Nov. 25, 1952 L. C. DOANE 2,619,515

VAPOR AND EXPLOSION PROOF PLUG AND RECEPTACLE

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Fig. 1.

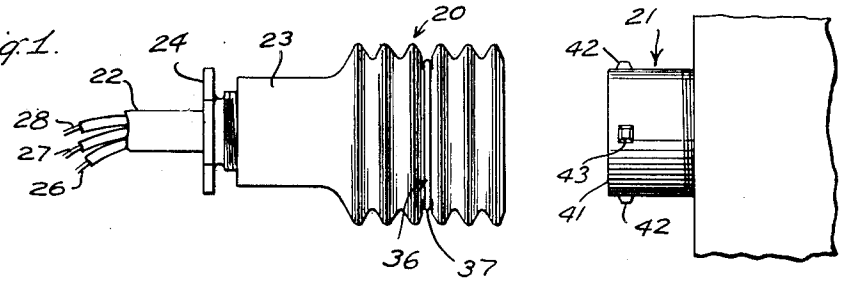


Fig. 2.

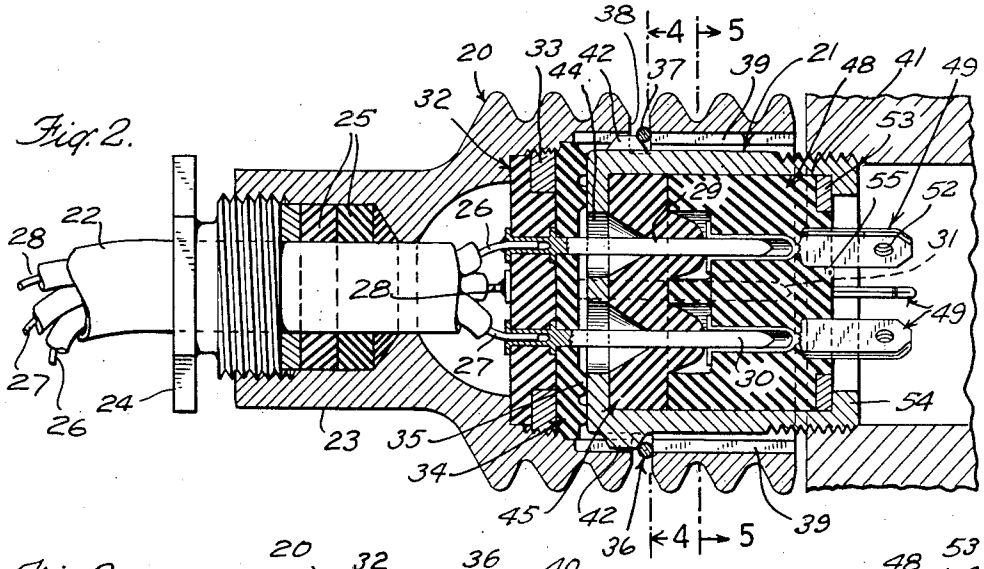
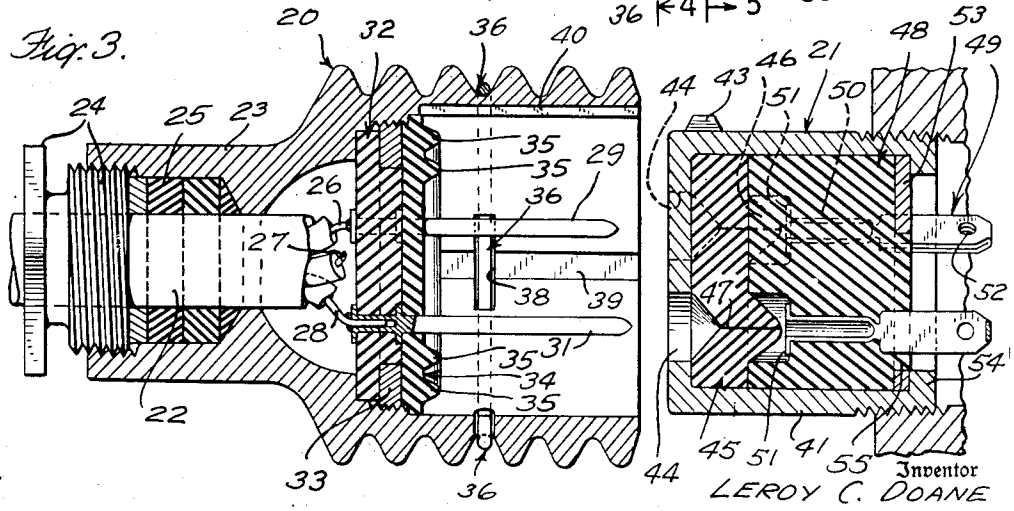


Fig. 3.



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VAPOR AND EXPLOSION PROOF PLUG AND RECEPTACLE

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Fig. 4.

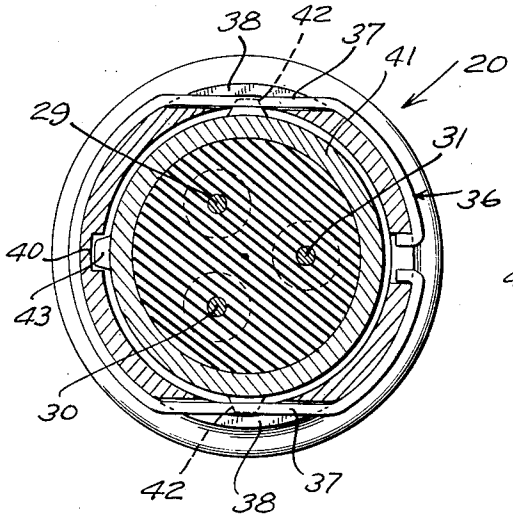


Fig. 5.

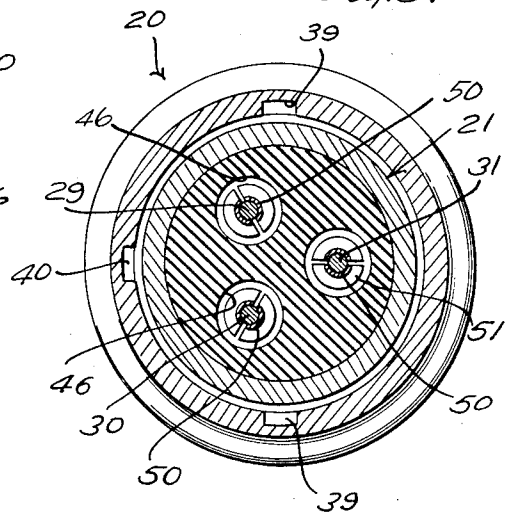


Fig. 6.

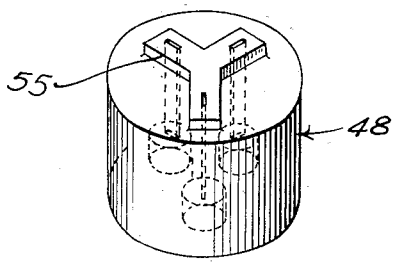
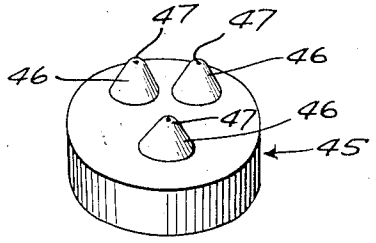


Fig. 7.



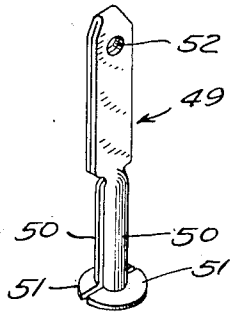


Fig. 8.

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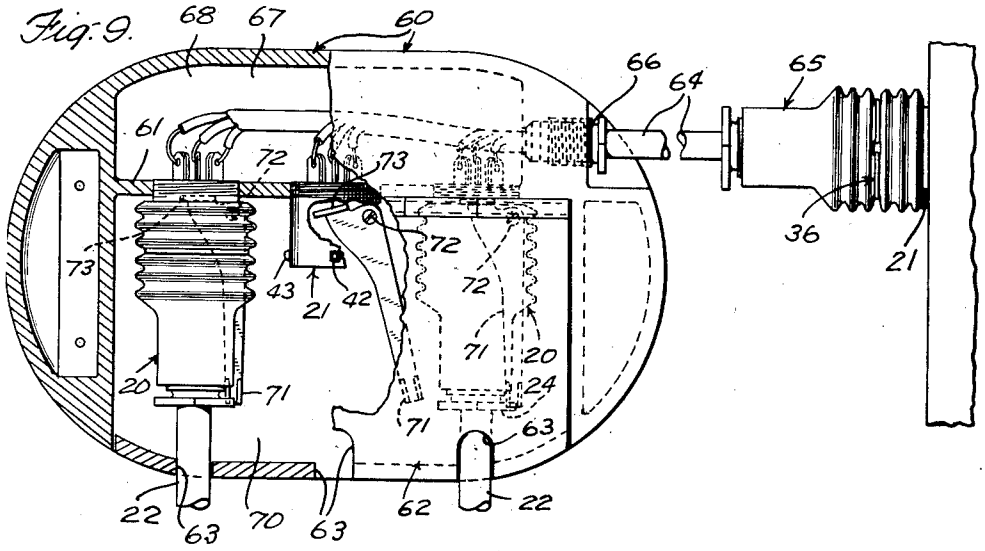
Fig. 9.



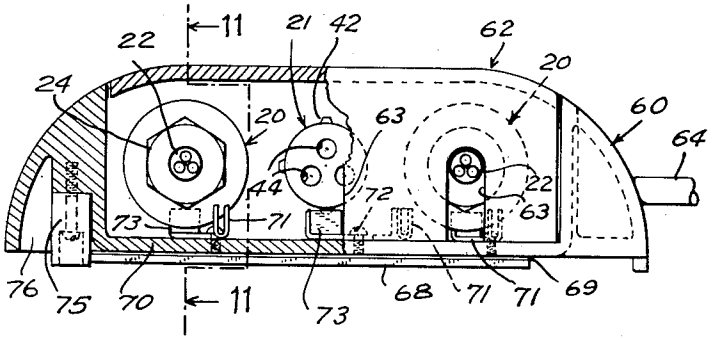


Fig. 10.

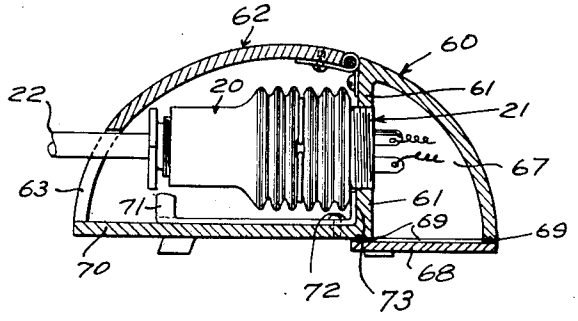


Fig. 11.

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Fig. 12.

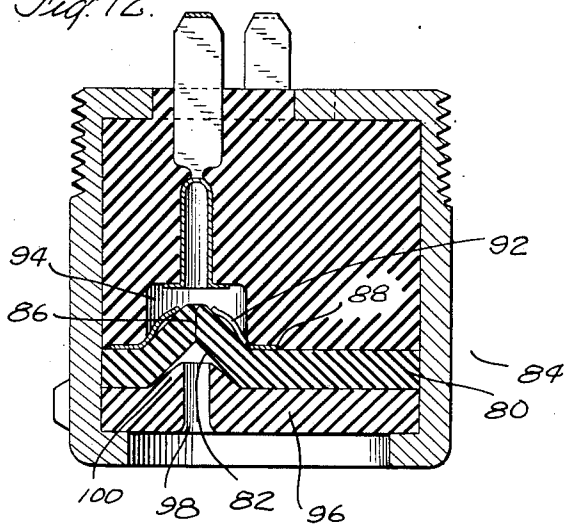


Fig. 13.

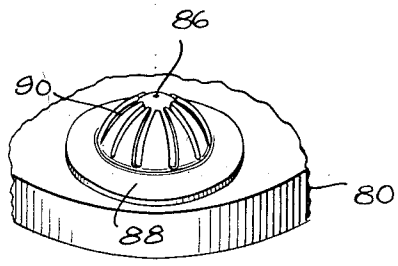


Fig. 15.

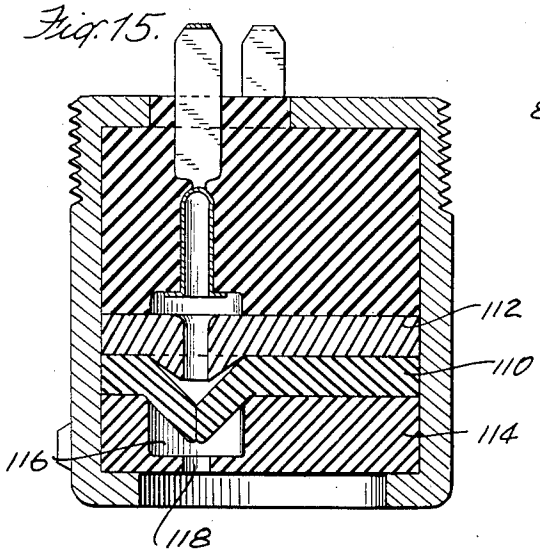
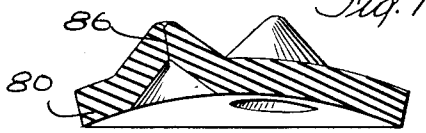


Fig. 14.



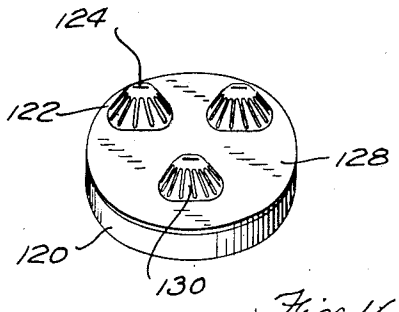


Fig. 16.

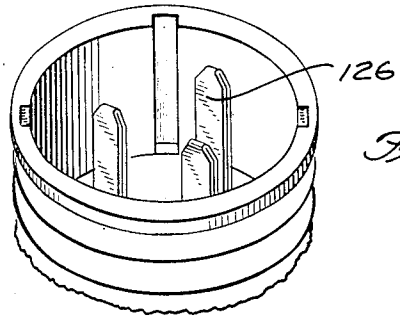


Fig. 17.

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UNITED STATES PATENT OFFICE

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VAPOR AND EXPLOSION PROOF PLUG AND RECEPTACLE

Leroy C. Doane, Essex, Conn.

Application December 20, 1947, Serial No. 792,906

5 Claims. (Cl. 173—328)

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The present invention relates to electrical plugs and receptacles of the vapor proof type.

An object of the invention is to provide an electrical connector comprising a plug portion and a receptacle portion in which the plug may be separated from the receptacle without exposing the current carrying parts of the receptacle to vapors which may be present in the surrounding atmosphere. The invention contemplates that the plug portion will be electrically energized from the receptacle portion and that there will be no danger in exposing the plug itself to the vapors.

A further object of the invention is to provide a receptacle in which any arcing which may occur upon engagement or disengagement between the current carrying parts of the plug and the receptacle will occur in an enclosed chamber from which vapors are excluded.

Still another object of the invention is to provide a receptacle having an enclosed arcing chamber which will remain sealed as the plug is inserted or withdrawn.

It is a feature of the invention that the plug is provided with a heavily constructed shell which is arranged to protect the prongs of the plug from mechanical injury notwithstanding rough usage and severe conditions of service.

It is a further object of the invention to provide a receptacle which, while permitting ready application and removal of the plug, is nevertheless sealed against external pressures, such as water pressure. Such a device is very useful upon ships where submerging of a compartment in which the receptacle is located would short circuit the electric system if water reached the interior of the receptacle.

Other and further objects will become apparent upon reading the following specification together with the accompanying drawing forming a part hereof.

Referring to the drawing:

Figure 1 shows a view in elevation of an embodiment of the invention with the plug removed from the receptacle,

Figure 2 is an approximately sectional view in elevation showing the plug inserted in the receptacle,

Figure 3 is a sectional plan view showing the plug removed from the receptacle,

Figure 4 is a sectional view taken along the line 4—4 of Fig. 2, looking in the direction of the arrows,

Figure 5 is a sectional view taken along the line 5—5 of Fig. 2, looking in the direction of the arrows.

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Figures 6, 7 and 8 are perspective views of portions of the receptacle,

Figure 9 shows a plan view of a cluster of receptacles, partly broken away,

Figure 10 is an elevational view of the cluster shown in Fig. 9, partly broken away,

Figure 11 is a sectional view taken along the line 11—11 of Fig. 10, looking in the direction of the arrows.

Figure 12 is an enlarged longitudinal sectional view of a modified form of receptacle.

Figure 13 is a fragmentary perspective view of a part of the valved insulator plate shown in Fig. 12.

Figure 14 is a longitudinal sectional view of an insulator plate of the form shown in Fig. 12 before being clamped in the receptacle.

Figure 15 is an enlarged longitudinal sectional view of a form of receptacle especially constructed to withstand external pressure.

Figure 16 is a perspective view of a modified form of valved insulator plate to be used with a plug having prongs of flat cross-section.

Figure 17 is a fragmentary perspective view of a plug having prongs of flat cross-section.

Referring to Fig. 1, the invention comprises a connector having a plug portion designated generally as 20 and a receptacle portion designated generally as 21. A flexible cord 22 enters the shell 23 of plug 20 through a vapor tight gland consisting of the packing nut 24 and packing 25. Nut 24 is threaded into shell 23 and may be tightened to compress packing 25 firmly against the external surface of cord 22 forming a vapor proof seal.

Cord 22 is shown comprising three conductors 26, 27 and 28 which extend within shell 23 to three prongs 29, 30 and 31, respectively. These prongs are secured in a plate of insulating material 32 which is held in shell 23 by a threaded retaining ring 33. Each prong is shown with a hollow portion which passes through plate 32 and which is headed over to secure the prong firmly in position. The hollow portion is arranged to receive the conductor which may be firmly secured and electrically connected by soldering, brazing, or similar means. A gasket 34 of rubber or similar flexible material is fitted tightly over the prongs 29, 30, and 31. Gasket 34 is provided with annular concentric ridges 35 which are arranged for sealing engagement with a flat face of the receptacle 21 as hereinafter described.

A snap ring 36 extends circumferentially around shell 23 and is provided with two straight

portions 37 which fit into slots 38 in shell 23. The slots 38 communicate with diametrically opposed grooves 39 in shell 23 and the straight portions 37 of snap ring 36 traverse these grooves for engagement with locking lugs on the receptacle 21 as described below. A third groove 40 is provided to prevent the plug from being inserted in the receptacle in any other than one particular positon. This makes certain that the same polarity will always be observed in establishing the electrical connections between the plug 20 and the receptacle 21.

The receptacle 21 comprises a body portion 41 which is threaded at one end for insertion in a conduit or metallic wall. A pair of diametrically opposed lugs 42 project outwardly from body 41 and are shaped for engagement with the corresponding grooves 39 in shell 23. When the plug 20 is firmly seated in the receptacle 21, as clearly seen in Fig. 4, the lugs 42 engage the straight portions 37 of snap ring 36 and prevent plug 20 from being removed unless sufficient force is exerted to spread the straight portions 37. A third lug 43 is arranged to engage groove 40 to maintain the correct polarity for the connections. The face of body 41 is flat and will engage the two annular ridges 35 of gasket 34 when the plug 20 is firmly seated in receptacle 21 thereby forming a tight seal which will exclude vapors from the space in the vicinity of the current carrying parts.

There are three holes 44 in the flat face portion of body 41 which are large enough to provide suitable clearance for the three prongs 29, 30, and 31 of plug 20. Disposed within body 41 and immediately behind the flat face thereof is a sealing insulator 45. This insulator is made of a flexible material such as rubber and is provided with three inwardly extending recessed portions 46 each of which is generally conical in shape and each of which is provided with an aperture 47 which is self-closing. When plug 20 is inserted in receptacle 21, the three prongs 29, 30, and 31 enlarge the apertures 47 so that the prongs may penetrate into the interior of the receptacle at the same time maintaining a vapor tight seal. When the plug is removed, the apertures close, thus excluding vapors from the interior portion of the receptacle. A further insulating member 48 which is made of yielding material such as rubber is provided with three contact members 49 which are arranged for engagement with the three prongs 29, 30, and 31. These contact members are shown as being constructed from a single strip of electrically conductive sheet material which has a good degree of resiliency in order to grip the prongs of plug 20. Acting conjointly with the resiliency of the flexible insulating material of insulator 48, the spring action of contact member 49 tends to maintain good electrical contact with each of the prongs. The semicircular portions 50 are flared and enlarged at 51 to guide the contact prong upon insertion in the receptacle and to prevent the contact member from being pulled out from the rear of the receptacle through the insulator 48. Contact member 49 is provided with a hole 52 for the attachment of a conductor which may then be soldered to establish a permanent connection.

Sealing insulator 45 and insulator 48 are assembled in body 41 with the sealing insulator 45 disposed immediately behind the holes 44 with the apertures 47 in alignment with the holes. A metallic plate 53 having a Y-shaped aperture therein is placed in position behind insulator 48, the aperture in plate 53 fitting around the Y-shaped projection 55 at the rear of insulator 48. The Y-shaped aperture thus prevents insulator 48 from rotating and the Y-shaped projection 55 provides an increased path to prevent electrical leakage to the body 41 and plate 53. In the embodiment of the invention illustrated, plate 53 is permanently secured by rolling over the edge of body 41 at 54 to hold the plate 53 securely in position. Other means of fastening may be used if desired. Body 41 is shown threaded at its rear portion and the cutting of these threads should be deferred until after completion of the rolling operation which secures plate 53 in order to avoid injury to the threads.

In operation, the plug 20 is inserted in receptacle 21 and the prongs 29, 30 and 31 engage the closed apertures 47 in flexible sealing insulator 45 penetrating into the interior of body 41 without affording an opportunity for vapors to enter the portion where electrical contact is made. Thus, any spark which may occur when the circuit is completed will not be likely to cause an explosion. Furthermore, any spark which may occur will be confined within the interior of the body 41 and within a closed chamber formed by the three spaces between the insulators 45 and 48. The construction may be made sufficiently heavy so that any explosions which may occur will be confined within the interior of body 41 and so that any flames accompanying the explosion will be confined within the interior of the receptacle. If the flames remain so confined, there will be no danger of communicating the explosion to other vapors in the area surrounding the place where the plug and receptacle are in use.

Similarly, the arc or sparking which may take place on removal of the plug will have been dissipated before the plug 20 can be removed. Moreover, the self-closing action of apertures 47 prevents communication between the surrounding atmosphere and the interior of the receptacle 21 as the prongs 29, 30, and 31 are removed.

Prong 31 has been shown somewhat longer than prongs 29 and 30. It is contemplated that in certain instances, as a safety precaution, the apparatus connected to plug 20 will be grounded by a separate grounding conductor. In such cases it is desirable that the ground be applied before the other conductors become energized and that the ground be not removed until after the other conductors have first been deenergized. By using a longer prong such as 31 for the grounding conductor, this sequence will be observed.

In Fig. 9, a group of receptacles 21 is arranged in a cluster to facilitate the connection of several plugs 20. It is desirable, where several pieces of portable apparatus are to be used at the same location which is at a distance from the nearest power receptacle, to avoid running a separate cord from each individual piece of apparatus back to the power receptacle. This arrangement also avoids the necessity for the installation of several permanent power receptacles in order to be able to establish simultaneous connection temporarily to the several pieces of apparatus.

The cluster comprises a housing 60 with an internal wall 61 in which are threaded three receptacles 21 as previously described. A hinged cover 62 is provided with three slots 63 arranged to permit the cords 22 to emerge from the cover 62. A main cord 64 is provided with a plug 65

similar in all respects to the plugs 20. Cord 64 enters housing 60 through a vapor and explosion proof packing gland 66 of construction similar to that of the gland provided in each of the plugs. Connections from cord 64 extend in multiple to the three receptacles within the wireway 67 inside housing 60. This wireway 67 is enclosed by a plate 68 which is sealed at 69 for the exclusion of vapors.

Disposed on a shelf portion 70 of housing 60 are three plug releasing levers 71 which are arranged to assist in the removal of any plug from each of the receptacles. These levers are particularly desirable when all three receptacles are in use and it is difficult to obtain a firm grasp on the plug to be removed. Each lever is pivoted at 72 and is provided with an extending flange 73 shaped for engagement with the end of one of the plugs. Upon moving lever 71 laterally, flange 73 urges the plug away from the receptacle as shown in Fig. 9. Once it has been moved a sufficient distance to disengage snap ring 36 from lugs 42, the plug may be readily removed without great effort. This arrangement also reduces the inclination on the part of persons using this apparatus to remove the plug by pulling on the cord.

The cluster may be provided if desired with magnetic means which will serve to hold it in position upon any iron or steel surface on which it may be placed, as for instance upon the steel deck of a ship. In the construction shown, a permanent magnet 75 is secured in a recess 76 in the housing 60, the lower face of the magnet being exposed so that it will rest upon and cling to a surface of magnetic material.

Figure 12 shows a modified form of receptacle from that shown in Figs. 2 and 3. In this figure a sealing insulator or diaphragm 80 is utilized which is somewhat thinner than that shown in Fig. 2. This makes the valve portion more flexible and it is easier to insert and withdraw the prongs of the plug. The conical recess 82 is of such depth that its apex extends beyond the plane of the face of the diaphragm, as indicated by the broken line 84. This facilitates the insertion of the prongs of the plug, as the material of the valve portion of the diaphragm can bend in order to permit the aperture 86 to open to receive the prong. Bodily displacement of the yielding material of the diaphragm is therefore minimized.

Figures 12 and 13 also show the use of a metal reinforcing disc 88 having a number of spring fingers 90 projecting therefrom, the tips of which bear against the conical valve portion of the diaphragm near the apex thereof, so as to assist in tight closing of the aperture 86. The fingers 90 are preferably bowed outward between their ends, as indicated at 92, so that the firmest engagement is between the tips of the fingers and the cone near its apex.

As the diaphragm 80, which is thinner than the form of valve insulator shown in Figs. 2 and 3, may not be sufficiently stiff to resist outward pull of the prongs of the plug or internal pressure caused by explosions within the explosion chambers 94, it is preferable to provide a reinforcing disc 96 of rigid insulating material mounted in the end of the receptacle outside of the diaphragm 80. The rigid member 96 has openings 98 big enough to permit the plug prongs to pass freely through the same. The member 96 is furthermore provided with conical projections 100 on its inner surface which extend part way into the conical recess 82 in the diaphragm so as to limit the movement of the conical valve portions.

Figure 14 shows a shape in which the valve insulator or diaphragm 80 may be initially molded and cured. It will be seen that the diaphragm is molded in concavo-convex form with the valve cones extending from the convex side. When a diaphragm of this shape is clamped between two flat surfaces in the receptacle, it is thereby flattened out into flat shape, as shown in Fig. 12. This produces increased pressure between the side walls of the apertures 86 adjacent to the apices of the valve cones and helps to secure a tight seal.

Figure 15 shows a receptacle especially constructed to withstand external pressures of either vapors or liquids. Such a construction is particularly useful under conditions where the receptacle may be submerged so as to be subjected to external water pressure. This is a condition frequently encountered on naval or other vessels. If water enters the receptacle and reaches the electrical connections, it may cause a short circuit entailing serious consequences. In the construction shown in Fig. 15 the receptacle is provided with a diaphragm 110 shown as similar to the diaphragm in Fig. 12, but reversed with the valve cones pointing outwardly. The diaphragm is clamped between the insulating block 112 similar to the block 96 shown in Fig. 12, but placed behind the diaphragm with the conical projections pointing outwardly, and a block of insulating material 114 having chambers 116 for reception of the valve cones, and openings 118 to permit entrance of the contact prongs. Pressure entering the chambers 116 through the openings 118 will exert pressure on the valve cones, so as to seal the valve apertures therethrough and exclude the water or other fluid under pressure from reaching the electrical connections.

Figure 16 shows a form of valve diaphragm 120 having cone shaped valve protuberances 122 thereon which are of flattened or elliptical cross-section and provided with apertures 124 of flat shape. This construction permits the use of a plug having prongs 126 of flat shape, as shown in Fig. 17. Such form of prongs and apertures is desirable where heavy currents are to be carried, as the section of the prongs may be made as large as desired by simply utilizing prongs of greater width. The valve apertures of flat shape will readily receive such wide flat prongs without undue distortion and will seal properly when the prongs are removed.

Figure 16 also shows a slightly modified form of spring reinforcing member for the valve cones. As here shown, a metal disc 128 having the same diameter as the diaphragm 120 is provided, this disc having spring fingers 130 struck therefrom to press upon the several valve cones and assist in sealing the same.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown but what I wish to cover by Letters Patent is set forth in the appended claims.

I claim:

1. In a connector of the class described, a receptacle body having a contact therein for engagement with a removable contact prong, and means for sealing said receptacle against admission of a fluid under pressure into contact with said contact in the receptacle body, said means comprising a diaphragm of rubber-like

material having an outwardly projecting conical valve projection having a self-closing opening through the apex thereof, and means for clamping said flexible diaphragm in the receptacle.

2. In a connector of the class described, a receptacle having a body of insulating material therein, a contact member within said insulating body exposed at its outer end for engagement by a contact prong, and an insulating diaphragm of rubber-like material having a conical portion provided with a self-closing opening at the apex of the conical portion, said insulating diaphragm being mounted adjacent to the insulating body, and a metal plate surrounding the conical portion of said diaphragm, said plate carrying spring fingers engaging the outer surface of said conical portion and constructed to press thereon so as to assist in sealing said self-closing opening.

3. In a connector of the class described, a receptacle body having a contact therein for engagement with a removable contact prong and sealing means for said receptacle comprising a thick diaphragm of rubber-like material having a portion thereof molded and cured to form an elastic conical valve projection, said valve projection having an opening through the apex thereof through which the contact prong may be inserted or removed, the walls of said opening when the prong is removed closing into sealing contact due to the resiliency of the rubber-like material so as to render the opening self-closing and means for clamping said rubber-like diaphragm in the receptacle.

4. In a connector of the class described, a receptacle body having a contact therein for engagement with a removable contact prong and sealing means for said receptacle comprising a thick diaphragm of rubber-like material having a portion thereof molded and cured to form an elastic conical valve projection, said valve projection having an opening through the apex thereof through which the contact prong may be inserted or removed, the walls of said opening when the prong is removed closing into sealing contact due to the resiliency of the rubber-like material so as to render the opening self-closing, the body of said diaphragm being molded and

cured in convex form and means for flattening out said convex body and clamping the same in flat shape within the receptacle thereby increasing the self-closing pressure between the walls of the valve opening.

5. In a connector of the class described, a receptacle including an insulating member having a recess therein opening in a direction to receive a contact prong, said insulating member carrying a contact within the recess for engagement with the contact prong, said recess providing an arcing chamber, and sealing means for said receptacle and arcing chamber comprising a thick diaphragm of rubber-like material having a cone-like formation thereon projecting part way into said arcing chamber and having an opening extending through the apex thereof through which the contact prong may be inserted or removed, the walls of said opening when the prong is removed closing into sealing contact due to the resiliency of the rubber-like material so as to render the opening self-closing, and means for clamping said rubber-like diaphragm in the receptacle.

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