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ELECTRICAL CONNECTING MEANS AND RADIO
SHIELDING MEANS THEREFOR
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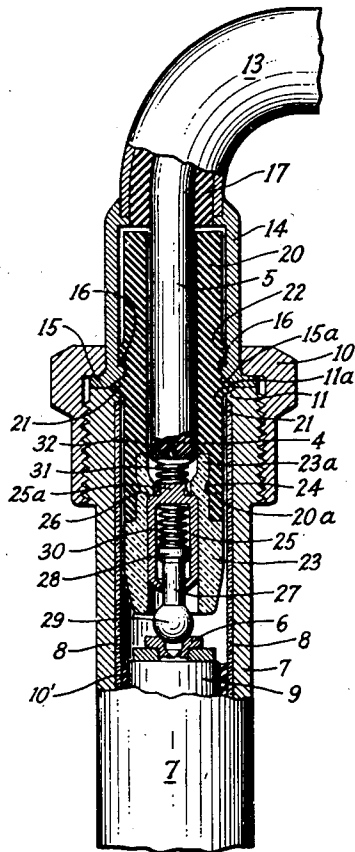


Fig. 1

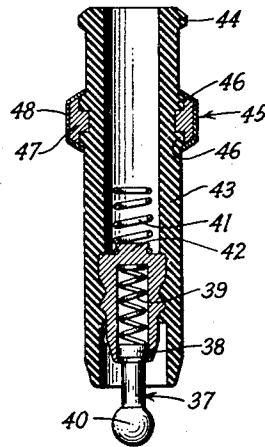


Fig. 3

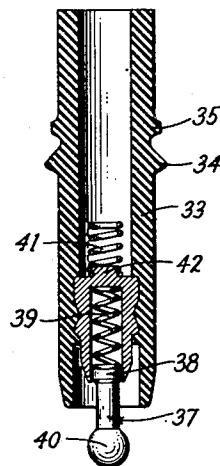


Fig. 2

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ELECTRICAL CONNECTING MEANS AND
RADIO SHIELDING MEANS THEREFOR

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1

This invention relates to electrical apparatus and more particularly to electrical connector means adapted for use in a radio-shielded ignition system of an internal combustion engine.

A solution to the problem of providing a well insulated, heat resistant, good electrical connection in a radio-shielded ignition system, for example between the central electrode of a spark plug and high tension cable for supplying current thereto, has been a major difficulty in the ignition art. Connectors insulated by a ceramic sleeve or other rigid material, while satisfactory in operation if properly assembled, introduce a considerable hazard during assembly and disassembly because of the close quarters in which these operations must be performed. The end of the high tension cable during removal or attachment is frequently subjected to a substantial pressure at right angles to its axis which forces the rigid connector against the internal walls of the spark plug and because of its rigidity subjects the insulation in the plug and on the connector to forces which tend to damage or break the same.

It is, accordingly, one object of the present invention to provide a novel means for electrically connecting radio-shielded terminals of an ignition system whereby assembly and disassembly of the connection can be effected in close quarters without introducing danger of breakage.

Another object is to provide a novel insulating member for an electrical conductor.

A further object is to provide a novel insulated terminal for a radio-shielded electrical conductor.

Still another object is the provision of novel means for mechanically and electrically connecting two high tension radio-shielded conductors, such as a high tension insulated cable and the central electrode of a spark plug of a radio-shielded ignition system.

A still further object is to provide novel connecting means of the above type which is so constructed as to facilitate assembly and protect the cable insulation from the deleterious effects of high temperatures, hot gases and moisture.

Another object is to provide insulating means for the connection between a supply cable and a spark plug, said means being constructed so as to cooperate in a novel manner with the radio shielding conduit for said conductor and the radio-shield for said 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, how-

2

ever, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention, reference for this latter purpose being primarily had to the appended claims.

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

Fig. 1 is a side elevation to an enlarged scale, partly in section and with parts broken away, of ignition apparatus embodying one form of the invention;

Fig. 2 is a sectional view of a modified embodiment of the insulated connector or terminal of Fig. 1; and,

Fig. 3 is a sectional view of still another type of insulated connector embodying the invention.

Referring to Fig. 1, the novel connecting means is illustrated, by way of example, as connecting conducting portion 4 of an insulated cable 5 to the central electrode 6 of a radio-shielded spark plug of the type generally used on aircraft engines, only the upper end of said plug being shown in the drawing. The spark plug comprises a radio-shielding barrel or socket 7 within which electrode 6 is housed and from which said electrode is insulated by a liner or tube 8 lining the interior of said socket and a sleeve 9 closely surrounding said electrode, said tube and sleeve being formed of any suitable insulating material, such as laminated sheet mica, ceramic or the like. A layer 10' of insulating compound, such as polymerized cashew-nut-shell oil, may fill the space between said tube and said sleeve to provide additional insulation. To receive a suitable coupling nut 10, the upper end of socket 7 is externally threaded and, in the form shown, the end of said socket is provided with an internal flange or projection 11 which is preferably bevelled at 11a.

Cable 5, which is adapted to deliver high tension current to the spark plug, is suitably encased in a metallic radio-shielding conduit of well-known construction comprising, for example, a rigid elbow 13 and a ferrule 14, said parts being secured together by any suitable means, such as soldering or brazing. An external flange 15 is formed at the lower end of ferrule 14 to cooperate with coupling nut 10 whereby said ferrule may be rigidly secured to the spark plug, a bevel 15a being preferably provided on the inner periphery of said flange to form an internal channel with bevel 11a of flange 11 when said ports 7 and 14 are secured end to end. An internal flange or shoulder 16 may be formed in the interior of ferrule 14 adjacent the lower end thereof, the same being

adapted for cooperation with the novel connector comprehended by the invention in a manner to appear hereinafter. The space within conduit elbow 13 around cable 5 may be filled with a suitable solid insulating material 17, such as polymerized cashew-nut-shell oil.

The novel means shown in Fig. 1 for connecting conducting portion 4 of cable 5 to central electrode 6 preferably comprise a sleeve 20 of suitable flexible, high heat-resistant, insulating material, such as rubber or "Neoprene," the upper portion of which slidably extends into ferrule 14 to receive the free end of cable 5, and the lower portion of which projects into socket 7. Formed intermediate the ends of said sleeve is an external flange 21, preferably V-shaped in section, which is adapted to be compressed in the internal channel formed by bevels 11a and 15a as the metallic ends of barrel 7 and ferrule 14 are pressed into sealing engagement. An excellent gas-tight seal is thus obtained at the connection between the spark plug and the cable and sleeve 20 is securely held in operative position. A second annular flange 22 is preferably formed a short distance above flange 21 and has an external diameter which is greater than the internal diameter of shoulder 16 whereby the end of the connector is removably held in ferrule 14 by the coalition between flange 22 and said shoulder. Flange 22 is adapted to support said connector on said shoulder so as to permit limited axial and free angular movement of the latter relative to said ferrule.

Rigidly secured to the lower end of sleeve 20 for providing greater heat resistance without destroying the flexibility of the terminal is a connector carrying member or tip 23 which conforms to the tubular shape of said sleeve, said member being molded or formed of suitable rigid insulating material, such as a ceramic, aluminum oxide ("Alfrax"), a synthetic resin such as "Melmec," or the like. To insure a good bond, the lower end 20a of sleeve 20 surrounds a substantial portion of the length of the upper portion 23a of said tip member and is molded or vulcanized in position thereon. These overlapping portions may be more securely bonded by being provided at their surfaces of contact with indentations or corrugations, an annular groove 24 being formed in end portion 23a for this purpose.

In order to conduct current from the conducting portion 4 of cable 5 to electrode 6 so as to insure good electrical contact between these members and eliminate arcing within the spark plug, suitable connector means are mounted in the lower end of insulating tube 20, 23. As shown, said connector comprises a cup-shaped metallic retainer or cylinder 25 which is rigidly secured in gas-tight sealing engagement with the bore of member 23, for example, by being cemented thereto. An internal shoulder 26 may be provided adjacent the upper end of tip 23 for engaging the upper end of said cylinder to predetermine the axial position of the latter relative to tube 20, 23. A contact 27, having an enlarged portion 28 slidably mounted in the bore of cylinder 25 and a ball-shaped contact portion 29 projecting from the lower end of said cylinder, is resiliently biased in the direction of the spark plug electrode by a suitable spring 30 disposed in the bore of the cylinder between the upper closed end of the latter and said enlarged portion. Contact 27 is of sufficient length to normally project a substantial distance below the lower end of tube 20, 23 and the latter is adapted when operatively mounted in a spark plug to have the lower blunt

or ball-shaped end thereof in contact with the central electrode 6 of the spark plug. As a result, when said tube is operatively mounted on a spark plug, spring 30 is compressed by the inward displacement of contact 27 and the pressure exerted thereby on said contact maintains member 29 in good electrical contact with electrode 6.

To connect conducting portion 4 of cable 5 to cylinder 25 and thereby complete the circuit from said cable to electrode 6, a spring 31 is mounted on the upper end of said cylinder and is adapted to be compressed into engagement with said conducting portion when said cable is operatively positioned in the bore of tube 20, 23, i. e., when terminal sleeve 20, 23 is installed in ferrule 14. An upwardly projecting boss or lug 25a is preferably formed at the upper end of said cylinder to securely mount said spring. It is to be understood that the spring 31, instead of being mounted on said lug, may be fixed in operative position by having a turn thereof pressed between the upper end of cylinder 25 and shoulder 26. When conductor 4 is formed of wire strands, it is preferable to insert a tack 32 into the lower end of cable 5 into said strands to expose a smooth contact surface on the end of the cable for engagement with the upper end of spring 31.

To operatively assemble the above-described parts so as to connect the radio-shielded cable to the spark plug, insulating tube 20, 23 carrying connector 25, 27 is first loosely secured in ferrule 14 by having flange 22 forced through the circular space surrounded by shoulder 16. Thereafter, the lower end of said tube is inserted into socket 7 of the spark plug and coupling nut 10 is threaded on the upper end of barrel 7 to force the flat annular surface of flanges 11 and 15 into engagement with each other. This presses flange 21 between bevels 11a and 15a and rigidly secures the connector unit in operative position. In this position contact 29 is pressed by spring 30 into yielding engagement with electrode 6 and spring 31 is in yielding contact with tack 32, thereby electrically connecting conductor 4 to said electrode. When removing the terminal plug from the spark plug or other socket, the same may be readily flexed without danger of damaging insulating sleeve 8. This flexibility is also desirable in making it possible to use a relatively long terminal where space is limited. The construction of this terminal also insures against any leakage of hot gases into the shielding conduit 13, 14 from the spark plug well which would destroy the insulation of cable 15.

A modification of the above-described connector is shown in Fig. 2 and differs from the embodiment of Fig. 1 by having an insulating tube or sleeve 33 which is entirely formed from a flexible, heat-resistant material, such as neoprene, rubber or the like. The external contour of tube 33 is like that of tube 20, 23, the same being provided with flanges 34 and 35 which are similar in shape to and perform the same function as flanges 21 and 22, respectively. A metallic cylinder, preferably closed at one end, is embedded in the lower end of tube 33, preferably by being molded therewith, and a contact 37 has piston portion 38 thereof slidably mounted in said cylinder. A spring 39 in said cylinder is adapted to engage said piston portion to bias ball-shaped portion 40 of said contact into yielding engagement with the spark plug electrode. A spring 41 is suitably mounted on the upper end of said cylinder, for example, on a lug 42 for yieldably engaging the conducting portion of a cable and thereby insuring a good connection

between the latter and the electrode engaged by contact 37.

Another embodiment of the connector unit is shown in Fig. 3 and comprises a tube 43 formed entirely of neoprene or other flexible heat-resisting insulating material, said tube, in the form illustrated, having the lower portion thereof constructed like tube 33 of Fig. 2, with the same electrical conducting means mounted therein. A flange 44 at the upper end of tube 43 serves the same function as flanges 22 and 35 of the previously described embodiments. In order to render the mechanical connection between the connector unit and the spark plug and the cable with which it is associated gas-tight, a novel flange-like means 45 is provided intermediate the ends of tube 43 for cooperation with the flanged lower end of the cable shielding ferrule and the flanged upper end of the spark plug or socket. As shown, said flange-like means comprises a pair of axially spaced external flanges or ridges 46 formed on said tube and a ring 47 of metal, such as steel, mounted on said flanges and anchored in the groove between said flanges. A layer 48, preferably of a soft metal, such as copper, is provided over the external surfaces of ring 47 and said flanges, for example, by being pressed thereon. The upper bevelled surface of flange means 45 is adapted to be engaged by the end of cable conduit ferrule 14, whereas the lower surface thereof is adapted for engagement with the end of the spark plug barrel or socket and forms separate gas-tight seals with said parts. Moreover, the compression to which said parts subject said flange means when operatively positioned relative thereto causes ring 47 to be pressed radially inward, further insuring a fluid-tight engagement between said ring and sleeve 43 and the overall fluid tightness of the joint so that gas cannot escape from the spark plug into the interior of the cable conduit. It is to be understood that this novel construction of the upper portion of the insulating sleeve of the above-described connector unit can be embodied in a unit having its lower portion constructed as shown in Fig. 1.

There is thus provided novel means for readily electrically connecting radio-shielded conductors of high tension electrical current so as to obtain a good electrical connection between said conductors and a good gas-tight mechanical connection between the shielding means for the conductors. The connecting means and the conductors connected thereby can be positioned in operative relation to each other in close quarters without danger of breakage despite misalignment and forcing of the parts during assembly. There is also provided novel, readily assembled means for connecting a high tension radio-shielded cable to the central electrode of a radio-shielded spark plug.

Although only three embodiments or modifications of the invention are illustrated and described, it is to be expressly understood that the same is not limited thereto. Various changes may be made in the design and arrangement of the parts illustrated without departing from the spirit and scope of the invention as will now be apparent 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 pair of axially aligned radio-shielding conduits, electrical conductors fixed in and insulated from

each of said conduits, the end of one of said conductors projecting from one of said conduits into the other of said conduits, means for securing said conduits together, a tube of insulating material removably mounted in one conduit and slidably extending into the other conduit, said tube being flexible and loosely surrounding and readily removable from the projecting end of the conductor, a rigid insulating tube secured to the flexible tube, and axially yieldable means carried by said rigid tube and sealing one end thereof, said yieldable means having abutting engagement with said conductors for electrically connecting the same.

2. In apparatus of the class described, a radio-shielding conduit, an electrical conductor fixed in and insulated from said conduit, said conductor projecting from said conduit, a tube of insulating material having one end extending into said conduit to receive said projecting end of the conductor, said tube being physically detached from said conductor and flexible, a rigid insulating tube secured to the flexible tube, yieldable means removably mounting said rigid tube in said conduit for limited axial and free angular movement relative thereto, and means embedded in the free end of said rigid tube, said last-named means being adapted for electrically connecting said conductor with conducting means outside said tube.

3. In apparatus for electrically connecting two conductors encased in radio-shielding conduits, an insulating tube consisting at least in part of a sleeve of flexible, heat-resistant insulating material for receiving the end of one of said conductors, a flange secured to said sleeve intermediate the ends thereof and adapted for sealing engagement with adjacent ends of said conduits, a second flange axially spaced from said first-named flange and formed on said flexible sleeve, said second flange being adapted for cooperation with an internal shoulder on one of said conduits to removably fix said sleeve in said conduit for free angular and limited axial movement relative thereto, and connector means mounted in said tube adjacent the end thereof remote from said second flange for carrying current from the conductor in said tube to the other of said conductors.

4. In apparatus comprising a pair of radio-shielded insulated conductors which have metallic shielding conduits adapted to be secured together, the combination therewith of means for electrically connecting said conductors to each other, said means comprising a sleeve of flexible insulating material adapted to receive one of said conductors and to extend into the conduit containing said conductor, said sleeve having a pair of axially spaced annular flanges formed intermediate the ends thereof, one of said flanges being adapted to cooperate with a shoulder in said last-named conduit to removably fix said sleeve therein for limited axial movement and for free angular movement relative thereto when said conduits are not connected together and the other of said flanges being adapted to cooperate with the connected ends of said conduits to form a fluid-tight seal therewith and rigidly position said sleeve relative thereto when said conduits are in assembled relation.

5. In apparatus comprising a pair of radio-shielded insulated conductors which have metallic shielding conduits adapted to be secured together, the combination therewith of means for electrically connecting said conductors to each

other, said means comprising a sleeve of flexible insulating material adapted to receive one of said conductors and to extend into the conduit containing said conductor, said sleeve having a pair of axially spaced annular flanges formed intermediate the ends thereof, one of said flanges being adapted to cooperate with means in said last-named conduit to removably fix said sleeve therein for limited axial movement and for free angular movement relative thereto when said conduits are not connected together and the other of said flanges being adapted to cooperate with the connected ends of said conduits to form a fluid-tight seal therewith and rigidly position said sleeve relative thereto when said conduits are in assembled relation, a tip member of rigid insulating material embedded in said sleeve, and connector means carried by said member.

6. In apparatus comprising a pair of radio-shielded insulated conductors which have metallic shielding conduits adapted to be secured together, the combination therewith of means for electrically connecting said conductors to each other, said means comprising a sleeve of flexible insulating material adapted to receive one of said conductors and to extend into the conduit containing said conductor, said sleeve having a pair of axially spaced annular flanges formed intermediate the ends thereof, one of said flanges being adapted to cooperate with means in said last-named conduit to removably fix said sleeve therein for limited axial movement and for free angular movement relative thereto when said conduits are not connected together and the other of said flanges being adapted to cooperate with the connected ends of said conduits to form a fluid-tight seal therewith and rigidly position said sleeve relative thereto when said conduits are in assembled relation, and connector means embedded in said sleeve to connect the conductor therein to the other conductor.

7. In apparatus for electrically connecting two conductors encased in radio-shielding conduits which may be secured together, a flexible insulating tube adapted to receive one of said conductors and extend into the conduit containing said conductor, a yieldable member on said tube adapted to cooperate with a shoulder in said conduit to removably mount said tube therein so as to permit limited axial and free angular movement of said tube relative to said last-named conduit when said conduits are not secured together, a flange on

said tube adapted to be compressed between the ends of said conduits to provide a fluid-tight seal for the joint between said conduits when the latter are secured together, and connector means sealing one end of said tube, said means comprising a yieldable contact in said tube adapted to connect with the conductor on the interior of said tube and a yieldable contact on the exterior of said tube adapted to connect with the other conductor.

8. In apparatus of the class described, a pair of radio shielding conduits, an electrical conductor fixed against movement in and insulated from each of said conduits, an end portion of one of said conductors projecting from one of said conduits into the other of said conduits, means for securing said conduits together, a tube of insulating material having one end slidably extending into said other conduit and having means thereon for removably securing the other end thereof in said one conduit, said tube being flexible and slidably receiving but physically disconnected from said projecting end portion of the conductor, a rigid insulating tube secured to the flexible tube, and axially yieldable means in said rigid tube for electrically connecting said conductors, said last-named means including means yieldably engaging each of said conductors and means molded into said rigid tube for sealing the bore thereof against the passage of gases there-through.

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