are not shown as being filled since such a showing would tend to obscure other structural features of the unit.

There is thus provided a novel spark plug and ignition coil unit which is simple and compact and may be used in the place of spark plugs embodied in engines already designed and built. When the novel unit provided is incorporated in a low voltage distribution ignition system all high voltage leads will be eliminated and, hence, the radio shielding requirements will be reduced to a minimum. Additionally, the possibilities of ignition failures, especially those caused by flashovers at high altitudes, will be minimized.

Although only a single embodiment of the invention is illustrated and described in the accompanying drawings and the foregoing specification, it is to be expressly understood that the same is not limited thereto. For example, the spark plug portion of the unit may vary widely in construction and the type of material employed. Various other changes, particularly in the design and arrangement of parts illustrated and in the compositions mentioned as being suitable without departing from the spirit and scope of the invention as the same will now be understood by 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 ignition apparatus of the class described, a tubular shell having a tubular shielding barrel extending therefrom, a center electrode assembly including a center electrode and insulating means therefor mounted in said shell and terminating intermediate the ends of said barrel, a transformer coil unit in said barrel, said unit comprising a spool of rigid insulating material having external flanges at opposite ends thereof and an axial recess in one end thereof for receiving the end of said assembly, a laminated core of magnetic material filling the inner end of said recess, a secondary winding on said spool between said flanges, a primary winding on said secondary winding, a split sleeve of magnetic material around said windings, an insulating sleeve surrounding said sleeve, means for grounding said windings, means extending through the wall of said spool for connecting said secondary winding to said core, resilient means for electrically connecting said core and electrode when said unit is inserted into said barrel, a terminal in the end of said spool opposite said recess, means connecting said primary winding to said terminal, means secured in the open end of said barrel for holding said unit in said barrel, and insulating means filling the spaces in said barrel around said unit and assembly.

2. In ignition apparatus of the class described, a tubular shell having a tubular shielding barrel extending therefrom, a center electrode assembly including a center electrode and insulating means therefor mounted in said shell and terminating intermediate the ends of said barrel, and an ignition coil unit slidably mounted in said barrel, said unit comprising a rigid insulating member having an axial recess in one end thereof for receiving the end of said assembly, a core magnetic material in said recess, primary and secondary windings on said insulating member, a terminal in the end of said insulating member opposite said recess, means connecting said primary winding to said terminal and means including resilient means for connecting said secondary winding to said electrode when said unit is inserted in said barrel.

3. In ignition apparatus of the class described, a tubular shell having a tubular shielding barrel extending therefrom, a center electrode assembly including a center electrode and insulating means therefor mounted in said shell and terminating intermediate the ends of said barrel, and an ignition coil unit in said barrel, said unit comprising a rigid insulating member having an axial recess in one end thereof for receiving the end of said assembly, a core of magnetic material in said recess, primary and secondary windings wound on said insulating member, a split sleeve of magnetic material surrounding said windings, an insulating layer surrounding said split sleeve and means for operatively connecting the high potential end of said secondary winding to said electrode.

4. In ignition apparatus of the class described, a tubular shell having a tubular shielding barrel extending therefrom, a center electrode assembly including a center electrode and insulating means therefor mounted in said shell and terminating intermediate the ends of said barrel, and a transformer coil unit adapted to be slidably inserted into said barrel, said coil unit comprising a rigid insulating member having an axial recess in one

end thereof for receiving the end of said assembly; a core of magnetic material in said recess, electrically conductive resilient means interposed between said core and said electrode, primary and secondary windings on said insulating member, a sleeve of magnetic material around said windings, insulating means between said sleeve and said barrel, means electrically connecting said secondary winding and said resilient means, a terminal in the end of said insulating member opposite said recess and means connecting said primary winding to said terminal.

5. An ignition unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond an insulated center electrode, an ignition coil unit comprising primary and secondary windings on rigid insulating means having a recess in one end thereof for receiving the end of said insulated electrode, and means for connecting the high potential end of said secondary winding to said electrode.

6. An ignition unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond an insulated center electrode, an ignition coil unit in said barrel comprising a rigid insulating member having a recess therein for receiving the end of said insulated electrode, primary and secondary windings on said insulating member, a metallic core in said recess, and means for operatively connecting the high potential end of said secondary winding to said electrode.

7. An ignition coil unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond a center electrode assembly including a center electrode and insulating means therefor, and an ignition coil in said barrel comprising primary and secondary windings wound on a rigid insulating member having a recess in one end thereof for receiving the end of said assembly, a terminal in the end of said member opposite said recess, means connecting the primary winding to said terminal and means for connecting the high potential end of said secondary winding to said electrode.

8. In an ignition coil unit, a spark plug of the type wherein a tubular shielding barrel surrounds and extends beyond a center electrode assembly comprising a center electrode and insulating means therefor, and an ignition coil in said barrel comprising a rigid insulating member surrounding the end of said assembly, a core of magnetic material in said member, primary and secondary windings wound on said member, a split sleeve of magnetic material around said windings and insulating means interposed between said sleeve and said barrel.

9. An ignition coil unit comprising a rigid insulating member having external flanges at opposite ends thereof and a recess in one end thereof, a core of magnetic material in said recess, primary and secondary windings wound on said member between said flanges, a split sleeve of magnetic material surrounding said windings, insulating means around said sleeve, a terminal in the end of said member opposite said recess, means connecting said primary winding to said terminal, and means extending through the wall of said recess for connecting said secondary winding to said core.

10. An ignition coil unit comprising a rigid insulating member having a recess in one end thereof, a terminal in the other end of said member, a core of magnetic material in said recess, primary and secondary windings wound on said member, means connecting said primary winding

to said terminal, and means connecting the high potential end of said secondary winding to said core.

11. An ignition unit comprising a spark plug of the type wherein a shielding barrel surrounds and extends beyond a center electrode assembly including tubular insulating means and metallic conducting means in said insulating means, at least a portion of said conducting means consisting of magnetic metal, an ignition coil in said barrel comprising primary and secondary windings wound on a rigid insulating member having a recess in one end thereof for receiving the end of said assembly, and means connecting the high potential end of said secondary winding to said conducting means.

12. In ignition apparatus of the class described, a tubular metallic shell, a center electrode assembly including tubular insulating means and conducting means therein mounted in said shell and terminating intermediate the ends thereof, a portion of said conducting means in the end of said assembly within said shell consisting of magnetic flux conducting metal, and an ignition coil unit in said shell comprising primary and secondary windings surrounding said flux conducting portion of said conducting means.

13. A transformer comprising telescoped tubular insulators, transformer windings about one of said insulators, and a transformer core comprising a metallic sleeve between said insulators.

14. An ignition unit comprising telescoped tubular insulators, electrically connected conducting means within said insulators constituting a transformer core, and transformer wind-

ings carried by one of said insulators and connected to the high tension end of said core.

15. An ignition unit comprising telescoped tubular insulators, a conducting body mounted within each of said insulators, said bodies being electrically interconnected, and transformer windings carried by one of said insulators and encircling said bodies whereby said bodies tend to act as a core for the transformer coil.

16. An ignition unit comprising telescoped tubular insulators separated by a sleeve of conducting material, electrically connected conducting means within said insulators and connected with said sleeve to constitute a transformer core and a conductor, and transformer windings carried by one of said insulators and connected at the high tension end to said core.

MORGAN G. WEATHERLY.

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