This invention relates to spark plugs and consists more particularly in new and useful improvements in terminal connectors for use with spark plugs of the type employed in aircraft motors.

These spark plugs usually include an annular spark plug shell containing a center electrode which is inset form the upper end of the shell with its upper extremity serving as the point of contact for a coil spring connected to the end of an electric wire or cable. Generally, the end of the cable is skinned so as to protrude into a hole in a rivet or grommet which in turn is electrically connected to one end of the coil spring, an insulating sleeve being provided around the end of the cable and supporting the grommet and spring so that the whole unit can be inserted into the upper end of the spark plug shell with the coil spring in electrical contact with the spark plug electrode.

A number of objectionable features or disadvantages have been encountered in the use of conventional connectors with spark plugs of the type here involved. One of the most troublesome of these disadvantages has been the failure to make intimate contact with the stranded wire of the high tension cable, due to the methods employed in connecting the skinned wire to the eyelet of the connector. Another disadvantage has resulted from the use of a conventional coil spring as the contact member, due to the tendency of such a spring to catch on the edge of the spark plug when removing it from the spark plug well, thus causing the spring to stretch beyond its elastic limit which requires replacement of the complete unit. Ordinarily these springs are formed of resilient wire of circular cross-section.

Still another disadvantage of conventional equipment includes the necessity of including a spring, lies in the failure of the spring to carry sufficient current and its tendency to wear under the vibration of use. A coil spring frequently rubs on the side walls in the retaining recess of the connector and occasionally wears in two, thus requiring replacement.

It is therefore the primary object of the present invention to provide a connector assembly for the high tension cables employed in shielded spark plugs of the aircraft type, which overcomes all of these disadvantages noted in conventional equipment. To this end, we have provided a connector assembly including an insulator sleeve member having a transverse web or bridge extending across the lower portion thereof in upwardly spaced relation from its lower end, dividing the interior of the sleeve into a main cable receiving compartment and a contact cup receiving recess, means being provided for retaining the contact cup in said recess and establishing a maximum effective electrical contact between the stranded wire of the cable, the connecting eyelet, and the contact cup.

Another object of the invention resides in the use of an internally wound volute spring formed of a flat resilient metal strip, as the actual contact member, in place of the conventional circular coil spring. One of the advantages of a volute spring for this use lies in the increased electrical contact available between the component parts.

Furthermore as the volute spring is compressed, a progressively greater area of contact is made between the cup and the terminal of the spark plug which eliminates heating by poor electrical contact which in some instances has burned the round helical spring in two.

Still another object of the invention is to provide an improved means of connecting the skinned end of the wire to the connecting eyelet by crimping the latter around the wire.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like character designate similar parts throughout the several views,

Figure 1 is an elevational view partly broken away, showing the relationship of the connector, to the spark plug and its central electrode.

Figure 2 is an exploded view of the assembly, showing the sleeve, cup and eyelet in section, and

Figure 3 is an enlarged transverse sectional view showing the well portion of a spark plug insulator with the connector assembly and cable in place, the cable being shown in elevation, and the spark plug shell omitted.

In the drawing, referring first to Figure 1, the conventional aircraft spark plug is generally represented by the numeral 1 and includes the usual shell 2 with its insulator 3a, forming a cable connecting well 6 for housing the center electrode 7 of the spark plug. The upper end of the shell 2 is reduced and externally threaded as at 8 to receive the coupling nut 9 on one end of elbow 10 which receives the high tension cable to be connected to the plug. The opposite end of the elbow 10 is provided with a similar connecting collar 11, by means of which it is connected to a conventional ground shielding 12 surrounding the cable. The cable consists of a central conductor 13 enclosed in an insulating sheath 14. In this figure, the coupling nut 9 is shown disengaged from the threads 8, to more clearly illustrate the relationship of the connector assembly to be described.

The component parts of the connector assembly will best be seen from Figure 2. A cylindrical sleeve 15 composed of sheet steel, aluminum, teflon or other suitable material, forms the main supporting element of the connector assembly. Adjacent its lower end the interior of the sleeve 15 is provided with a transverse partition or web member 16, formed integrally therewith and defining within the sleeve a cable receiving compartment 17, open at its upper end, and a connector cup receiving recess 18 opening at the lower end of the sleeve. The partition 16 is provided with a central aperture 19 adapted to receive the upper end of a grommet or eyelet generally indicated by the numeral 20, for securing the inverted connector cup 21 in the recess 18 and embracing the skinned end 13a of the high tension wire 13 in intimate electrical contact as will later appear.

The connector cup 21 is of a diameter to fit closely within the recess 18 and its transverse or base wall is provided with an opening 22 adapted to register with the opening 19 in the partition 16 when the inverted cup is inserted in the recess 18. The annular side wall of the cup 21 may extend axially a slight distance beyond the annular bounding wall of the recess 18, with its edge turned inwardly as at 23 to form an annular lip for retaining the volute spring 24 in place as will be seen from Figure 3.

The eyelet or grommet 20 comprises a tubular body portion, one end 25 of which is of a diameter to fit through the opening 22 in the cup 21 and the registering opening 19 in the partition 16, its bore 26 being of a diameter to receive the skinned end 13a of the high-
The grommet 20 is provided with a radial flange 27, spaced a sufficient distance from the extremity of the end portion 25, to provide a shank which projects slightly beyond the inner face of the partition 16 when the flange 27 is in abutment with the under side of the base wall of cup 21 in the assembled positions of these components, so as to permit the projecting extremity 25 to be flared outwardly around the edges of opening 19, in the upper core of a rivet. A predetermined area of the tubular grommet, between the flange 27 and the opposite end of the grommet is of reduced thickness as at 28 to facilitate the crimping of the skinned end 13a of the wire 13 when the device is assembled.

The volute spring element 24 is formed of a flat strip of an annealed resilient metal, preferably inconel, and is internally wound clockwise or counterclockwise from its top convolution 29 so as to form a downwardly projecting spiral, maintaining a constant tendency to expand both radially and axially from a contracted coiled condition. In other words, when the reduced lower convolution 30 is turned in the same direction it is wound and simultaneously forced upwardly, the spring retracts to itself within the confines of the upper convolution 29 which in turn is contracted to a sufficiently reduced diameter to fit within the cup 21. Upon release of the spring it expands radially until the periphery of the top convolution 29 engages the inner wall of the cup, the lip 23 of the cup engaging the lower edge of the convolution 29 and retaining the same in place as the remaining convolutions expand and project axially of the spring.

In the assembly of the connector, the annular flange 27 of the eyelet is preferably although not necessarily welded to the under side of the base wall of the cup 21 to insure intimate electrical contact between the cup and eyelet which is most important for this assembly. The cup 21 is then inserted in the bottom recess 18 of the sleeve 15 with its transverse base wall in close contact with the under side of the web or partition 16 and the opening 22 in the cup, registering with the opening 19 in the web. The upper end 25 of the long eyelet 20 projects through registering openings 19 and 22 and its extremity is flared or crimped outwardly over the top surface of the web 16 around the opening 19.

The insulating sheath is then removed from the high tension cable 13 as at 13a, leaving a skinned area of a length equal to the length of the cramped rivet. The stranded wire 13a is then pushed into the bore 26 of the rivet as the cable end is inserted into the upper compartment 17 of the sleeve 15. The thinned section 28 of the eyelet is then crushed along the stranded wires as at 28a in Figure 3, holding them in intimate electrical contact with the eyelet. This operation may be accomplished by the use of any suitable crimping tool or pliers, the jaws of which are inserted within the open end of the cup 21, a force being used in the crushing operation which will hold against a specified pull on the cable. Thus, a positive solderless connection is maintained which will not be affected by heat, high current impulses, ozone or the products of ozone and moisture.

Next, the volute spring 24 is turned manually in the same direction as it is wound as previously explained, and its contracted top convolution 29 is snapped into the cup 21 where it is retained against axial movement, by the inturnd lip 23. Upon release, convolutions of the spring expand both radially and axially and maintain a constant downward tension on the lower or contract convolution 30. The assembled connector and cable is then inserted in the well 6 of the spark plug 4, until the lower convolution 30 of the volute spring 24 contacts the upper end of the center electrode 7 which projects upwardly a slight distance within the well 6, whereupon, the terminal nut 9 is screwed on to the threads 8 on the shell 5 to retain the connector in place.

It will be noted that as the volute spring 24 is compressed against the contact element of center electrode 7, a progressively greater area of contact is made between the cup and the terminal of the spark plug, thus eliminating heating by poor electrical contact which as before stated, in some cases has been responsible for electrical burnout or helical spring in two. Furthermore, the area of the flat volute spring is greater than the conventional coil spring and as a result, will carry more current.

This will thus be seen that the present invention is far more practical, economical and efficient than those previously used. The use of the volute spring eliminates the tendency of rubbing on the side walls of the conductor and therefore the spring cannot wear through. The volute spring can be easily placed in or removed from the cup by a simple action of twisting the spring in the direction it is wound as the spring is pushed into the cup which causes the coils to wind tightly and the diameter to become smaller. However, once in the cup, the spring unwinds to its normal diameter with the result that there is no danger of the spring falling out.

Furthermore, by crimping the long eyelet around the lead wires, more area of contact is obtained, giving better electrical contact than that provided by bending the strands of lead wire over the standard short eyelet. At high energies and current, bent over wires become rough due to poor contact and unless exceptional care is taken in bending the conductors strands of the high tension cable around the end of the eyelets, these strands will interfere with the spring action. This disadvantage is completely eliminated by the present invention, involving the wire cramped within the eyelet.

A further advantage lies in the possible salvage value, as the volute spring can be replaced without separating the combination cup and eyelet from the lead assembly, whereas, when the conventional coil spring is used the assembly is made inoperative when the spring is worn out and the complete unit must be destroyed. When the combination cup and eyelet assembly is a permanent part of the sleeve as in the present invention, the volute spring can be replaced without separating the sleeve from the lead assembly, making it unnecessary to scrap the sleeve.

As from the foregoing it is believed that the invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details disclosed without departing from the spirit of the invention as set forth in the following claims.

Claims

1. A sparkplug terminal connector, comprising an insulating sleeve adapted to receive an electrical cable through one end, a transverse web spaced inwardly from the opposite end of said sleeve and defining therein an annular recess, an insulated metal cup in said recess with its base wall abutting the under side of said web, registering openings in the central portions of said base wall and web to receive the conductor of said cable, common means cooperating with said web for retaining said cup in said recess and establishing fixed electrical contact between the cup and said conductor, said common means comprising an elongated eyelet, having a substantially centrally located radial flange adapted to abut the under side of the base wall of said cup when one end is inserted through said registering openings, the extremity of the inserted end of said eyelet being outwardly cramped over said web to form a retaining flange, binding the cup within the recess in tight engagement with said web, said radial flange maintaining electrical contact between said eyelet and cup, the bore of said eyelet receiving the end of the conductor of said cable in electrical contact therewith, and a partially radially compressed volute spring in said cup and retained in electrical contact therewith, solely by its own radial expanding tension, with its diminishing convolutions projecting axially from said cup and terminating in a contact end for electrical engagement with a spark plug center electrode.

2. A spark plug terminal connector as claimed in claim...
5. A terminal connector as claimed in claim 4 wherein said eyelet is crimped around said conducting wires, and is provided with a radial flange welded to the base wall of said cup, whereby intimate electrical contact is maintained between said conducting wires, eyelet and cup.

6. A spark plug terminal connector comprising an insulating sleeve adapted to receive an electric cable through one end, an inverted metal cup inserted in the opposite end of said sleeve, means securing said cup in said sleeve in electrical contact with the conductor of said cable, and a partially radially contracted, internally wound, volute spring formed of a flat resilient metal strip, readily insertable and removable with respect to said cup and adapted to be retained in electrical contact with said cup, solely by its own radial expanding tension, with its diminishing convolutions projecting axially from said cup and terminating in a contact end for electrical engagement with a spark plug center electrode.

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5. wherein said radial flange is welded to the base wall of said cup.

3. A spark plug terminal connector as claimed in claim 1 wherein said eyelet is crimped around said conductor to maintain electrical contact.

4. A terminal connector for use with a spark plug of the type including a central electrode housed within an annular open-ended insulated shell, comprising an insulating sleeve adapted to be inserted within said insulated shell, a transverse partition defining in said sleeve a cable receiving compartment open at one end and a coaxial connector cup receiving recess opening at the opposite end of said sleeve, an inverted metal connector cup in said lastnamed recess, registering openings in the base wall of said cup and said partition, a tubular eyelet, one end of which is insertable in said registering openings in electrical contact with said cup, means associated with said eyelet and partition for securing said cup in said recess, an electric cable terminating at one end within said compartment and having its conducting wires projecting into the bore of said eyelet, means establishing electrical contact between said wires and eyelet, and a volute spring, one end of which is insertable in said cup in electrical contact therewith, its diminishing convolutions being projected axially from said cup under spring tension and terminating in a contact end adapted to engage and establish electrical contact with the center electrode of said spark plug, in said insulated shell.