

[54] **ENGINE IGNITER TIP CONNECTOR WITH COMPENSATION FOR DIFFERENTIAL THERMAL EXPANSION**

[75] Inventor: **Thomas Parker Haselton**, Lynn, Mass.

[73] Assignee: **General Electric Company**, Wilmington, Mass.

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[58] Field of Search ..... **317/79, 96, 97; 174/13, 174/69, 86, 94 R, 99 E; 338/316; 219/384, 553**

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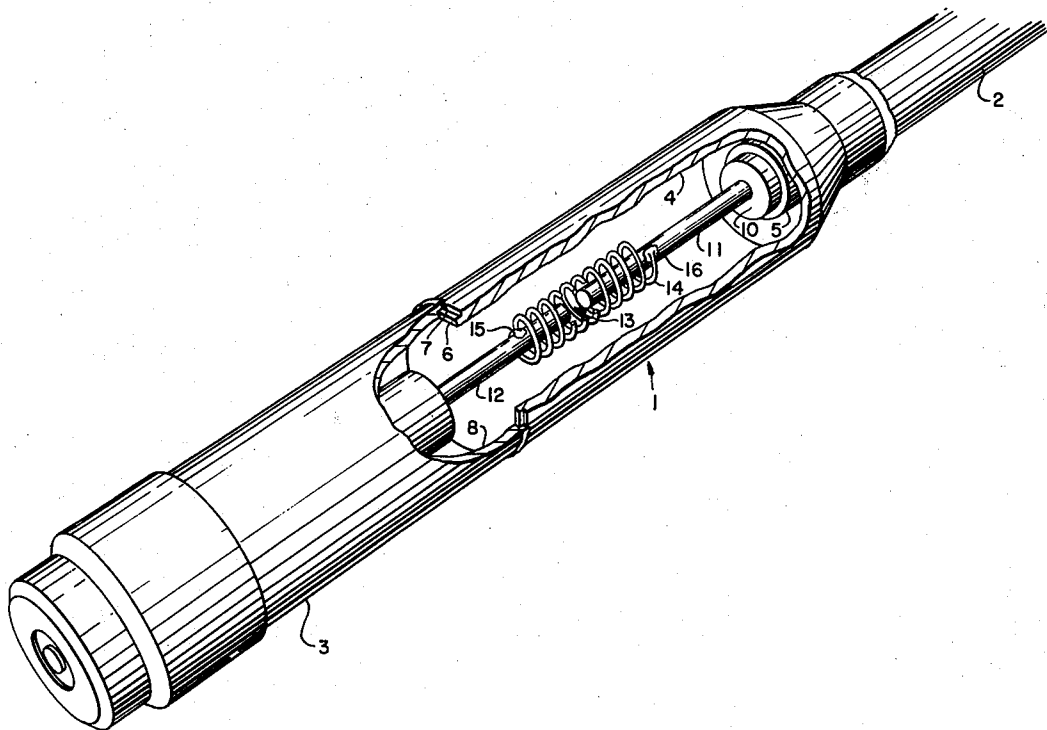
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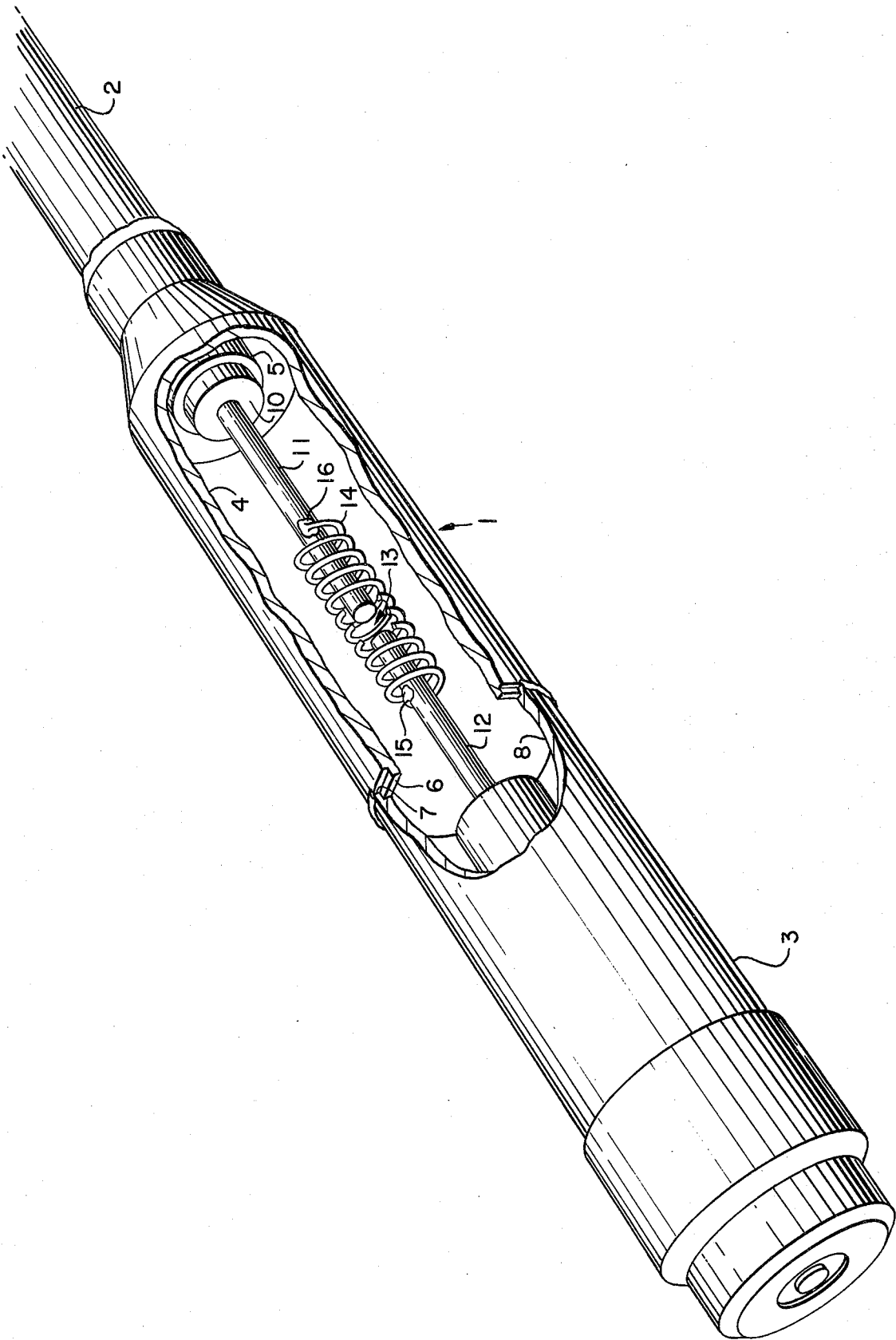
*Primary Examiner*—Volodymyr Y. Mayewsky

[57] **ABSTRACT**

A thermally compensated connector for coupling a lead cable to the tip of a jet engine igniter is described which is not subject to deterioration due to differential thermal expansion between the outer and inner members of the connector. The arrangement contemplated is one in which the interior lead wire and the igniter tip electrode which are positioned in a connector housing are spaced apart by an amount which is greater than the expected differential thermal expansion between the outer housing and these interior components. The lead wire and the electrode are mechanically and electrically connected by a spring, preferably a coil spring which has the ability to act over long axial changes in dimension with small stress on the material and thus accommodates the differential expansion without any permanent deformation.

**1 Claim, 1 Drawing Figure**





## ENGINE IGNITER TIP CONNECTOR WITH COMPENSATION FOR DIFFERENTIAL THERMAL EXPANSION

The instant invention relates to an electrical connector, and more particularly, to an electrical connector for a jet engine igniter which is compensated for differential thermal expansion of the connector components.

The customary arrangement for igniting or "lighting off" a jet engine involves a spark plug or igniter which is connected through a suitable connector to a cable which transmits the firing impulses to the igniter. The connector for the igniter and cable usually includes a stainless steel shell or housing which is connected to the rigid outer sheath of the cable and to the igniter housing. Electrical contact between the cable lead wire and the igniter electrode is achieved by welding the junction between the lead wire and the electrode.

A connector of this type for an aircraft igniter is subject to wide temperature variations as the engine is alternately ignited and shut down. Before starting, the igniter and the connector are both at a temperature which is the ambient temperature of the fuel and air mixture in which the igniter and connector are immersed. When the engine is "lit off," the environment temperature rises rapidly to an ignition temperature of approximately 3600°F. The outer, stainless steel shell of the connector which is directly exposed to this high temperature expands rapidly. The interior lead wire and the igniter electrode, however, are still relatively cool. The shell therefore, expands more rapidly than the interior wires and electrode, elongating the wires by as much as 0.001 to 0.005 of an inch in a typical connector for an engine igniter. When the engine shuts down, the outer shell cools more rapidly than the interior wire and electrode and as a result, the wire and electrode are compressed. As the engine starts-up and shuts-down, the welded joint between the electrode and the cable lead wire undergoes many compressions and expansions.

Initially, the welded wire and electrode are deformed into an S-shaped configuration and ultimately breaks at or adjacent to the weld. Once the wire and electrode connection breaks, then arcing between the two begins until the connector is destroyed. Thus, it is not uncommon for connectors for the igniter of a jet engine to last only 100 to 150 hours of engine operation at which time, the engine has to be shut down and the connectors replaced.

In order to overcome some of the problems due to differential thermal expansion in connectors in which the electrode and the cable lead wire are welded or otherwise rigidly fastened together, a connector construction was devised in which the electrical contact is made through a slip joint. That is, the lead wire and electrode are not rigidly connected but are surrounded by a springlike conducting sleeve. The lead wire is free to move within the sleeve while maintaining electrical contact with the sleeve. While this is an improvement in a number of ways, it has been found that it too has shortcomings. That is, it was found that as the wire moves within the slip joint, localized spot welding takes place along the surrounding sleeve because of the current flow between the lead wire and the slip joint sleeve. Eventually, there is sufficient spot welding so that the lead wire becomes solidly welded to the sleeve. As soon as a solid connection is established, the entire arrangement is then subject to the mechanical stresses

due to differential thermal expansion in that the expansion and contraction cause the spot welds to break. This deterioration of the surfaces of the sleeve and the lead wire results in poor electrical contact and increase the subsequent spot welding until a spot weld which is strong enough to prevent relative motion results. The action is now equivalent to the original direct welded design and subject to the same failure mode.

It is therefore a primary objective of the instant invention to provide a connector for a jet engine igniter which is not susceptible to damage due to differential thermal expansion between the outer and inner members of the connector.

Another objective of the invention is to provide a connector for a jet engine igniter which accommodates differential expansion without taking a permanent deformation of the connector elements.

Yet a further objective of the invention is to provide a high temperature connector for a jet engine igniter in which the elements to be connected are electrically and mechanically connected by an element which is capable of acting over long axial changes in dimension with minimal stresses on the material.

Other objectives and advantages of the invention will become apparent as the description thereof proceeds.

The various advantages and objectives of the invention may be realized by providing a connector in which the igniter electrode and lead wire are connected by a coil spring which maintains a gap between the wire and electrode which exceeds the differential expansion which the connector normally undergoes during thermal cycling of the connector by the jet engine. As the connector undergoes thermal differential expansion and the electrode and lead wires are pulled apart and brought together again, the spring absorbs this mechanical change in axial dimension without stressing the material of the spring to any great extent. Consequently, this construction eliminates problems of wire breakage and welding of the contacts, simplifies manufacture of the device by utilizing a simple spring, and greatly enhances the reliability and operational characteristics of the connector.

The novel features which are characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with other objectives and advantages, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

The sole drawing is a partially cutaway, partial perspective of an igniter tip connector.

As shown in FIG. 1, a coaxial connector illustrated generally at 1 establishes a mechanical and electrical connection between lead cable 2 and igniter 3. Connector 1 consists of an outer stainless steel housing 4 which is fastened at the ends, as by welding or the like, to an outer, rigid cable sheath 5 and the outer shell 8 of the igniter. Cable 2 which is of coaxial construction includes a cylinder of insulating material 10 which supports a central lead wire 11 which is coaxial with cable sheath 5.

The ends of lead wire 11 and igniter electrode 12 extend into connector housing 4 and are separated by a gap 13 which is greater than the maximum differential thermal expansion between the outer housing and the interior components of the connector so that the lead wire and electrode are never in direct physical contact.

Surrounding lead wire 10 and electrode 4 is a spring member 14 shown in the form of a coil which connects the lead wire to the electrode. One end of spring 14 is welded at 15 to lead wire 11 and the other end is welded at 16 to electrode 12. The inner diameter of spring 14 is greater than the outer diameter of the lead wire and electrode so that the lead wire and electrodes extend into the coil spring and the spring is free to move axially with respect thereto without touching or otherwise sliding against the lead wire and electrodes. Spring 14 may be any suitably stiff, compression spring which can move axially as the connector elements expand and contract with thermal cycling. Spring 14 expands or contracts correspondingly in an axial direction and absorbs the axial movements without stressing the spring material to any great extent. Simultaneously, because of the absorption of the axial movement by the spring, no great stress is applied to the welds 15 and 16 which connect the lead wire and electrode to spring 14. Typically, the spring may be made of ingot iron which is commercially pure iron and will have the proper stiffness and rigidity to absorb axial displacement of the components due to differential thermal expansion. The dimensions of the spring and the stiffness of the spring will depend on the application and hence, will vary with the particular application. Thus, for any given situation, the thermal range through which the connector is cycled, the material of the outer shells and the electrodes and lead wires, will determine the expansion and contraction which these elements undergo. The requisite stiffness of the spring can then be determined and the spring fabricated for the particular application.

It will be apparent from the previous description that the arrangement is simple in nature by providing a connection between the lead wire and electrode of an igniter through means of a spring which compresses and expands with the differential thermal expansion of the elements and absorbs what may be fairly large axial motions quite easily without stressing the material of the spring excessively. In this fashion, the connector can undergo many, many more thermal cycles than are now possible without in any way affecting the integrity of the connector and the electrical continuity between the lead cable wire and the igniter electrode. As a result, the life of the connector is substantially greater than for connectors previously known and failures of

the connectors and replacement with the concomitant requirement for taking the engine out of operation is substantially reduced.

While a coil spring has been shown as the preferred embodiment for mechanical and electrically connecting the lead wire in the electrode, it will be apparent to those skilled in the art that the invention is not limited to a coil spring but will encompass any spring which can absorb large axial movements without overly stressing the material during thermal cycling which produces large differential thermal expansions between the outer and inner members of the connector.

While a particular embodiment of this invention has been shown and described above, it will, of course, be understood that the invention is not limited thereto since many modifications thereof may be made. It is contemplated by the appended claims to cover any such modifications which fall within the true spirit and scope of this invention.

What is claimed as new and desired to be secured by Letters Patent of the U.S. is:

1. In an igniter tip connector, the combination comprising:

- a. a metallic outer shell adapted to engage the metallic housing of an igniter at one end thereof and the metallic sheath of a cable at the other end thereof,
- b. an igniter electrode extending into said metallic outer shell, said igniter electrode being mounted in insulated relationship with the said igniter housing and the said metallic outer shell,
- c. a lead wire from said cable extending into said metallic outer shell, said lead wire being mounted in electrically insulated relationship with said metallic outer shell and the said metallic sheath of the cable, the ends of said electrode and said lead wire being separated by a gap which is greater than the maximum differential, thermal expansion between said metallic outer shell and said wire and electrode,
- d. axially extensible coil spring means connected between said lead wire and said electrode extending partially into said coil spring which has a diameter larger than the diameters of said wire and said electrode, whereby said spring means absorbs any differential expansion.

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