June 20, 1967 C. J. LOMBARD 3,327,279

PLUG

Filed Sept. 11, 1964 2 Sheets-Sheet 1

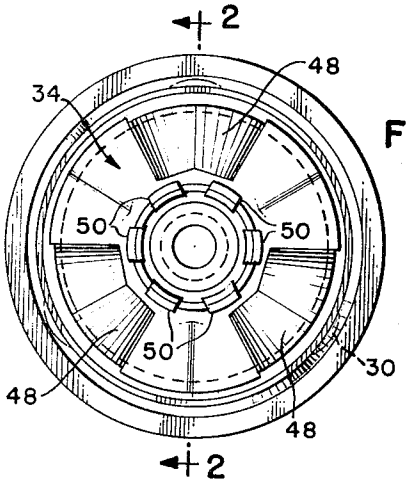
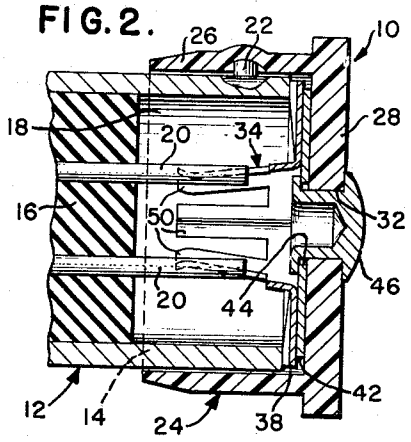


FIG. 1.

FIG. 2.



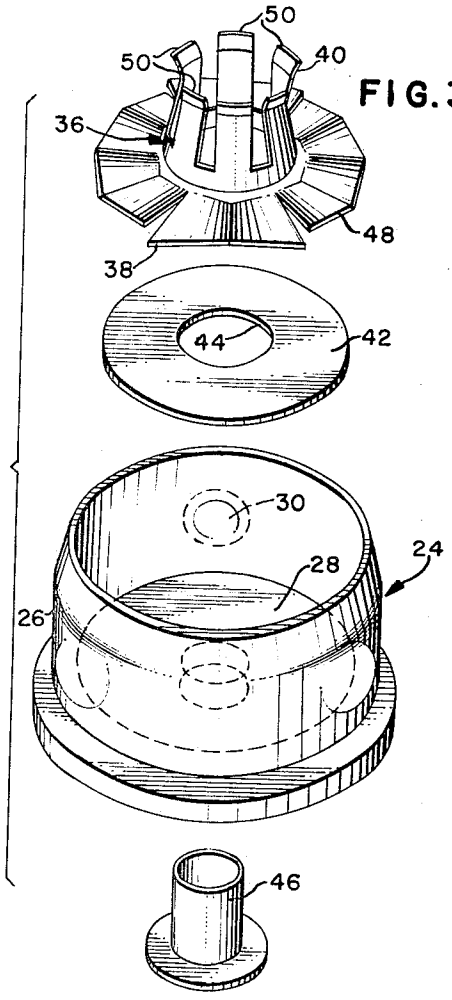
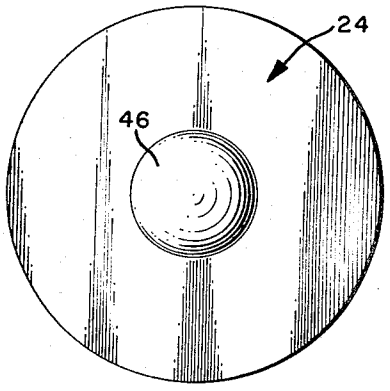


FIG. 3.

FIG. 4.



INVENTOR

CHARLES J. LOMBARD

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Fig. 5

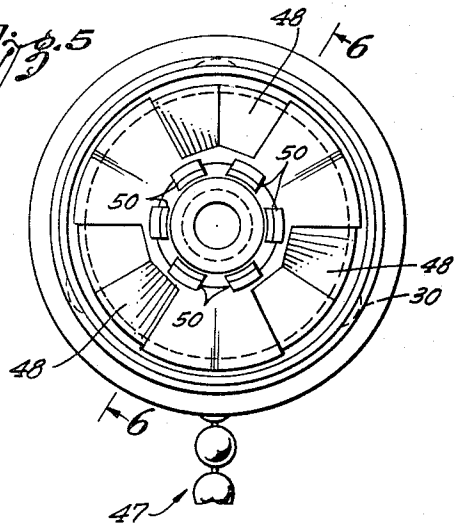


Fig. 6

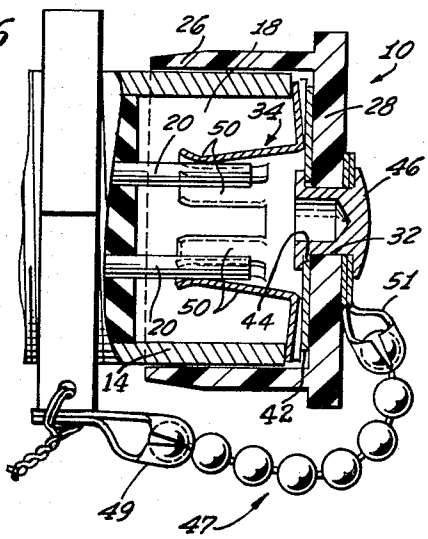


Fig. 7

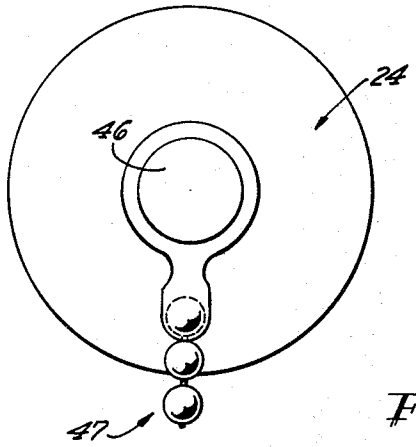


Fig. 8

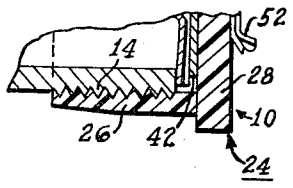
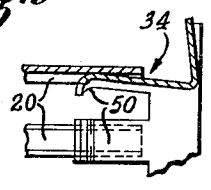


Fig. 9



INVENTOR:
Charles J. Lombard

By Smyth, Roston & Pavitt

Attorneys

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3,327,279

PLUG

Charles J. Lombard, 7663 Willis Ave., Van Nuys, Calif. 91405

Filed Sept. 11, 1964, Ser. No. 395,962
11 Claims. (Cl. 339—19)

This application is a continuation-in-part of copending application, Ser. No. 381,301 entitled, "Plug," and filed July 9, 1964, now abandoned in the name of Charles J. Lombard.

The present invention relates to shorting caps and more particularly to electrical shorting or grounding plugs or caps for temporarily electrically grounding certain portions of an electrical circuit so as to prevent an accidental energization of the circuit.

At the present time, many assemblies employ a plurality of electrical components that are physically separated from each other. In order to facilitate the servicing and interchanging of the components, it is customary to employ an interconnecting cable and one or more readily detachable connectors. The connectors normally include a female connector having a plurality of sockets disposed inside of a surrounding body and a male connector having a corresponding number of pins disposed inside of a surrounding body. When the connectors are separated, the pins are exposed to the surrounding atmosphere. It is thus possible, when a component is disconnected, to energize one or more portions of the component by imposing a suitable signal on one or more of the exposed pins.

On some occasions, the components are of such a nature that they should not be accidentally energized. By way of example, a component may employ a squib or pyrotechnic device which is used to produce a visual or audio signal, to inflate a structure such as a lifeboat, to cause the separation of two structures, or even to explode with sufficient force to completely destroy a structure. It can be readily appreciated that the accidental detonation of such a device can result in substantial financial loss or severe personal injury or death.

Most electrically ignited squibs or pyrotechnic devices are of a relatively sensitive nature and can frequently be detonated as a result of very small amounts of current or energy. Under some circumstances, it is possible for sufficient quantities of static electricity to accummulate in an electrically disconnected component to detonate a pyrotechnic or similar device. It is also possible for stray electromagnetic energy to produce an electrical signal in one or more portions of a circuit that is of sufficient magnitude to detonate a pyrotechnic or similar device. It is also very possible for an electrically charged member such as a loose conductor to accidentally contact one of the exposed pins and detonate such a device.

In order to prevent accidental energization of various disconnected electrical components and particularly those containing pyrotechnic devices, it has been customary to ground various portions of the component. One means of accomplishing this is to provide a special female connector which fits onto the male connector. The female connector must, of necessity, be of the type and size that fits the male connector. Also, it must be specially wired so that the various sockets therein are electrically wired to ground. Although such an arrangement is reasonably effective in grounding the desired portions of the component, there are inherently several solder connections in the grounding circuit. Each of these connectors and the interconnecting wires have some resistance. This tends to reduce the effectiveness of the grounding circuit. By way of example, it has been found that the best of solder connections have a substantial resistance. As a result of the solder connections, the prior grounding connectors

have had large resistances that reduce the effectiveness of the grounding action.

The preparation of the special grounding connectors is time consuming and expensive. Where male connectors of several different sizes and types are employed, it is necessary to have a substantial inventory of corresponding female grounding connectors. This further increases the cost and handling problems. Also occasionally the particular grounding connector required is not available and the electrically disconnected component is not properly grounded. It will thus be seen that the foregoing means for electrically grounding electrically disconnected components have not been entirely satisfactory.

The present invention overcomes the foregoing difficulties by providing a shorting or grounding plug that is not only simple and inexpensive, but is also easy to employ and reliable in operation. More particularly, the present invention provides a grounding plug that may be employed with a wide variety of different types and sizes of connectors and will be effective to insure a complete and positive grounding of all of the electrical circuits interconnected with the connector. In one operative embodiment of the invention, the plug includes a resiliently deformable cap that may be quickly forced onto and off of the connector body. However, the cap has a sufficient rigidity to insure its remaining securely attached to the connector. An electrically conductive spring or grounding structure is provided inside of the cap. The grounding structure includes a first set of spring fingers which are adapted to resiliently engage all connector pins disposed inside of the connector body. The structure also includes a second set of resilient fingers which are positioned to engage a ground contact, such as the connector body. Since all of the various fingers are resiliently deformable and deflectable over a considerable range, they will electrically engage all of the pins and the body and insure a low resistance path that completely grounds all of the desired portions of the connector and interconnected circuit.

These and other features and advantages of the present invention will become readily apparent from the following detailed description of a limited number of operative embodiments thereof, particularly when taken in connection with the accompanying drawings wherein like reference numerals refer to like parts and wherein:

FIGURE 1 is an end view of a shorting plug embodying one form of the present invention;

FIGURE 2 is a cross-sectional view of the shorting plug taken substantially along the plane of line 2—2 of FIGURE 1;

FIGURE 3 is an exploded perspective view of the shorting plug;

FIGURE 4 is an end view of the shorting plug;

FIGURE 5 is an end view of a modified shorting plug;

FIGURE 6 is a cross-sectional view taken along the plane of line 6—6 of FIGURE 5;

FIGURE 7 is an end view of the modified shorting plug;

FIGURE 8 is a fragmentary sectional view similar to that shown in FIGURE 2 and illustrating another embodiment of the invention; and

FIGURE 9 is a fragmentary sectional view similar to that shown in FIGURE 2 and illustrating an additional embodiment of the invention.

Referring to the drawings in more detail, the present invention is particularly adapted to be embodied in a shorting or grounding plug 10 for use on a conventional male-type connector 12. Such a connector 12 normally is adapted to be connected to a complementary female connector whereby one or more electrical interconnections will be provided between the two connectors.

In the present instance, the connector 12 includes an outer body 14 that may be rigidly mounted on a sidewall

of a housing enclosing an electrical component or circuit. Alternatively, it may be merely attached to the end of a cable. The body **14** normally is constructed of an electrically conductive material such as metal. The body **14** may thus be electrically connected to a portion of the circuit such as electrical ground.

A dielectric support **16** may be positioned inside of the body **14**. The support **16** is normally cylindrical so as to just fit into the body **14**. The support **16** only extends a portion of the length of the body **14** so as to leave an open space **18** on the inside of the body **14**.

A plurality of electrical pins **20** are provided in the support **16** so as to project into the space **18**. The pins **20** will thus be supported by the dielectric support **16** and their outer ends will be protected by the body **14**. The inner ends of the pins **20** are disposed in the support **16** and may be electrically interconnected with the various portions of an overall component or circuit whereby a potential applied to the pins **20** will energize the circuit. For example, the pins **20** may be electrically connected with a squib or pyrotechnic device. An electrical current flowing through one or more of these pins **20** will be effective to ignite the device.

The female connector that is used with the male-type connector **12** may be constructed in a manner similar to that disclosed in McCutcheon Patent 3,140,908, Green Patent 3,172,716 and Ashby Patent 3,182,277 include a dielectric member which is adapted to fit inside of the body **14** and fill the space **18**. This dielectric member includes a plurality of small holes or apertures which are aligned with the pins **20** so as to form sockets that receive the various pins **20** when the connectors are joined together. The sockets may include electrical contacts that will engage the pins **20** and form an electrical circuit therebetween. The electrical contacts, are in turn, connected to a second circuit. This second circuit will be effective to supply appropriate signals to the pins **20** for energizing the first circuit. By way of example, the first circuit may include a squib or pyrotechnic device and the second circuit may be effective to supply an electrical current to several of the pins **20** so as to ignite the device.

In order to connect the two connectors together, the dielectric plug in the female connector is inserted inside of the body **14** and forced inwardly to engage the support member **16**. This will force the pins **20** into their respective openings in the dielectric plug. After the dielectric plug is properly positioned, the two connectors may be locked together by any suitable means. For example, an outer ring or collar may be provided on the female connector to fit over the exterior of the body **14**. This ring or collar may be internally threaded so as to be screwed onto threads on the exterior of the body **14**. Alternatively, as in the present embodiment, the ring or collar may include bayonet fastening means such as the key pins **22**. The collar or ring will then include slots that receive the key pins **22** and cam lock the two connectors together.

It will be noted that when the female connector is removed from the male connector **12**, the various electrical pins **20** will be disposed in the space inside of the body. Thus, the pins **20** will be at least partially protected to a limited degree. However, these pins will be electrically isolated from the body and any other grounded portion of the circuit.

Since the pins **20** are exposed, it will be possible for an electrical contact such as a loose wire or electrically charged member to accidentally contact one or more of the pins **20** and produce an electrical current in some portion of the circuit. It will also be possible for a charge of static electricity to accumulate on one or more of the pins **20** or in some portion of the circuit and then discharge therethrough. It is also posible for such a charge to contain a sufficient quantity of energy to detonate a squib or pyrotechnic device. It will also be possible for stray electromagnetic energy to be received by one or more of the pins **20** or some portion of the electrical circuit whereby an electrical current may flow. Such a current may also be of sufficient magnitude to ignite a pyrotechnic device.

In order to avoid the accidental energization of the circuit and particularly a pyrotechnic device, the shorting and grounding plug **10** may be employed. This plug **10** fits on the end of the connector body **14** so as to protect the pins **20** and electrically interconnect all of the pins with each other and electrical ground. As a consequence, all of the critical portions of the circuit will be maintained electrically at ground potential and it will be impossible for stray signals such as may be produced by static electricity, electromagnetic energy or accidental physical contact to energize the circuit. In addition, the cap or plug may be effective to provide an air tight or dust-proof seal. However, this is not necessarily inherent in the seal and the cap or plug may only be effective to electrically short the connector. Accordingly, the term sealing whenever used herein is not limited to an air tight or dust-tight seal.

The present plug **10** includes an outer protective housing or cap **24** having a barrel portion **26** and an end wall **28**. The barrel **26** is substantially cylindrical and has an inside diameter that is equal to or slightly less than the outside diameter of the body **14**. It will thus be seen that the barrel **26** may fit over the body **14**.

The cap **24** is preferably fabricated from a pliable material such as a plastic. The barrel **26** has sufficient strength to maintain its basic cylindrical shape. However, it does have a sufficient resilience to permit the barrel **26** to be deformed sufficiently from its normal or free shape to permit its being attached to the body **14**.

If the exterior of the body **14** is threaded (FIGURE 8), the barrel **26** may be threaded onto the body **14** or merely pushed thereover. In any event, the threads on the outside of the body **14** will embed themselves in the barrel **26** and securely lock the plug **10** in position. If, as in the present instance, the connector **12** is of the bayonet or cam-lock pin type, the pins **22** will be effective to engage the inside of the barrel **26** when the cap **24** is forced into position and thereby lock the cap **24** in position. Although it is not necessary, a small recess **30** may be provided on the inside of the barrel **26** in alignment with the pins **22**. This forms a small clearance space for receiving the bayonet pins **22** and assists in retaining the plug **10** in position.

The end wall **28** is disposed at right angles to the barrel **26** and closes the end of the connector **12**. It will thus be seen that when the plug **10** is in position on the connector, the space **18** inside of the body **14** will be completely closed.

An electrically conductive structure **34** may be provided on the inside of the cap **24**. This structure **34** may be secured in position by any suitable means such as a hollow rivet **46** disposed in a rivet hole **32** in the center of the end wall **28**. The structure **34** preferably has a very low electrical resistance and by way of example may be fabricated from a low resistance, resilient alloy such as beryllium-copper.

The conductive structure **34** includes a spring or grounding member **36** having an end flange **38** and an axial extension **40**. The unique design of the electrically conductive structure **34** and particularly the spring **36** will act as a heat sink and because of its high thermal conductivity and widely spaced fingers will transfer heat from the pins **20** to the body **14**. The spring member **36** may have a support such as a washer **42** soldered or otherwise attached to the end flange **38**. The washer **42** is adapted to engage the inside of the end wall **28** and fit snugly thereagainst and assist the rivet **46** in maintaining the structure in position.

The washer **42** may include an opening **44** in the center thereof which is positioned to register with the rivet

opening 32 in the center of the end wall 28. The hollow rivet 46 is inserted into the openings 32 and 44 and through the end wall 28 and the washer 42 and has its end upset. This will be effective to permanently and firmly attach the washer 42 and spring member 36 to the end wall 28. For reasons that will become apparent subsequently, a limited amount of clearance space may be provided between the opening 32 and/or the opening 44 and the rivet 46. This will be effective to permit a limited amount of movement between the washer 42 and end wall 28 whereby the entire conductive structure 34 will be free to move over a limited range.

The end flange 38 is positioned substantially normal to the extension 40 and has a sufficient diameter to engage the end of the body 14. Although the periphery of the flange 38 may directly engage the body 14, it has been found desirable to provide a plurality of resilient fingers 48. These fingers 48 are positioned so as to register with the end of the body 14 when the cap 24 is positioned on the body 14.

Any desired number of fingers 48 may be employed. However, in the present instance, there are three separate fingers 48 equally spaced around the periphery of the flange 39 so as to engage the body 12 at three equally disposed points. Since three points are effective to define a plane, these three fingers 48 will always be in intimate electrical contact with the end of the body 12 and will exert equal forces thereagainst. Thus, in the event the sealing plug 10 is "cocked" or out of axial alignment with the body 14, there will still be a uniform electrical contact between the spring fingers 48 and the body 12.

The extension 40 is disposed substantially normal to the flange 38 and projects axially therefrom. The extension 40 includes a plurality of resilient fingers 50 that are adapted to be resiliently deflected radially inwardly and outwardly. These fingers 50 are intended to engage the pins 20. Accordingly, the structure and positioning of these fingers 50 will be dependent upon the number and spacing of the various pins 20. In the present instance, there are four separate pins 20 arranged substantially equal distances from the center of the body 14.

The fingers 50 may be arranged so as to be inside of the pins 20 (FIGURE 9) and to expand radially outwardly against the outside thereof. However, in the present instance, they are arranged to be outside of the pins 20. When in position, the fingers 50 will tend to contract radially inwardly into intimate contact with the pins 20. The spring fingers 50 are sufficiently resilient to permit a limited amount of misalignment between the various members while still maintaining an intimate electrical contact wth all of the pins 50. Also, the entire spring structure 34 is adapted to be movable about the rivet 46 to accommodate misalignment.

In the event that it is desired to use the present sealing plug 10 for grounding the various portions of an electrical circuit, the male connector 12 may be disconnected from its complementary female connector. The sealing plug 10 is then attached to the connector. This is accomplished by sliding the barrel 26 of the cap 24 over the outside of the body 14. The cap 24 is forced inwardly until it is pushed as far as it will go. At this point, the bayonet or cam-lock pins 22 will be disposed in the clearance spaces formed by the recesses 30. This will be effective to securely lock the cap 24 in position upon the body 14 of the connector 12. In the event the body 14 does not employ cam-lock pins 22, the fastening means such as threads will grip the pliable material in the barrel 26 and lock the cap 24 in position.

In the event it is found desirable to more positively insure a complete contact between the body 14 and the electrically conductive structure, the barrel 26 may include a cam-lock opening or additional spring member. Also, the body 14 may be threaded so as to insure the cap 24 being positively locked directly onto the connector 12.

In the process of forcing the cap 24 into position, the various spring fingers 50 on the extension 40 will be forced outside of the connector pins 20. The fingers 50 will tend to be expanded radially outwardly and maintain electrical contact with the pins 20.

In the event the pins 20 are slightly mispositioned or eccentric and/or the electrically conductive structure 34 is mispositioned or eccentric, the washer 42 may move relative to the end wall 28 until it is precisely centered with the various connector pins 20. At this point, the resilient fingers 50 will be in intimate electrical contact with all of the various pins 20 and will bear thereagainst with substantially equal forces to form low resistance contacts therebetween.

When the cap 24 has been fully pushed onto the connector body 14 and locked into position by the bayonet pins 22, the three resilient fingers 48 of the flange 38 will engage the end of the body 14. This will form a low resistance electrical path between the flange 38 in the electrically conductive structure 34 and the connector body 14. When the cap 24 is in position, very low resistance paths are provided to ground. Since the paths are free of any soldered junctions, it has been found that by the proper choice of materials and spring tensions, it is now possible to provide a path of less than 0.005 ohm between each pin and ground and a resistance of less than 0.02 ohm for the entire assembly.

It will thus be seen that after the sealing plug 10 is in position, a low resistance electrical path will be maintained between all of the pins 20 and the body 14. As a consequence, it will be impossible for any electrical currents to circulate through the electrical circuit and cause a malfunction or actuation thereof.

In the event it is desired to interconnect the component with any adjoining components, the cap 24 may merely be pulled from the male connector 12 and the mating female connector attached to the present connector so as to establish the desired electrical paths therebetween.

It will be apparent that a single plug 10 may be employed with a wide variety of connectors 12 having different numbers of pins 20, different fastening means 22, etc. whereby a positive grounding may be provided with a minimum inventory of plugs 10. Also, the plugs 10 are very inexpensive and easy to use.

As an alternative, the embodiment of FIGURES 5 to 7 may be employed. This embodiment is substantially identical to the preceding embodiment in that it also includes a cap 24 having a barrel 26 and an end wall 28. An electrically conductive structure 34 is disposed inside of the cap 24 and includes a spring member 36 and a washer 42. These are secured in position by a rivet 46 and will form an electrical shorting path between the various pins 20 and the body 14.

In order to prevent loss of the cap 24, a suitable connector may be provided that attaches the cap 24 to the socket 12. It has also been found desirable to make the connector electrically conductive so as to ground the rivet 46. In the present instance, a short electrically conductive ball chain 47 is employed. One end of this chain includes a fitting 49 that is wired to the body 14 and establishes electrical contact. The other end includes a fitting 51 that is attached in position by the rivet 46. This will be effective to maintain an electrically conductive path between the conductive structure 34 and the body 14 even though the cap 24 may not be properly seated. The ball chain 47 will be effective to directly ground the structure 34 prior to the time it contacts the pins 20. Thus, it will be impossible to short the pins 20 to each other without shorting them to ground.

As a consequence, when employing this embodiment, a complete grounding will be assured even though the cap 24 may be improperly installed or subsequently becomes mispositioned.

While only a limited number of embodiments of the present invention are disclosed and described herein, it will be readily apparent to persons skilled in the art that numerous changes and modifications may be made without departing from the scope of the invention. Accordingly, the foregoing disclosure and description thereof are for illustrative purposes only and do not in any way limit the invention which is defined only by the claims which follow.

What is claimed is:

1. A sealing plug for electrically grounding an electrical circuit which includes an electrically conductive body electrically interconnected with the ground of said circuit and includes an array of electrical pins disposed inside of the body and electrically interconnected with the portions of the circuit to be grounded, said plug including the combination of:

a resiliently deformable cap having a barrel and an end wall, said barrel having an inside dimension that fits over the outside of the body so as to become secured to the barrel,

a support secured to the inside of the end wall,

an electrically conductive grounding member carried by the support,

a group of resilient fingers on said grounding member, said fingers being positioned to electrically contact the pins in said array and maintain a low resistance electrical path between the grounding member and the pins, and

a plurality of resilient contacts carried by the grounding member, said contacts being positioned to electrically engage the body and maintain a low resistance path between the body and grounding member,

said grounding member being effective to maintain a low resistance electrical path between all of the pins and the body.

2. A shorting plug for electrically grounding an electrical circuit which includes an electrically conductive body electrically interconnected with the ground of said circuit and including an array of electrical pins disposed inside of the body and electrically interconnected with the portions of the circuit to be grounded, said plug including the combination of:

a resiliently deformable cap having a barrel and an end wall, said barrel having an inside dimension that fits over the outside of the body,

means on said barrel effective to secure the barrel to the body,

a support disposed on the inside of the end wall,

a rivet securing said support to the end wall to allow the support to move relative to the end wall,

an electrically conductive grounding member carried by the support,

a group of resilient fingers on said grounding member positioned to electrically contact the pins in said array and maintain a low resistance electrical path between the grounding member and the pins, said fingers being effective to bias the support into a position wherein the fingers engage the pins with substantially equal force, and

a plurality of resilient contacts carried by the grounding member, said contacts being positioned to electrically engage the body and maintain a low resistance path between the body and grounding member.

3. A sealing plug for electrically grounding an electrical circuit which includes an electrically conductive body electrically interconnected with the ground of said circuit and includes an array of electrical pins disposed inside of the body and electrically interconnected with the portions of the circuit to be grounded, said plug including the combination of:

a resiliently deformable cap made from an electrically insulating material and having a barrel and an end wall extending in a transverse direction from the barrel, said barrel having an inside dimension that provides for a fit of the barrel over the outside of the body so as to become secured to the barrel,

a support secured to the inside of the end wall,

an electrically conductive grounding member disposed in contiguous relationship to the support,

a group of electrically conductive resilient fingers on said grounding member, said fingers being positioned to electrically contact the pins in said array and maintain a path of low electrical resistance between the grounding member and the pins, and

a plurality of electrically conductive resilient contacts carried by the grounding member in the transverse direction relative to the resilient fingers, said contacts being positioned by the support in contiguous relationship to the body to maintain between the body and grounding member a path having a low electrical resistance,

said grounding member being effective to maintain a low resistance electrical path between all of the pins and the body.

4. The sealing plug set forth in claim 3 wherein the support constitutes a washer and wherein a rivet extends through the end wall of the cap and has a flange for retaining the support against the end wall of the cap and for providing for an action of the support against the contacts of the grounding member to press the contacts against the electrically conductive body.

5. The sealing plug set forth in claim 4 wherein an electrically conductive chain is fastened at one end to the rivet and at an opposite end to the body.

6. An end shorting plug for use with a connector having an electrically conductive body and an array of electrically conductive pins disposed inside of the body and connected with an electrical circuit, said sealing plug including the combination of:

a cap made from electrically insulating material and having an end wall and a barrel extending from the end wall in a direction transverse to the end wall,

a grounding member disposed on the inside of the end wall, the grounding member being provided with a plurality of resilient fingers,

securing means disposed within the barrel and movably securing said resilient fingers of said grounding member to said end wall to provide for a movement of the grounding member across the end wall,

a group of electrically conductive resilient fingers carried by the grounding member and extending in the transverse direction from the support, said fingers being positioned to engage the electrically conductive pins and form an interconnection between the fingers and the pins in the array with a low electrical resistance, said electrically conductive resilient fingers being effective to bias the resilient fingers of the grounding member into a position wherein the electrically conductive resilient fingers bear against the pins in said array with substantially equal forces, and

at least one electrically conductive contact carried by the grounding member and electrically interconnected with the electrically conductive resilient fingers in the group, said contact being positioned to electrically engage the body and electrically interconnect the pins with the body.

7. The plug set forth in claim 6 wherein second means extend through the end wall and engage the securing means and wherein the securing means are disposed relative to the grounding member to press the contact on the grounding member against the electrically conductive end wall.

8. The plug set forth in claim 7 wherein third means extend from the electrically conductive contact to the second means and provide for a support of the plug by the end wall upon a removal of the plug from the end wall and facilitate an electrical continuity of low resistance between the grounding member and the end wall.

9. A shorting plug for electrically grounding an electrical circuit which includes an electrically conductive body electrically interconnected with the ground of said circuit and including an array of electrical pins disposed inside of the body and electrically interconnected with the portions of the circuit to be grounded, said plug including the combination of:

a resiliently deformable cap made from an insulating material and having a barrel and an end wall extending in a direction transverse to the barrel, said barrel having an inside dimension that fits over the outside of the body,

means on said barrel to secure the barrel on the body when the barrel is fitted on the body,

a support disposed on the inside of the end wall,

a rivet extending through the end wall of the barrel and provided with a flange to secure said support to the end wall,

an electrically conductive grounding member carried by the support,

a group of resilient fingers on said grounding member, the fingers being positioned to electrically contact the pins in said array and maintain a path of low electrical resistance between the grounding member and the pins, said fingers being effective to bias the support into a position wherein the fingers engage the pins with substantially equal force, and

a plurality of electrically conductive resilient contacts carried by the grounding member in the transverse

direction relative to the resilient fingers, said contacts being positioned to electrically engage the body and maintain a path of low electrical resistance between the body and grounding member when the barrel is fitted on the body.

10. The shorting plug set forth in claim 9 wherein the support constitutes an electrical washer which presses the resilient contacts of the grounding member against the end wall.

11. The shorting plug set forth in claim 10 wherein a chain extends between the rivet and the end wall to prevent the plug from being displaced upon removal from the end wall and wherein the chain is electrically conductive to maintain the end wall and the rivet at substantially the same electrical potential.

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MARVIN A. CHAMPION, *Primary Examiner.*

PATRICK A. CLIFFORD, *Examiner.*