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M. F. WALTHER ETAL

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ELECTROMAGNETIC RADIATION PROOF PLUG AND RECEPTACLE

Filed Feb. 11, 1965

3 Sheets-Sheet 1

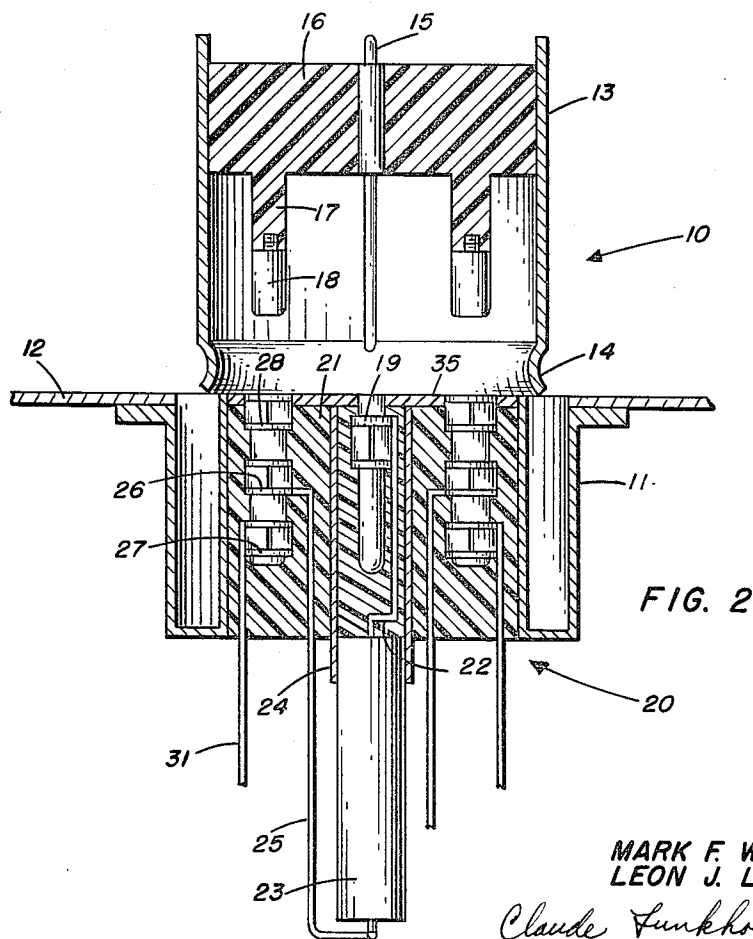
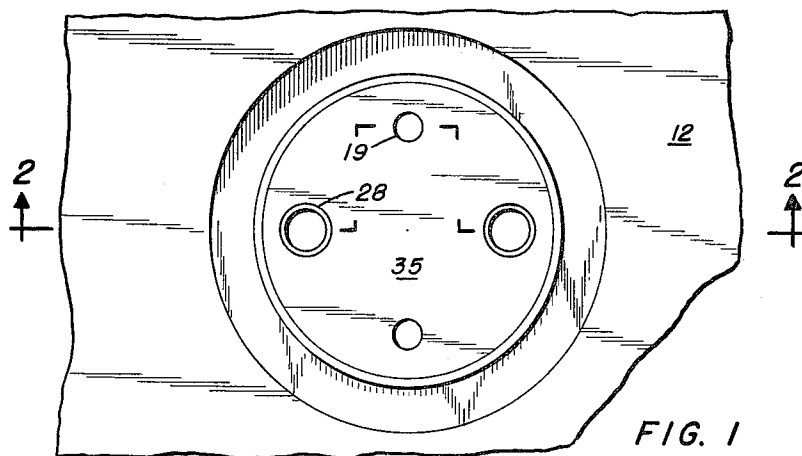


FIG. 2

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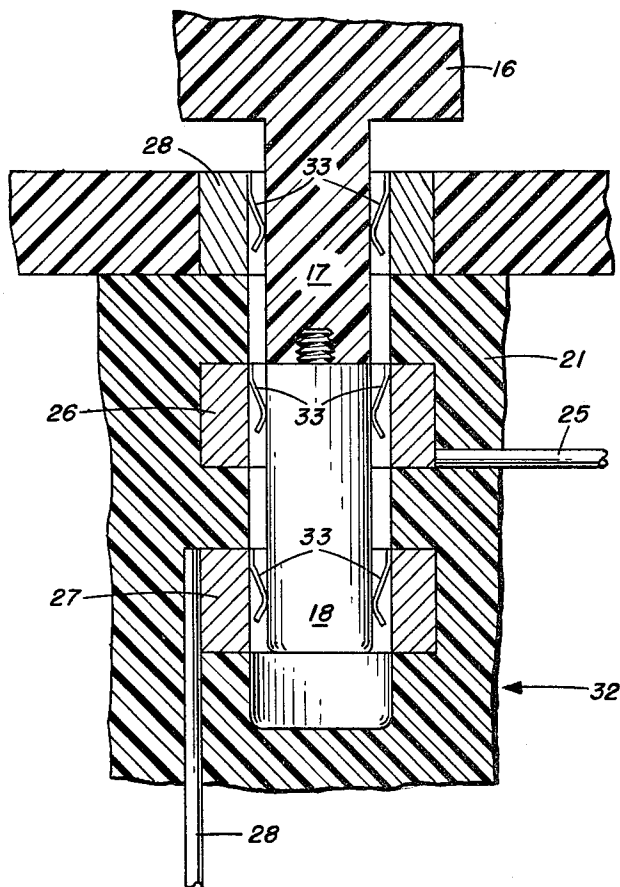
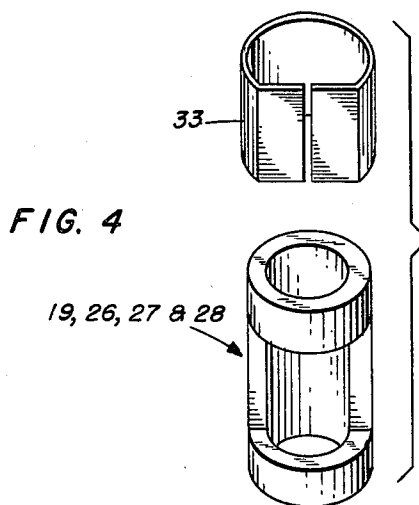


FIG. 3



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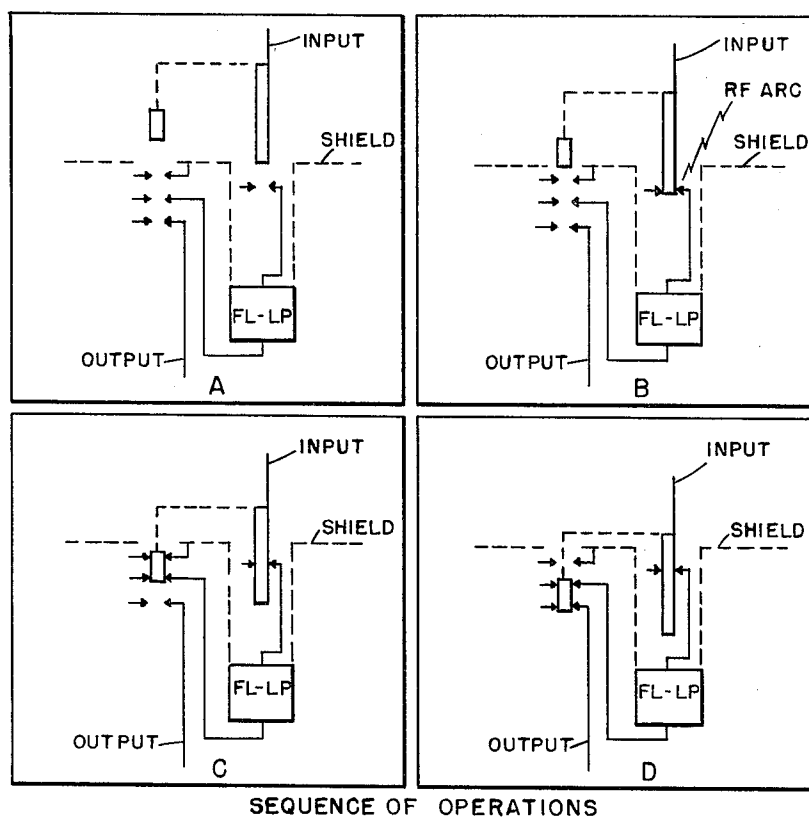


FIG. 5

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ELECTROMAGNETIC RADIATION PROOF PLUG AND RECEPTACLE

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as represented by the Secretary of the Navy
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5 Claims. (Cl. 200—51.12)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to electric cable connectors and more particularly to an electric cable connector, for use in high energy fields, that provides elimination of transient low frequency energy generated by radio frequency arcing whenever making or breaking separate electrical contacts.

Modern weapons and missiles utilize solid fuels as propellants in many applications. Solid fuel missile units usually have a propellant, a combustion chamber and igniter components. The propellant may be one of any number of suitable chemical compounds presently available. The construction of solid fuel units is such that the propellant of a solid fuel rocket is usually stored and burned in the combustion chamber. An igniter is also positioned in the combustion chamber unit which usually takes the form of a small charge of an explosive powder that can easily be ignited by a spark discharge or a hot wire which provides sufficient temperature to ignite the main rocket propellant charge. In operation, a missile is attached to a launching apparatus which may be mounted to either land, sea or air vehicles and is ignited by electrically energizing the igniter or igniter squib assembly through suitable control circuitry. Once ignition of the main propellant charge starts, the igniter squib assembly is usually blown out of the combustion chamber by the burning of the solid fuel propellant which will burn continuously until the propellant supply is exhausted.

The use of electro-explosive or igniter squib assemblies in areas which have high energy fields present creates a serious problem, since, if sufficient energy is picked up by the electrical firing circuit associated with the squib, a premature firing may occur. A premature ignition could cause serious damage to associated weapons or injury and loss of life to personnel handling the missiles. Therefore, it would be desirable to have a simple, foolproof and reliable apparatus or technique that would positively preclude the possibility of premature ignition under any circumstances.

Exhaustive work has been done in recent years to preclude hazards of electro-magnetic radiation to weapons and ammunition used by the military. Most prior art apparatus uses the principle of frequency discrimination; that is, they incorporate filter circuitry that rejects or dissipates radio frequency energy and passes the direct current or low frequency firing signal. In order for the frequency discriminator technique to accomplish satisfactory rejection or attenuation, it is necessary for the firing signal to be unique from any spurious signal introduced at the input of the frequency discriminator. Usually, units using the frequency discriminator technique work well in high energy fields except when the missile is connected to the launching apparatus. During connection of two separate units, which are in the area of high radio frequency energy, arcs may be created due to the difference of potential between the separate units, and this radio frequency arcing may generate frequencies below the cut-off frequency of the frequency discriminator of sufficient current magnitude to energize the igniter. Because of the ineffectiveness of frequency discriminators in arcing environments, it would be desirable to have an

apparatus or technique that would not be susceptible to radio frequency arcing and which would be simple and reliable in operation.

The instant apparatus utilizes the advantages gained by the use of a frequency discriminator filter and eliminates its disadvantages. This is accomplished by providing a unique connector arrangement that prevents radio frequency arcing energy from flowing through the firing circuitry during connecting procedure. The connector provides a simple, foolproof switching technique that provides the proper sequence of switching operations for the safest operation without the necessity of multiple separate switching operations. All of the switching sequence takes place at the proper times as the male and female connector are mated or unmated.

An object of the present invention is the provision of an improved electrical connector combination that may be used in high energy fields.

Still another object of the present invention is to provide an improved electrical connector that is simple and inexpensive.

Another object of the present invention is the provision of an electrical connector combination that suppresses and eliminates energy transfer to external circuitry.

A further object of the present invention is to provide a protective device which permits safe, reliable and rapid connection to external circuitry in high energy fields.

Still another object of the present invention is to provide an electrical switching sequence as the male portion of the electrical connector is mated with the female portion.

Another object of the present invention is the provision of an electrical device that permits electro-explosive devices to be connected to external circuitry without danger of detonating.

Still another object of the present invention is the provision of a technique of connecting missiles having electro-explosive devices to fire and control circuitry whenever the missile is in a high energy radio frequency field.

A further object of the present invention is the provision of an electrical connector that is easily and readily installed in any missile circuitry that has an electro-explosive device.

Still another object of the present invention is the provision of an improved electrical connector that is adaptable for use in aircraft missile circuitry.

Another object of the present invention is the provision of a foolproof switching sequence as the electrical connector is plugged into external electrical circuitry.

Another object of the present invention is the provision of an electrical connector that permits safe operation and connection to an electro-explosive device in high energy radio field.

Another object of the present invention is the provision of an electrical connector apparatus that will not be susceptible to passage of audio frequency or direct current arc energy output.

A further object of the present invention is the provision of an electrical connector that has a switching provision for grounding the energy that may be stored in filtering networks and other attenuating devices prior to initiation and completion of the firing circuit of an electro-explosive device.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. 1 shows a top view of the connector and the location of its respective electrical pins.

FIG. 2 shows a cross-section of male and female portions of the connector body.

FIG. 3 shows a detail of the short electrical pin of the male connector as it mates with the female portion.

FIG. 4 illustrates the pin clip of the connector.

FIG. 5 illustrates the sequential switching as the male and female portions are mated and unmated.

With reference to FIG. 1, there is illustrated a top view of the female connector which is shown in more detail in FIG. 2. The view is taken looking toward the receptacle end of the female connector, and it shows the location of the short secondary pin 18 with respect to the relatively long thin main pin 15. These pins are shown as having their centers on the same radius and positioned 90° from one another. Although this pin position configuration is shown, it is to be understood that the disclosure is not limited to this particular pin configuration and other configurations could be used with the structure of the connector when feasible.

FIG. 2 shows a sectioned view of the male portion 10 and the female portion 20 in their unmated position. The connector portion 10 is entirely enclosed by a solid metal container 13 which effectively provides a radio frequency shield for the main pin 15 and the short secondary pin 18. Positioned inside this generally cylindrical shaped container 13 is an insulating plug member 16. This insulating member may be fastened to the interior wall of the shield member 13 by any suitable means. The cylindrical plug member 16 has positioned therein and protruding out of a main electrical pin 15 and short secondary pins designated as 17 and 18. The secondary pin has a cylindrical protrusion from the main plug member 16 and is designated as 17. Attached to the member 17 is a metal pin 18. This pin 18 is shown as threaded to the member 17, but it may be fastened by any other suitable means. The insulating plug member 16 is positioned far enough back from the peripheral edge of shield 13 so that an annular chamber is formed for the main pin 15 and the short secondary pin 18. By this construction, these pins are not only shielded from radio frequency energy, but are physically protected. Thus, the main pin as shown does not extend any further than the inner end of the slotted fingers at 14.

The shield member 13 which first comes in contact with the female member 20 has formed on its peripheral edge a radial portion 14. This portion is serrated along the peripheral edge (not shown) so that a multiplicity of fingers are formed around the connector and provide a spring contact against the inner shield wall. On the other side or the cable end of the male portion 10, there is formed an annular chamber by the interior wall of the shield 13 and one edge of the insulating plug 16. This construction is necessary so that the cable shield may be securely soldered to the interior wall of the radio frequency member 13 in order to provide an unbroken radio frequency shield for the pin 15. The cable is not shown since it was not considered as necessary for clarifying the cable connector.

The female portion of the conductor is contained in a generally cylindrical shaped radio frequency shield 11. Shield 11 forms a ring-like chamber around the outer periphery of the female connector portion 20. Shield 11 is fastened electrically and mechanically to the weapon skin indicated generally as numeral 12. The inner wall of the ring-like chamber is also electrically and mechanically connected to a metallic member 35 which encloses the top of the female connector. This sort of arrangement provides a radio frequency shield completely about the female pin portions 19, 26, 27 and 28, respectively. Positioned on the interior wall of the ring-like chamber is an insulating cylindrical plug 21. This plug has positioned therein members 19, 26, 27 and 28, respectively, which co-act with the male members 15 and 18, respectively. The female electrical connection 19 is positioned inside a cylindrical metallic chamber 24. This chamber is electrically and physically attached to the member 35 and to cylindrical frequency discriminator filter unit 23. An

electrical lead 25 soldered to element 19 passes through the insulation of plug portion 21 and connects the input of the frequency discriminator unit.

An output lead 25 electrically connects the output terminal of the frequency discriminator filter unit 23 and the female contact element 26. Electrical female contact element 27 is electrically connected to an output lead designated as 31 which may be connected to the igniter unit (not shown).

Referring now to FIG. 3, which shows in greater detail the connection of the short secondary pin 18 to its female counterparts 26, 27 and 28, each of the female electrical connectors are constructed as shown in FIG. 4. As shown, they are formed of a hollowed cylindrical section which has a substantial wall thickness with a segment cut out of the center of one of the walls of the cylindrical section. Positioned over and surrounding the outer wall is a pin clip 33. This pin clip has a generally rounded portion which fits intimately with the outer wall of the cylinder and has a flatted portion which fits in the cut-out segment. This sort of construction permits a positive spring action to maintain the respective male portions in good electrical contact with the respective female portions of the connector.

The cylindrical chamber in insulating plug 21, which has the female electrical contacts positioned therein, is the only break in the radio frequency barrier of the female plug portion 20. Any radio frequency leakage through this portion is overcome by providing a small enough diameter and length so that this chamber acts as a waveguide below cut-off at the highest radio frequency energy of concern.

In operation, with reference to the total connector, best illustrated by FIG. 2, once the male portion 10 mates with the female portion 20, the first contact is made by the serrated portion 14 contacting one of the inner walls of the ring-like chamber around the female connector portion 20. Once electrical contact is made by the respective shields 11 and 13, respectively, a completely radio frequency free chamber is provided by the annular chamber of the male member before any electrical pin connection is made. As the male portion is further mated with the female portion 20, the spring fingers 14 slide along and physically grip the inner wall of the ring-like chamber providing a good electrical and physical contact. The sequence of these operations is best shown with reference to FIG. 5. Section A of FIG. 5 shows the male portion 10 and the female portion 20 before any contact is made. As the contacts are mated, the first electrical contact, of course, would be the shields of the respective portions of the connector, as explained above, but upon further mating, the relatively long thin main pin contacts the female electrical connector 19. If any radio frequency energy of a sufficient amount is present, a radio frequency arc would be struck as the two connectors made electrical contact. Current from the radio frequency arc would not flow through the output lead 31 because the circuit is still open, although it may flow through the filter section 23. As the connector is further pushed together, the main pin 15 remains in good electrical contact with 19 and slides along, and the secondary pin 18 contacts the grounded female terminal 28 and, finally, will bridge the two female connectors 26 and 28. This operation is best shown by section C of FIG. 5. Once these two contacts have been bridged, if any radio frequency energy is stored in the filter, then it will be discharged to ground by completion of this circuit. FIG. 5, section D shows the connector as it is completely mated and the secondary portion or pin 18 bridges the female electrical contacts 26 and 27, respectively, to allow current to flow from pin 15 through the frequency discriminator 23, the two bridged female electrical connectors 26 and 27, respectively, to the output lead 31 circuit which may be connected to the igniter of the weapon. Although the electrical connector is shown

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and explained with only a single electrical circuit with one filter and one multiple switching sequence, it is to be understood that the connector may be used with a multiplicity of frequency discriminator filters and electrical circuits.

Although the connector as shown in the drawings has the bridging feature of the secondary pin 18 bridging contacts 26 and 28, it may be desired to simplify the female portion of the connector 20 by elimination of female contact 28 which is always maintained at ground potential. This may be done where it is not felt that sufficient electrical energy from the radio frequency arc would be stored in the frequency discriminator filter unit 23. This would slightly simplify the connector without affecting its overall protective value of providing complete radio frequency energy protection from causing premature detonation of the weapon. Another alternative construction may be desired by utilizing a bleeder resistance connected from terminal 26 to the ground plate 24. This construction is not shown in the drawings, but it may be used instead of the extra female connect contact 28, if the time constant of the cylindrical frequency discriminator filter unit 23 is short enough to dissipate the energy stored in the filter during the shortest connection sequence anticipated.

The instant connector disclosed provides complete physical and radio frequency isolation in each of the male and female portions. An unbroken radio frequency shield is maintained even though the male connector is disconnected from the female connector which is in the squib or igniter circuitry. In addition, a foolproof switching sequence is provided by the unique male and female pin connection so that it is impossible to connect the squib circuit in the improper sequence, thus allowing a possible predetonating condition to exist.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

1. An electrical connector for use in high energy fields that prevents low frequency transient energy generated by radio frequency arcing from entering an output circuit comprising

a first connector body having contained therein a first insulating means,

first and second pin members protruding from said first insulating means, said first pin member having a relatively long thin shape and substantially longer length with respect to the external dimensions of said second pin member,

a second connector body having contained therein a second insulating means,

first, second and third electrical contact means positioned internally of said second insulating means, said first and second electrical contact means substantially in juxtaposition with one another, said first electrical contact means positioned so as to mate with said first pin member and said second and third electrical contact means positioned to mate with said second pin member,

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whereby the mating of the first connector body with the second connector body causes the first pin member to mate with the first electrical contact means before the second pin member contacts the second and third contact means.

2. The electrical connector of claim 1 wherein said second connector body comprises

a ringlike hollow metallic chamber encircling said second insulating means,

metallic means having apertures for passage of said first and said second pin members,

said metallic means electrically and physically connected at its outer peripheral edge to the inner peripheral edge of said ringlike hollow metallic chamber and

metallic tubular means enclosing said first electrical contact means,

said metallic tubular means electrically and physically connected at one of its edges to said metallic means, thereby providing complete radio frequency shielding for said second connector body.

3. The electrical connector of claim 2 wherein said second insulating means comprises

first washer shaped member adjacent said ringlike hollow chamber,

said first washer shaped member having first chamber means containing said second and third electrical contact means,

said first chamber means having a diameter and depth that is small thereby preventing the entrance of radio frequency energy at the frequency range of concern, and

a second cylindrical shaped member adjacent said metallic tubular means,

said second cylindrical shaped member having a second chamber means containing said first electrical contact means.

4. The electrical connector of claim 1 wherein said first, second and third electrical contact means comprise a tubular member having a segment removed from one of its walls forming an aperture therethrough and

a clip member fitting around said tubular member and positioned adjacent said aperture.

5. The electrical connector of claim 1 wherein said first, second and third electrical contact means comprise first, second and third female contacts,

said first, second, and third female contacts positioned vertically to one another,

whereby the first and second, then the second and third contacts are bridged by the second pin member.

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