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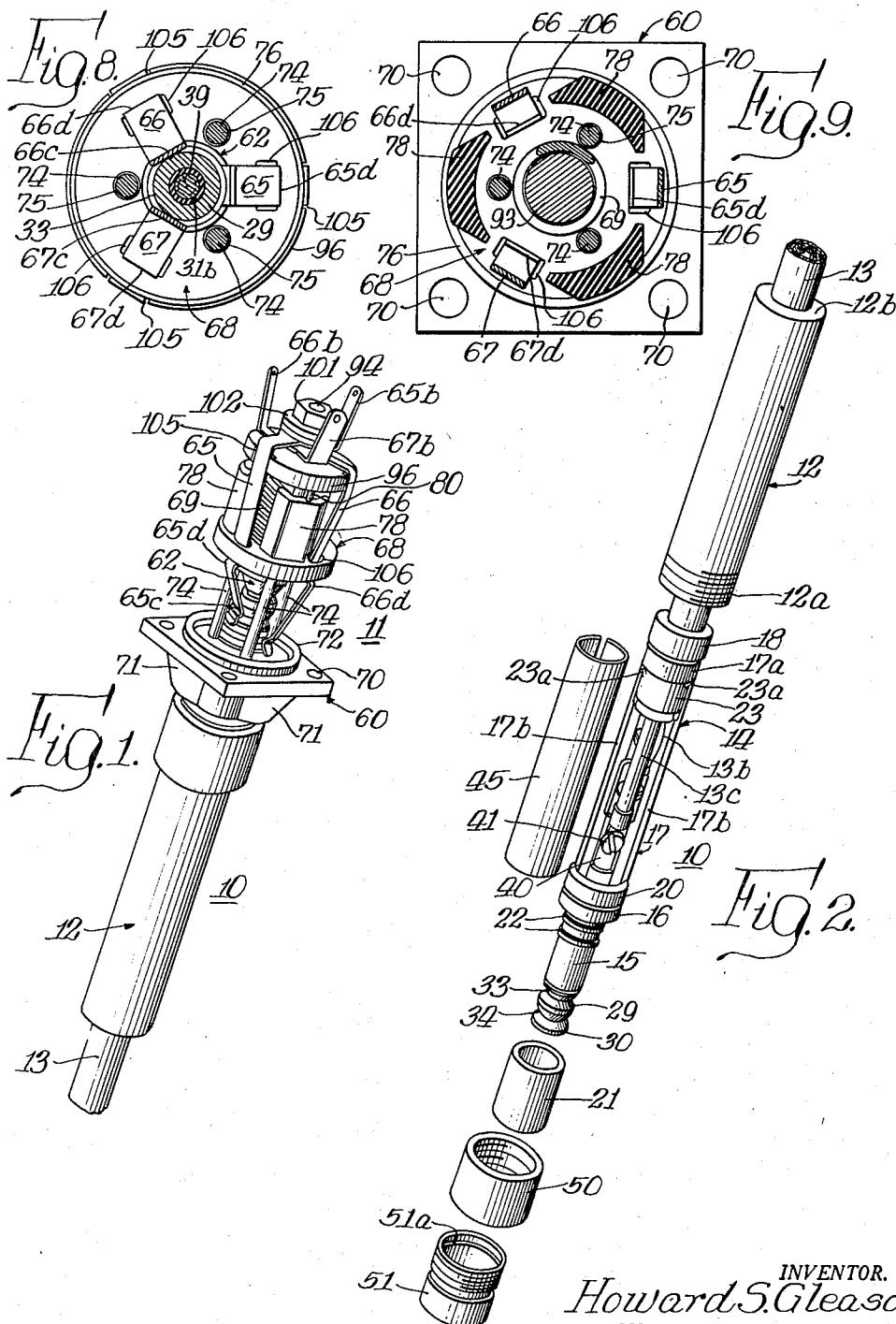
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WATERTIGHT PLUG AND JACK

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3 Sheets-Sheet 1



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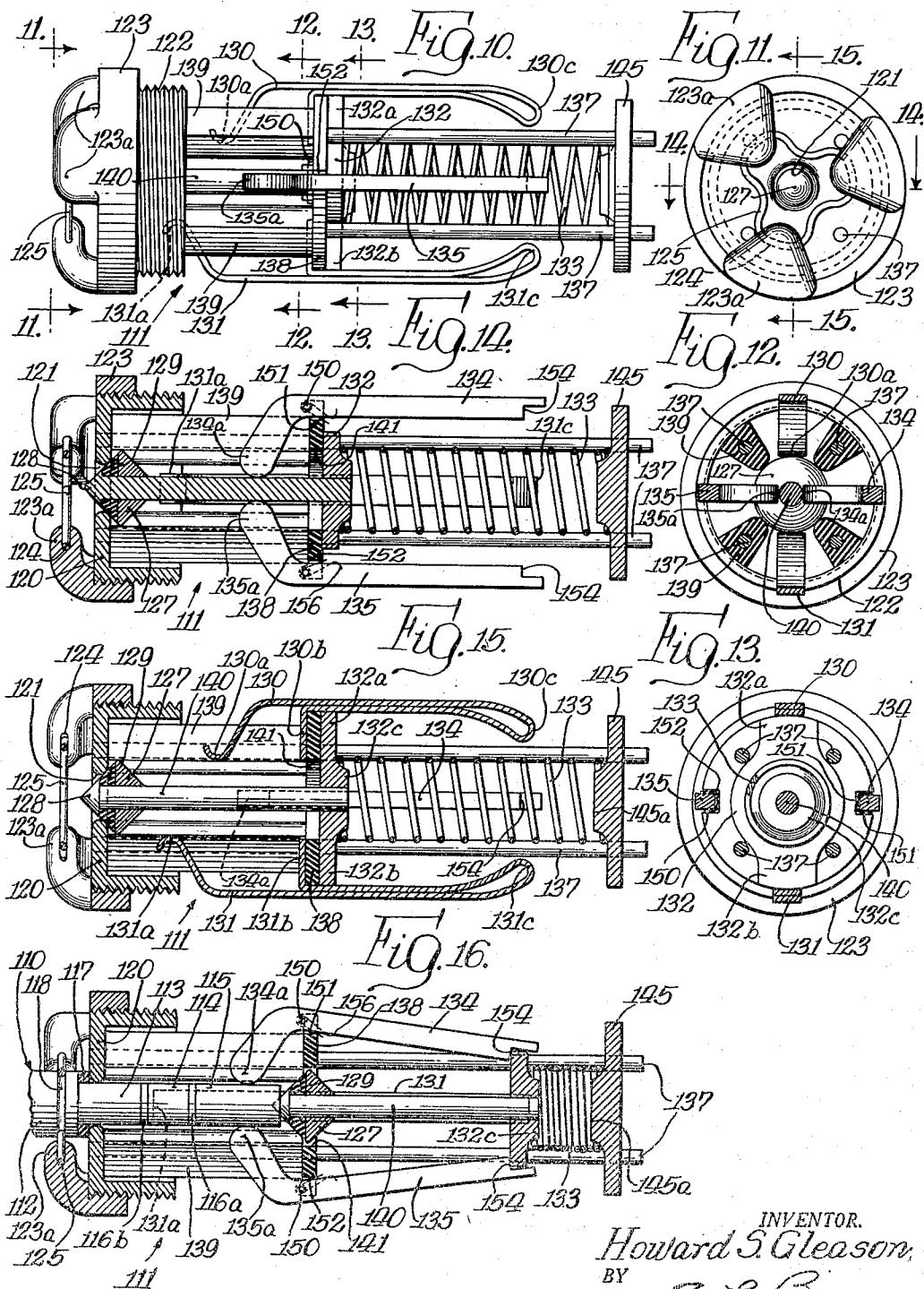
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UNITED STATES PATENT OFFICE

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WATERTIGHT PLUG AND JACK

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1

The present invention relates to a multi-contact water tight plug and jack and more specifically to a three contact plug and jack arrangement which is completely sealed against water or other foreign material such as sand or the like, both when the plug and jack are in engagement as well as when they are disengaged.

Plugs and jacks are extensively employed in all sorts of communication devices. Many times it is desirable to provide an arrangement which is unaffected by moisture, water, foreign objects and the like, and which will function well under adverse conditions where conventional plugs and jacks are never called upon to operate. It would be desirable to provide a multi-contact plug and jack arrangement in which the contact surfaces on both the plug and the jack are completely protected at all times.

It is an object of the present invention to provide a new and improved multi-contact plug and jack in which the contact surfaces on both the plug and jack are protected against moisture, water, sand and the like whether the plug and jack are in engagement or disengagement.

It is another object of the present invention to provide a multi-contact plug and jack which is small, compact and fool proof in operation regardless of adverse conditions under which it is required to operate, such as extreme ranges of temperature and in contact with moisture, water, sand and the like.

It is a further object of the present invention to provide a water tight multi-contact jack including positive means for moving the contacts of the jack into contacting engagement with an associated plug when such plug is inserted in the jack.

Still another object of the present invention is to provide a new and improved jack including a sealing plunger for sealing the opening therein when the plug is withdrawn and further including cammed contacts which are positively moved into engagement with the plug when the plug is inserted in the jack.

It is another object of the present invention to provide a multi-conductor plug and jack which is effectively sealed against water or moisture and which works satisfactorily under extreme temperature conditions with no sticking or jamming thereof.

It is another object of the present invention to provide a new and improved multi-contact plug and a new and improved multi-contact jack which are electrically as well as mechanically satisfactory, which are simple and inexpensive

2

to manufacture and which are fool proof in operation.

A still further object of the present invention is to provide a water tight plug and jack combination which may be locked in contacting engagement.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this application.

For a better understanding of the present invention reference may be had to the accompanying drawings in which:

Fig. 1 is a perspective view of the plug and jack of the present invention shown in locked contacting relationship;

Fig. 2 is an exploded perspective view of the plug of the present invention;

Fig. 3 is an enlarged sectional view of only the plug of the present invention;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3, assuming that Fig. 3 shows a complete device;

Fig. 5 is an enlarged sectional view of only the jack of the present invention taken substantially on line 5—5 of Fig. 6;

Fig. 6 is an end view of the jack of Fig. 5 looking in the direction of the arrows 6—6 of Fig. 5, and assuming that Fig. 5 shows a complete device;

Fig. 7 is a sectional view of the plug and jack of the present invention similar to Figs. 3 and 5, showing the plug and jack in the condition shown in Fig. 1;

Fig. 8 is a sectional view taken on line 8—8 of Fig. 7 assuming Fig. 7 shows a complete device;

Fig. 9 is a sectional view taken on line 9—9 of Fig. 7, also assuming Fig. 7 shows a complete device;

Fig. 10 is a view of a modified jack embodying the present invention;

Fig. 11 is a view taken along the line 11—11 of Fig. 10;

Fig. 12 is a sectional view taken on line 12—12 of Fig. 10;

Fig. 13 is a sectional view taken on line 13—13 of Fig. 10;

Fig. 14 is a sectional view taken on line 14—14 of Fig. 11;

Fig. 15 is a sectional view taken on line 15—15 of Fig. 11; and

Fig. 16 is a sectional view of the jack of Fig. 10 taken along line 14—14 of Fig. 11 and showing

the plug in position and the locking arms in locking engagement.

The present invention is primarily concerned with a three contact water tight plug and jack whereby water, moisture and other foreign material such as sand or the like is prevented from entering any part of the plug or jack whether the plug and jack are disconnected or the plug is inserted in the jack.

Referring now to the modification of the present invention illustrated in Figs. 1 to 9 of the drawings, the water tight three-contact plug 10 of the present invention and the cooperating water tight three-contact jack 11 of the present invention are shown in Figs. 1 and 7 with the plug locked in contacting engagement with the jack 11. The present invention is concerned with both the plug 10 and the jack 11 and each is separately described in detail in the following description.

Considering first the construction of the plug 10 of the present invention reference may be had to Figs. 2, 3 and 4 of the drawings. Essentially the plug comprises a hollow shell 12 having a threaded portion 12a at one end thereof and a flanged portion 12b at the other end so as to define at said other end a cable receiving opening of a cross section substantially less than the internal diameter of the hollow shell 12. A suitable multi-conductor cable 13 specifically illustrated as a three conductor cable, is adapted to be inserted through the opening defined by the flange 12b. The cable 13 is illustrated as an insulated cable and the three conductors are also individually insulated from each other. The plug 10 further includes a hollow sleeve 14 having a portion 15 of reduced cross section at one end which provides the so-called "sleeve contact" of the three contact plug 10 for engaging with a cooperating contact in the jack 11. The portion 15 of the sleeve 14 is separated from the remainder of the sleeve by an integral annular flange 16 whose outer diameter is very slightly larger than the internal diameter of the shell 12 to limit the position of the sleeve 14 when in telescopic relationship with the shell 12 as is clearly shown in Fig. 3 of the drawings, the flange 16 being engageable with the threaded end 12a of the shell 12. On the side of the flange 16 opposite the contact sleeve 15 there is provided a cylindrical portion 17 which is adapted to be telescoped within the shell 12. The end of this cylindrical portion 17 remote from the flange 16 is designated as 17a and includes a suitable sealing surface for cooperating with an annular sealing gasket 18 adapted to be compressed between the flange 12b and the annular sealing surface or end 17a. As is clearly illustrated in Fig. 3 of the drawings the sealing gasket 18 is compressed sufficiently so as slightly to deform the insulation on cable 13 thereby insuring a water tight seal at the opening in the shell 12 for receiving the cable 13. For the purpose of sealing the other end of the shell 12 the portion 17 adjacent the annular flange 16 is provided with an annular recess 19 for receiving a suitable sealing gasket 20.

In order that suitable electrical connections to be described hereinafter can readily be made between the individual conductors of the cable 13 and portions of the plug 10 an opening or window is cut into the cylindrical portion 17 between the recess 19 and the end portion 17a. Actually between these points the portion 17, as illustrated, is only a semi-cylindrical sleeve with the edges of this semi-cylindrical sleeve being clearly shown in Figs. 2 and 4 of the drawings and designated

as 17b. When the cable 13 extends through the end 17a of the sleeve portion 17 the ends of the individual conductors thereof, which conductors are specifically designated as 13a, 13b and 13c, are disposed so that when the shell 12 is removed access thereto can readily be had through the window or opening defined by virtue of the fact that the sleeve 17 between the recess 19 and the end 17a is only a semi-cylindrical sleeve. The sleeve contact 15 is provided adjacent the flange 16 with suitable means for retaining in fixed position a suitable face plate sealing gasket 21. As illustrated these means comprise a plurality of spaced peripheral ridges 22 which are adapted to deform the gasket 21 to hold the same, or the gasket 21 may be provided with cooperating recesses.

In order that the cable 13 may be held in fixed position relative to the sleeve 14 regardless of whether or not the conductors 13a, 13b and 13c are suitably fastened to some conducting portion or the like, there is provided a cable clamp 23 which may be rigidly clamped to the cable 13 as is clearly shown in Fig. 2 of the drawings. Suitable means are preferably provided to relate the cable clamp 23 to the sleeve 14 to prevent relative movement therebetween. Such means might comprise ears formed of punched out portions of the clamp 23 such as are shown at 23a in Fig. 2 of the drawings for engaging with the edges 17b of the semi-cylindrical portion of the sleeve 14. As illustrated the portion 17 of the sleeve 14 is recessed at 24 to receive the cable clamp 23, which recess may be designed so as to limit the movement of the cable clamp 23 and consequently the cable 13, along the longitudinal axis of the plug 10 should that be desirable or necessary. One of the conductors of the cable 13, and specifically the conductor 13a, has been illustrated as being electrically connected to the sleeve 14 and consequently to the sleeve contact 15. This electrical connection is specifically illustrated as comprising a suitable terminal 26 fastened to the end of the conductor 13a and a screw 27 threadedly engaging a tapped opening provided in the sleeve 14.

For the purpose of providing electrical contacts on the plug 10 in addition to the sleeve contact 15 so as to provide a three contact plug there are provided a ring contact 29 and a tip contact 30 which are arranged in spaced axial alignment with the sleeve contact 15. As illustrated the contacts 29 and 30 have a generally cylindrical outer surface with an external diameter substantially the same as that of the sleeve contact 15 so that the three contacts 15, 29 and 30 provide a rod like plug portion for insertion into a cooperating jack such as 11, with the individual contacts however being electrically insulated from each other as is clearly shown in Fig. 3 of the drawings thereby providing tip, ring and sleeve contacting surfaces. The ring contact 29 is spaced axially from the sleeve contact 15 by a predetermined amount which axial space is filled with suitable insulating material designated as 31a in Fig. 3 of the drawings. Similarly the tip contact 30 is spaced axially from the ring contact 29 by a predetermined amount which axial space is filled with a suitable insulating material designated as 31b in Fig. 3 of the drawings. A slight recess 32 is defined in the end of the tip contact 30 which is adapted to receive the end of a suitable sealing plunger provided in the jack 11 to be described hereinafter, to insure better positioning during the plugging operation. For a purpose

which will become more apparent as the following description proceeds the ring contact 29 is provided with a circumferential locking groove 33 and the tip contact 30 is provided with a similar circumferential locking groove 34. These locking grooves are illustrated as having a somewhat V-shaped cross-section and are designated hereinafter as ring groove 33 and tip groove 34.

To enable electrical connection between the ring contact 29 and an appropriate one of the conductors within the cable 13 to be made readily, the ring contact 29 is provided with an integral sleeve like extension 35 of smaller outside diameter than the inner diameter of the sleeve 14 so as to define a space for insulating material therebetween when the sleeve like extension 35 is disposed in concentric relationship with the sleeve 14. The end of the sleeve like extension 35 is indicated as being provided with a tapped opening for receiving a screw 36 which in turn clamps the terminal 37 fastened to the conductor 13b in a manner to complete the electrical connection between the conductor 13b and the ring contact 29.

For the purpose of electrically connecting the remaining conductor 13c to the tip contact 30 there is provided a rod 39 having a threaded end screwed to the tip contact 30 as is clearly shown in Fig. 3 of the drawings. This rod 39 is adapted to be disposed in concentric relationship with the sleeve 14 and the sleeve like extension 35 with a suitable annular space capable of being filled with insulating material being defined between the rod 39 and the sleeve like extension 35. As illustrated in Fig. 3 of the drawings the end of the rod 39 remote from the tip contact 30 is suitably welded or otherwise fastened to a member 40 having a tapped opening for receiving a screw 41 which in turn holds the contact terminal 43, electrically connected to the conductor 13c, in contacting engagement with the member 40 and consequently in electrical connection with the tip contact 30. With this arrangement the three conductors 13a, 13b, and 13c are respectively connected in current conducting relationship to the sleeve contact 15, the ring contact 29, and the tip contact 30. In order that the three contacts 15, 29 and 30 and the associated conductors are electrically insulated from one another, to provide annular contact surfaces which are spaced along the longitudinal axis of the plug with respect to one another, the annular space defined between the sleeve 14 and the sleeve like portion 35 and the annular space between the rod 39 and the portion 35 are preferably filled with an insulating compound which is liquid when hot and under pressure and cools to form a solid mass. The contacts 15, 29 and 30 and their integral concentrically arranged portions may be suitably held and the insulating compound 31 forced into the spaces defined therebetween including the axial spaces between the contacts themselves. Upon cooling the insulating material 31 hardens and holds the parts as a unitary assembly with the conducting parts suitably insulated from each other.

For the purpose of closing the opening which affords access to the terminals 26, 37 and 43, there is provided a sheet of insulating material such as is designated by the reference numeral 45 which is preferably wrapped around the portion 17 of the sleeve 14 in a manner to substantially completely surround the same. Such in-

insulating material might comprise a sheet of varnished cambric or similar material. It should be understood that the gaskets 18, 20 and 21 are preferably formed from any suitable gasket material which provides long life and insures proper sealing action under the same extremes of temperature as the complete plug and jack.

For the purpose of clamping the shell 12 and the sleeve 14 into sealed relationship there is provided a coupling member 50 and a gasket shield 51. The coupling member 50 is threaded internally from each end in the manner of a pipe coupling, with the threads at one end engageable with the threaded portion 12a of the shell 12. The gasket shield 51 is provided with an externally threaded portion for engaging with the threads at the other end of the coupling 50. The other portion of the gasket shield 51 is adapted to extend over the major portion of the face plate engaging gasket 21 to protect and hold the same in proper position as shown in Fig. 3 of the drawing. The shield 51 further includes a counterbored portion at the threaded end so as to define a shoulder 51a for engaging with the annular flange 16. The collar 50 may first be applied to the shell 12 after the other parts of the plug are assembled. By means of the shield 51 and by virtue of the shoulder 51a therein the sleeve 14 is forced into sealed telescopic relationship with the shell 12 in a manner so that the ends of the threaded portions of both the shell 12 and the shield 51 are pulled substantially into contacting engagement. It will be apparent that the shell 12 provides a satisfactory handle by which the plug 10 may be grasped by the operator in performing any plugging or unplugging operation. By virtue of the spaced peripheral ridges 22 on the sleeve contact 15 the face plate sealing gasket 21 is also firmly held in position by means of the shield 51. From an examination of Fig. 7 of the drawings it is apparent that the face plate sealing gasket 21 is slightly deformed at its tip when the plug 10 is fully inserted in the jack 11 to be described hereinafter thereby providing a suitable seal at the entrance to the jack 11 when the plug 10 is inserted therein. Also by virtue of the gaskets 18 and 20 moisture and other foreign material is completely excluded from the plug 10. The water tight three-contact jack of the present invention for cooperating with the plug 10 described in detail above is best shown in Figs. 5 to 9 inclusive of the drawing. Essentially the jack 11 comprises a face plate 60 within which there is defined a suitable orifice 61 having a diameter so as to just receive the plug portion of the plug 10 comprising the ring contact 29 and the tip contact 30. Preferably the sleeve contact 15 engages with the walls of the orifice 61 to provide an electrical connection which is preferably the ground connection. For the purpose of providing a watertight jack construction the orifice 61 is adapted to be sealed when the plug 10 is inserted therein by the face plate engaging gasket 21 described above which sealingly engages the face plate as is clearly shown in Fig. 7 of the drawings. In order that this orifice or opening 61 is sealed at the instant the plug is removed therefrom there is provided a conical sealing plunger 62 having a rounded metal nose piece or end 63 which is capable of being received within the recess 32 of the tip contact 30 in the manner mentioned above. A suitable gasket 64 having a conical external configuration forms a part of the plunger 62 and

is disposed so as sealingly to engage the edge of one end of the orifice 61. By employing a conical sealing plunger to seal a circular orifice proper sealing is not dependent on previous perfect alignment. Furthermore, a line contact seal with even wear is assured. By the nature of the design any foreign particles getting on the sealing surfaces would be easily extruded.

The other important elements of the jack 11 comprise a plurality of contact springs specifically designated as 65, 66 and 67 and a contact cam generally designated at 68 for camming the contacts into and out of engagement with the plug 10 both to make electrical contact and also to lock the plug and jack into contacting engagement. A helical spring 69 provides the necessary force for biasing the conical plunger 62 into sealing engagement with the orifice 61.

Considering now the elements of the jack 11 in detail it may be observed that the face plate 60 best shown in Figs. 1, 6 and 9, essentially comprises a rectangular plate with suitable openings 70 therein for fastening the same to a suitable panel board or the like. The plug entrance side of the face plate 60 is provided with a plurality of plug guide posts 71, four of such guide posts being illustrated in the drawings for guiding the plug during the initial part of a plugging operation and to serve to strengthen the plug from lateral blows. The other face of the face plate 60 is provided with a circumferential ring 72 which may be integrally formed with the face plate 70 and the plug guide posts 71. The circumferential ring 72 may provide a suitable sealing surface for a container not shown which may enclose the jack 11 and maintain the same in water proof condition. It may be that the entire panel board upon which jacks such as 11 are mounted is a sealed unit in which case the circumferential flange 72 performs the function of centering the face plate 60 in a suitable opening which must be defined in the panel board to receive the jack 11.

For the purpose of supporting the guide cam 68 for reciprocal movement and also for suitably supporting the helical spring 69 there are provided a plurality of helical spring guide posts 74 which extend from the face plate 60 in the opposite direction from the plug guide posts 71. The helical spring guide posts 74 are spaced around the orifice 61, three such posts being shown in the drawing, (Figs. 8 and 9). These helical spring guide posts 74 may be fastened to the face plate in any suitable manner such as by welding or as illustrated by threaded engagement with suitable tapped openings in the face plate 60.

The contact cam generally designated at 68 is adapted to be reciprocally movable along the guide posts 74 and accordingly the contact cam which is illustrated as a disk shaped cam member preferably formed of insulating material, is provided with a plurality of openings 75 for receiving the guide posts 74. For providing additional strength the disk like portion of the contact cam 68 is provided with a reinforcing ring 76 which may be embedded in a suitable recess defined around the periphery of the disk shaped portion of the contact cam 68. Although the openings 75 cooperating with the guide posts 74 satisfactorily guide the movement of the contact cam 68, to further insure accurate movement thereof there are provided a plurality of stabilizing fingers 78 extending from the disk shaped portion in a direction away from the face plate 60.

Each stabilizing finger 78 of the contact cam 68 is provided with an enlargement 78a for engaging with the associated helical spring guide post 74. The enlargements 78a tend to slide along the guide posts 74 thereby providing stable movement of the contact cam 68. If desired the stabilizing fingers 78 may be provided at their upper ends with suitable extensions 80 to provide stops for limiting the maximum movement of the contact cam 68 from the face plate 60 in a manner which will be more clearly understood as the following description proceeds.

In accordance with the present invention the contact cam 68 is rigidly fastened to the plunger 62 so that movement of the plunger 62 causes movement of the contact cam 68 and vice versa. To fasten the plunger 62 to the contact cam 68 the latter is provided with a central opening 81 in which is disposed a flanged sleeve 82 preferably molded into the walls defining the opening 81 in the disk portion of the contact cam 68. The flanged sleeve 82 defines a shoulder 83 in the opening 81. The metal nose piece 63 of the conical plunger 62 preferably includes an intermediate annular flange 84 and a rivet like portion 85 which latter portion extends into the opening 81 beyond the shoulder 83. The rivet like portion 85 may be peened over against the shoulder 83 as is clearly shown in Fig. 5 of the drawings firmly to fasten the conical plunger 62 to the contact cam 68 with the annular flange 84 engaging the end of the flanged sleeve 82 not engaged by the peened over portion 85. If desired a suitable sealing cement generally designated at 86 may be disposed within the opening 81 above the conical plunger 62.

From the description included thus far it is apparent that the helical spring 69 is disposed within the confines of the helical spring guide posts 74 with one end thereof engaging the contact cam 68 around the opening 81 defined therein. For the purpose of providing a suitable support against which the other end of the helical spring 69 may act there is provided a suitable disk-like member 90 which may be fastened in any suitable manner to the ends of the guide posts 74 not fastened to the face plate 60. Any suitable means for relating disk 90 with the guide posts 74 may be employed, such for example as welding, riveting or the like. As illustrated the ends of the guide posts 74 are threaded as indicated at 91 and are of reduced cross section so as to defined suitable shoulders to support the disk 90. Nuts 92 may be provided for the threaded ends 91 of the guide posts 74 extending through the disk 90. With this arrangement it is apparent that the face plate 60, the guide rods 74 and the disk 90 form a sort of pedestal for guiding and supporting both the contact cam 68 and the helical spring 69 and these members form a subassembly of the jack. It will be understood that the helical spring 69 will be compressed between the contact cam 68 and the disk 90 before the disk 90 is fastened to the guide posts 74.

As illustrated in Figs. 5 and 7 of the drawings a suitable stop member 93 is disposed within the confines of the helical spring 69. The stop member 93 is provided with a suitable threaded extension 94 of reduced cross section adapted to extend through an opening in disk 90. Preferably the stop member 93 is fastened to the disk 90 by soft solder or any other suitable means so as to hold it in the position shown in Fig. 5 of the drawings to aid in assembling other parts of

the apparatus to be described hereinafter. The function of the stop member 93 is clearly indicated in Fig. 7 of the drawings where the contact cam 68 is illustrated as in engagement with the stop 93 to limit the maximum movement thereof away from the face plate 60 during the plugging operation. In the event that the extensions 80 on the stabilizing fingers 78 are provided, stop member 93 may be dispensed with since the extensions 80 may be employed to engage with a suitable portion of the jack to limit the maximum movement of the contact cams 66 from the face plate 60. Although both means for limiting the movement of the contact cam 68 are illustrated it should be understood that one or the other alone will be sufficient.

For the purpose of supporting the contact fingers 65, 66 and 67 (which are preferably formed of beryllium copper) in the desired insulated relationship there is disposed above the disk 90 as viewed in Fig. 5 of the drawings a suitable insulating disk 96 having recessed openings for accommodating the nuts 92 associated with the upper ends of the helical spring guide posts 74. The insulating disk 96 preferably includes a sleeve like extension 97 for enclosing the threaded extension 94 and thereby insulating it from the contact fingers 65, 66 and 67. The threaded extension 94 therefore holds the disk 96 in position. The contact fingers 65, 66 and 67 include portions 65a, 66a and 67a respectively extending generally at right angles from the main body portion of the contact so as to lie substantially parallel with the insulating disk 96. These portions 65a, 66a, and 67a best shown in Fig. 6 of the drawings each include an opening through which the sleeve like extension 97 is adapted to extend. The ends of these right angled extensions 65a, 66a and 67a respectively provide suitable terminals for making electrical connections thereto and are designated as 65b, 66b and 67b respectively. As illustrated the portion 67a of the contact finger 67, is slipped over the threaded extension 94 and the sleeve 97 so as to be disposed closely adjacent the insulating disk 96, being spaced therefrom only by a suitable washer such as 99 for example. If desired the washer 99 may be dispensed with entirely. As illustrated the portion 66a of the contact finger 66 is positioned in contacting engagement with the portion 67a of the contact finger 67 as is clearly shown in Fig. 5 of the drawings. A suitable insulating washer 100 is disposed between the portion 65a of the contact finger 65 and the portion 66a of the contact finger 66. For the purpose of fixedly holding these contacting fingers in position a suitable nut 101 and a washer 102 may be provided, the nut 101 engaging the threaded extension 94 to clamp the contact fingers into position. An insulating washer 103 is preferably inserted between the washer 102 and the portion 65a of the contact finger 65. As illustrated the contact fingers 65, 66 and 67 are displaced from one another by substantially 120° and to maintain this desired displacement the insulating disk 96 is preferably provided with a plurality of notches 105 spaced around the periphery thereof by angles of substantially 120°.

The reason that the member 68 has been designated as the contact cam is because one of its primary functions in accordance with the present invention is to cam the contacting fingers 65, 66 and 67 into contacting engagement with cooperating portions of the plug 10. Accordingly, the disk portion of the contact cam 68 is pro-

vided with cam openings 106 spaced so that the free ends of the contact fingers may extend there-through. The ends of the contact fingers are disposed at an angle so that the contact tips, which include bent portions 65c, 66c and 67c respectively for moving into the ring and tip grooves 33 and 34, are closer to the longitudinal axis of the jack than intermediate portions of the fingers which are bent to form shoulders 65d, 66d and 67d respectively. It will be apparent, that by virtue of this construction the movement of the contact cam 68 from the position shown in Fig. 5 of the drawings to the position shown in Fig. 7 of the drawings causes the contact fingers to move radially inward toward the longitudinal axis of the jack and consequently to engage cooperating portions of the plug 10 when it is inserted in the jack 11. The shoulders 65d, 66d and 67d are, in effect, locking shoulders so that when the cam moves above the shoulders as indicated in Fig. 7 of the drawings there is a tendency to hold the cam in this position and consequently lock the contacts into contacting engagement with the plug.

In accordance with the present invention the plug is adapted to be lockingly held in contacting engagement with the jack 11. This is accomplished by virtue of the provision of the ring groove 33 and the tip groove 34 in the plug 10 which receive therein the contacting portions 65c, 66c and 67c of the spring contacts 65, 66 and 67, the ring groove 33 receiving the electrically interconnected contact tips 66c and 67c while the tip groove receives the contact tip 65c. When the plug 10 is inserted in the jack 11 and the contact cam 68 is moved over the locking shoulders 65d, 66d and 67d which are arranged in a common plane, the contact cam remains locked in this position and the plug 10 is locked in the jack 11. This locking action occurs by virtue of the nature of the forces acting on the contact springs 65, 66 and 67. The plug 10 and the contact cam 68 are exerting opposing forces on the contact springs. The resultant force acting between the contact cam 68 and the shoulders or back sides of the rises in the contact springs is equal to the force of the spring 69 in its compressed condition. By proper design the spring contacts make electrical connection with the plug 10 and at the same time lock the plug in position when inserted into the jack 11.

With the arrangement described it will be apparent that when the plug and jack are in the position shown in Figs. 1 and 7 of the drawings that the conductor 13c of the cable 13 is electrically connected to the contact finger 65 while the conductor 13b is electrically connected to the contact fingers 66 and 67. The third circuit is completed between the sleeve contact 15 and the edges of the orifice 61 in the face plate 60 which may provide a suitable ground connection. In other words the third conductor 13a is electrically connected to the face plate 60 and consequently to ground. It should be understood that the reason for two contacts engaging with the ring groove 33 while only one contact engages with the tip groove 34 is to reduce the bending moment in the plug, thereby reducing uneven wear in the orifice 61 of the jack 11. If it were not for this, the third contact 67 might be dispensed with. However the third contact permits a more uniform distribution of the forces and consequently mechanical balance.

In view of the detailed description included above the operation of the plug and jack con-

11

struction shown in Figs. 1 to 9 of the drawings will be understood by those skilled in the art and no further discussion thereof is included herewith. When the plug is removed from the jack the conical plunger 62 seals the orifice 61 as is clearly shown in Fig. 5 of the drawings. When the plug is inserted in the jack the face plate sealing gasket 21 seals the orifice 61 as is clearly shown in Fig. 7 of the drawings. The spring contacts are cammed into position and perform the dual functions of completing the electrical circuit and performing a locking action to lock the plug and jack in engagement.

In Figs. 10 to 16 of the drawings there is illustrated a plug and jack construction embodying the principles of the invention described above but differing in structural details therefrom. Referring now to Figs. 10 to 16 of the drawings there is illustrated a jack generally designated at 111 and a cooperating plug, a portion of which is shown in Fig. 16 and generally designated by the reference numeral 110. The plug 110 comprises a shell 112 and the axially arranged sleeve contact 113, ring contact 114 and tip contact 115. These contacts are suitably insulated from each other in the manner described above and a portion of the insulation designated at 116a is disposed between the contacts 114 and 115 while another portion designated at 116b is disposed between the contacts 113 and 114. A face plate sealing gasket 117 is provided which may be substantially similar to the face plate sealing gasket 21 described above. Unlike the plug 10 described above the plug 110 has no circumferential locking grooves associated with the ring and tip contacts, but instead the shell 112 is provided with a circumferential locking groove 118 the purpose of which will become apparent as the following description proceeds.

The jack 111 comprises the basic elements of the jack 11 described above including the movable conical sealing plunger, the helical biasing spring for the plunger and the camming means for camming the contacts into contacting position in response to a predetermined movement of the sealing plunger from its sealing position with respect to an orifice defined in the face plate of the jack. Essentially the jack 111 comprises a face plate 120 within which there is defined a suitable orifice 121 having a diameter so as to just receive the plug portion of the plug 110 described above. Preferably the sleeve contact 113 engages with the walls defining the orifice 121 to provide an electrical connection which is preferably the ground connection. Unlike the face plate 60 which is adapted to be bolted to a suitable panel or supporting structure, the face plate 120 is illustrated as being of circular configuration with a cylindrical extension, the exterior surface of which is threaded as indicated at 122.

It will be apparent that with this arrangement the face plate 120 may be supported from a suitable support by clamping means threadedly engaging with the threads 122. One of the clamping means is illustrated in the drawings and comprises the member 123 which supports a plurality of plug guide posts 123a, three such guide posts being shown in the drawings to guide the plug 110 during the initial part of the plugging operation. Consequently the plug guide posts 123a are on the plug entrance face of the face plate 120. The member 123 is in effect a nutlike member including the integral extensions 123a defining the guide posts. The guide posts 123a are furthermore provided with cooperating grooves 124 for

12

receiving and supporting a cloverleaf shaped locking spring 125 which is clearly shown in Figs. 10 and 11 of the drawings. When the plug 110 is fully inserted into the jack 111 as shown in Fig. 16 of the drawings the portions of the cloverleaf shaped locking spring 125 having the smallest diameter are adapted to engage with the locking groove 118 so as to lock the plug and jack in contacting engagement.

In order that the orifice 121 is sealed at the instant that the plug 110 is removed therefrom there is provided a conical sealing plunger 127 having a metal nose piece 128 which is capable of being received within a recess defined in the tip contact 115 as is indicated in Fig. 16 of the drawings. A suitable gasket 129 having a conical external configuration forms a part of the plunger 127 and is disposed so as to sealingly engage the edge of one end of the orifice 121. The reason for employing a conical sealing plunger was fully discussed above.

The important elements of the jack 111, in addition to those already mentioned are a plurality of contact springs 130 and 131, a contact cam 132 for camming the contacts into and out of engagement with plug 110, a helical spring 133 for biasing the conical plunger 127 into sealing engagement with the orifice 121, and a pair of pivotally mounted locking arms 134 and 135.

For the purpose of supporting the elements of the jack described above and particularly for supporting the conical plunger in reciprocating relationship with reference to the orifice 121 there is provided on the side of the face plate 120 opposite from the guide posts 123a a suitable support comprising a plurality of helical spring guide posts 137 in the form of slender metal rods which have the ends thereof fastened to the face plate 120 and extend therefrom in spaced parallel relationship, parallel with an axis extending through the center of the orifice 121. Four such rods disposed in equally spaced relationship around the orifice 121 are provided. The support comprising the helical spring guide posts 137 includes a stationary insulating supporting disk 138 suitably supported intermediate the ends of the guide posts 137. Preferably the insulating disk 138 may comprise an integral part of a plurality of insulating guide posts 139 best shown in Fig. 12 of the drawings which include suitable openings for receiving the ends of the helical spring guide posts 137 adjacent the face plate 120. These insulating guide posts 139 will prevent the plug 110 from electrically engaging one of the metal helical spring guide posts 137 during the plugging operation.

The contact cam generally designated at 132 is adapted to be reciprocally movable between the guide posts 137 as is clearly indicated in Fig. 13 of the drawings and includes a pair of lateral extensions 132a and 132b which provide the camming surfaces for camming the spring contacts 130 and 131 in a manner to be described hereinafter. An examination of Fig. 13 indicates that the particular shape of the contact cam 132 causes it to be maintained in a predetermined manner throughout its movement along the longitudinal axes of the guide posts 137. The contact cam 132 is provided with a central raised portion 132c for centering one end of the helical spring 133.

As in the embodiment described above the contact cam 132 is rigidly fastened by means of a connecting rod 140 with the plunger 127 whereupon movement of the plunger 127 causes reciprocal movement of the contact cam 132. To permit

this connection between the plunger 127 and the contact cam 132 which are disposed on opposite sides of the supporting disk 138 the latter is provided with an opening 141 of sufficient extent to permit not only of the passage of the connecting rod 140 but also the sealing plunger 127.

The contact springs 130 and 131 are illustrated as each comprising a strip of spring contact material bent back upon itself in the form of a loop with the major portion thereof parallel with the axis of the jack 111. One end of the contact spring 130 is bent radially toward the longitudinal axis of the jack and provided with a contact portion 130a. A corresponding end of the contact spring 131 is also bent radially toward the longitudinal axis of the jack 111 and provided with a contact portion 131a. The contact portions 130a and 131a are displaced in the direction of the longitudinal axis of the jack 111 as is clearly shown in Figs. 10 and 15 of the drawings so as respectively to engage the axially displaced tip and ring contacts 115 and 114 of the plug 110. The other ends of the spring contacts 130 and 131 are bent laterally as indicated at 130b and 131b respectively and suitably supported from the stationary insulating disk 138 as is clearly shown in Fig. 15 of the drawings. The lateral projections 130b and 131b effectively provide a pivot for the contact springs 130 and 131 respectively when the contact portions 130a and 130b are cammed radially inward to engage the plug 110 as described hereinafter. The right portions 130c and 131c of the contact springs 130 and 131 are bent radially toward the longitudinal axis of the jack 111 into the path of movement of the cam portions 132a and 132b respectively of the contact cam 132 so that upon a predetermined insertion of the plug 110 or in other words a predetermined movement of the plunger 127 away from the orifice 121 the contacting portions 130a and 131a will be moved into contacting engagement with the associated parts of the plug 110.

For the purpose of supporting the helical spring 133 in a manner to bias the plunger 127 into sealing engagement with the orifice 121 there is provided an end support 145 including a central portion 145a for supporting the other end of the helical spring 133 remote from the orifice 121. The end support 145 is fastened in any suitable manner to the guide posts 137 at the ends remote from the face plate 129. Consequently the helical spring 133 is adapted to be compressed between the contact cam 132 and the stationary support 145. The compressed condition of the helical spring 133 is illustrated in Fig. 16 of the drawings.

It will be understood that with the arrangement described thus far the helical spring 133 when compressed in the manner shown in Fig. 16 of the drawings will constantly tend to urge the plug 110 out of the jack 111 with a force sufficient to overcome the locking force provided by the cloverleaf spring 125 and the circumferential locking groove 118. In order to render the spring 133 ineffective under these conditions the locking arms 134 and 135 mentioned above are provided. These locking arms are pivotally mounted as indicated at 150 within diametrically opposed slots 151 and 152 respectively defined in the insulating supporting disk 138 so as to effectively provide pivotally mounted levers. The portions 134a and 135a respectively of the locking arms 134 and 135 to the left of the pivotal points 150 as viewed in Figs. 14 and 16 of the drawings are disposed at an angle so as to extend toward the connecting rod 140 and the plug 110 when the latter is inserted

into the jack 111. The other ends of the locking arms 134 and 135 are provided with shoulder portions 154 for engaging with the contact cam 132 in a manner clearly shown in Fig. 16 of the drawings. Suitable torsion springs 156 associated with the pivots 150 normally bias the locking arms 134 and 135 out of the locking position shown in Fig. 16 of the drawings and into the position shown in Fig. 14 of the drawings. Preferably the locking arms 134 and 135 are formed of non rigid material so that they may flex out of position when engaged by the plunger portion 127 while still being sufficiently rigid in compression to hold the spring 133 in the compressed locked position shown in Fig. 16 of the drawings. When the plug 110 is inserted fully into the jack 111 as shown in Fig. 16 of the drawings the tip contact 115 moves between the ends 134a and 135a of the locking arms 134 and 135 respectively so as to cause the shoulders 154 to move into engagement with the contact cam 132 thereby rendering the spring 133 ineffective to push the contact plug 110 out of the jack 111 whereby the clover leaf shaped locking spring 125 engageable with the groove 118 is sufficient to maintain the parts in locked contacting engagement.

In view of the detailed description included above the operation of the plug and jack arrangement shown in Figs. 10 to 16 inclusive of the drawings will be readily understood by those skilled in the art and no further discussion thereof is included herewith.

It will be understood that there have been disclosed a plurality of embodiments of a water tight multi-contact plug and jack comprising several very desirable features and including means for camming the jack contacts into engagement with the plug when the plug has been inserted a predetermined amount. The jack is completely sealed against the entrance of water, sand or other foreign material whether the plug is inserted therein or not and as is described above the plug is also sealed against the entrance of foreign matter such as water or the like. The constructions described above permit a very compact arrangement which is simple and relatively inexpensive to manufacture and which provides a substantially fool proof construction.

While there have been disclosed certain particular embodiments of the present invention it will be understood that the present invention is subject to various changes and modifications. It is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is desired to be secured by Letters Patent of the United States is:

1. A water tight jack comprising a support, a face plate associated with one end of said support having a plug receiving orifice defined therein, means comprising a conical movable sealing plunger for closing said orifice, spring means biasing said plunger into sealing engagement with said orifice, said plunger being movable out of a sealing position with reference to said face plate in response to the insertion into said orifice of an associated plug, spring contact means associated with said support movable radially toward and away from the longitudinal axis of said jack, and means responsive to a predetermined movement of said plunger away from said sealing position for moving said contacts radially toward said longitudinal axis.

2. A water tight multi-contact jack comprising

a plurality of spaced parallel rods defining a support, a face plate associated with one end of said support having a plug receiving orifice defined therein, a plurality of plug guide posts extending from said face plate, means comprising a movable sealing plunger for closing said orifice, spring means disposed between said rods for biasing said plunger into sealing engagement with said orifice, said plunger being movable out of a sealing position with reference to said face plate in response to the insertion into said orifice of an associated plug contact means associated with said support movable from a first position to a second position, and cam means rendered effective in response to a predetermined movement of said plunger away from said sealing position for camming said contacts into contacting engagement with a plug insertible in said jack.

3. A water tight multi-contact jack comprising a support, a face plate associated with one end of said support having a plug receiving orifice defined therein, means comprising a movable sealing plunger for closing said orifice, spring means biasing said plunger into sealing engagement with said orifice, said plunger being movable out of a sealing position with reference to said face plate in response to the insertion into said orifice of an associated plug, spring contact means associated with said support movable from a first position to a second position, said contact means including a plurality of axially displaced contacting portions, cam means rendered effective in response to a predetermined movement of said plunger away from said sealing position for camming said contacts into engagement with a plug inserted into said orifice.

4. A combined jack and plug comprising a jack face plate having a plug receiving opening defined therein, a stationary support comprising a plurality of rodlike members extending from said face plate, a contact cam slidable along said rod like members and confined by said rod like members to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means confined by said rod like members for biasing said plunger into sealing engagement with said opening, a plurality of spring contacts mounted in insulated relationship on said support, an elongated plug having three axially aligned contacts of substantially the same diameter, said plug being of such dimensions as to be insertible into said opening, said plunger being movable out of a sealing position with reference to said opening in response to the insertion of said plug, means on said cam for engaging said spring contacts to move contacting portions thereof radially inward to electrically engage said plug in response to a predetermined insertion of said plug into said jack, means controlled by said cam and rendered effective upon substantially complete insertion of said plug into said jack for releasably locking said spring contacts to said axially aligned contacts to hold said plug and jack in contacting engagement, and a resilient gasket sealing means on said plug engageable with said face plate around said opening when said plug and jack are in locked engagement for effectively sealing said opening.

5. A combined jack and plug comprising a jack face plate having a plug receiving opening defined therein, a stationary support comprising a

plurality of rodlike members extending from said face plate, a contact cam slidable along said rod like members and confined by said rod like members to movement along the longitudinal axis of said jack toward and away from said face plate, a conical sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means confined by said rod like members for biasing said plunger into sealing engagement with said opening, a plurality of spring contacts mounted in insulated relationship on said support, said plunger being movable out of a sealing position with reference to said opening in response to the insertion of an associated plug, and means on said cam for engaging said spring contacts to move contacting portions thereof radially inward electrically to engage said plug in response to a predetermined insertion of said plug into said jack.

6. A combined jack and plug comprising a jack face plate having a plug receiving opening defined therein, a stationary support comprising a plurality of rodlike members extending from said face plate, a contact cam slidable along said rod like members and confined by said rod like members to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means confined by said rod like members for biasing said plunger into sealing engagement with said opening, a plurality of spring contacts mounted in insulated relationship on said support, said plunger being movable out of a sealing position with reference to said opening in response to the insertion of an associated plug, means on said cam for engaging said spring contacts to move contacting portions thereof radially inward electrically to engage said plug in response to a predetermined insertion of said plug into said jack, and means rendered effective upon substantially complete insertion of said plug into said jack for releasably locking said plug and jack into contacting engagement.

7. A combined jack and plug comprising a jack support including a face plate having a plug receiving opening defined therein, a contact cam slidable along said support and confined by said support to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means associated with said support for biasing said plunger into sealing engagement with said opening, a plurality of spring contacts mounted in insulated relationship on said support, an elongated cylindrical plug insertible in said opening, said plug being provided with three axially aligned circular contacts of substantially the same diameter as said cylindrical plug, at least two of said circular contacts being provided with circumferential grooves, said plunger being movable out of a sealing position with reference to said opening in response to the insertion of said plug, means on said cam for engaging said spring contacts to move contacting portions thereof radially inward to electrically engage said circular contacts and to releasably engage and lock into said circumferential grooves of said plug in response to

a predetermined insertion of said plug into said jack, and cooperating means on said cam and support for limiting the movement of said plunger away from said sealing position.

8. A combined jack and plug comprising a jack support including face plate having a plug receiving opening defined therein, a contact cam slidable along said support and confined by said support to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means associated with said support for biasing said plunger into sealing engagement with said opening, a plurality of spring contacts mounted in insulated relationship on said support, an elongated plug insertable in said opening, said plunger being movable out of a sealing position with reference to said opening in response to the insertion of said plug, and means on said cam for engaging said spring contacts to move contacting portions thereof radially inward to electrically engage said plug in response to a predetermined insertion of said plug into said jack.

9. A combined jack and plug comprising a jack support including a face plate having a plug receiving opening defined therein, a contact cam movable relative to said support and confined by said support to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means associated with said support for biasing said plunger into sealing engagement with said opening, a spring contact mounted in insulated relationship on said support, a portion of said contact extending generally along the longitudinal axis of said plug, means defining a cam opening in said contact cam for receiving said contact whereby relative movement of said spring contact and said means defining said cam opening occurs in response to movement of said contact cam, and an elongated plug insertable in said face plate opening, said plunger being movable out of a sealing position with reference to said face plate opening in response to the insertion of said plug, said spring contact including an angular portion engageable by said means defining said cam opening to move a contacting portion thereof toward said plug in response to a predetermined movement of said contact cam upon insertion of said plug into said jack.

10. A combined jack and plug comprising a jack support including a face plate having a plug receiving opening defined therein, a contact cam slidable along said support and confined by said support to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means associated with said support for biasing said plunger into sealing engagement with said opening, a spring contact mounted in insulated relationship on said support, a portion of said contact extending generally along the longitudinal axis of said plug, means defining a cam opening in said contact cam for receiving said contact whereby relative movement of said spring contact and said contact cam occurs in response to move-

ment of said contact cam, said plunger being movable out of a sealing position with reference to said face plate opening in response to the insertion of an associated plug, said spring contact including an angular portion engageable by the means defining said cam opening to move a contacting portion thereof toward said plug in response to a predetermined movement of said contact cam upon insertion of said plug into said jack, and a shoulder on said spring contact engageable by the means defining said cam opening when said plug is fully inserted in said jack releasably to lock said plug and jack in contacting engagement.

11. A combined jack and plug comprising a jack support including a face plate having a plug receiving opening defined therein, a contact cam slidable along said support and confined by said support to movement along the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means associated with said support for biasing said plunger into sealing engagement with said opening, a spring contact mounted in insulated relationship on said support, a portion of said contact extending generally along the longitudinal axis of said plug, means defining a cam surface on said contact cam for slidably engaging said contact whereby relative movement of said spring contact and said cam surface occurs in response to movement of said contact cam, an elongated plug insertable in said face plate opening including a circumferential locking groove, said plunger being movable out of a sealing position with reference to said face plate opening in response to the insertion of said plug, said spring contact including an angular portion engageable by said cam surface to move a contacting portion thereof toward said plug so as to engage said locking groove in response to a predetermined movement of said contact cam upon insertion of said plug into said jack, and a shoulder on said spring contact engageable by said cam surface when said plug is fully inserted in said jack for releasably locking said plug and jack in electrical engagement.

12. A combined jack and plug comprising a jack face plate having a plug receiving opening defined therein, a stationary support comprising a plurality of rod like members extending from said face plate, a contact cam including openings therein for said rod like members and slidable along said rod like members in the direction of the longitudinal axis of said jack toward and away from said face plate, a sealing plunger for sealing said opening disposed between said contact cam and said face plate and fastened to said cam so that said cam and plunger move as a unit, spring means for biasing said plunger into sealing engagement with said opening, a plurality of spring contacts mounted in insulated relationship on said support and spaced angularly around the longitudinal axis of said jack, said spring contacts including contact portions disposed at different axial positions along the longitudinal axis of said jack, an elongated plug insertable in said opening, a resilient gasket sealing means carried by said plug said plunger being movable out of a sealing position with reference to said opening in response to the insertion of said plug, cooperating means on said contacts and said cam effective after a predeter-

mined insertion of said plug into said jack for moving said contact portions toward said plug electrically to engage the same, said sealing means being rendered effective upon substantially complete insertion of said plug into said jack for sealing the connection between said plug and jack.

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