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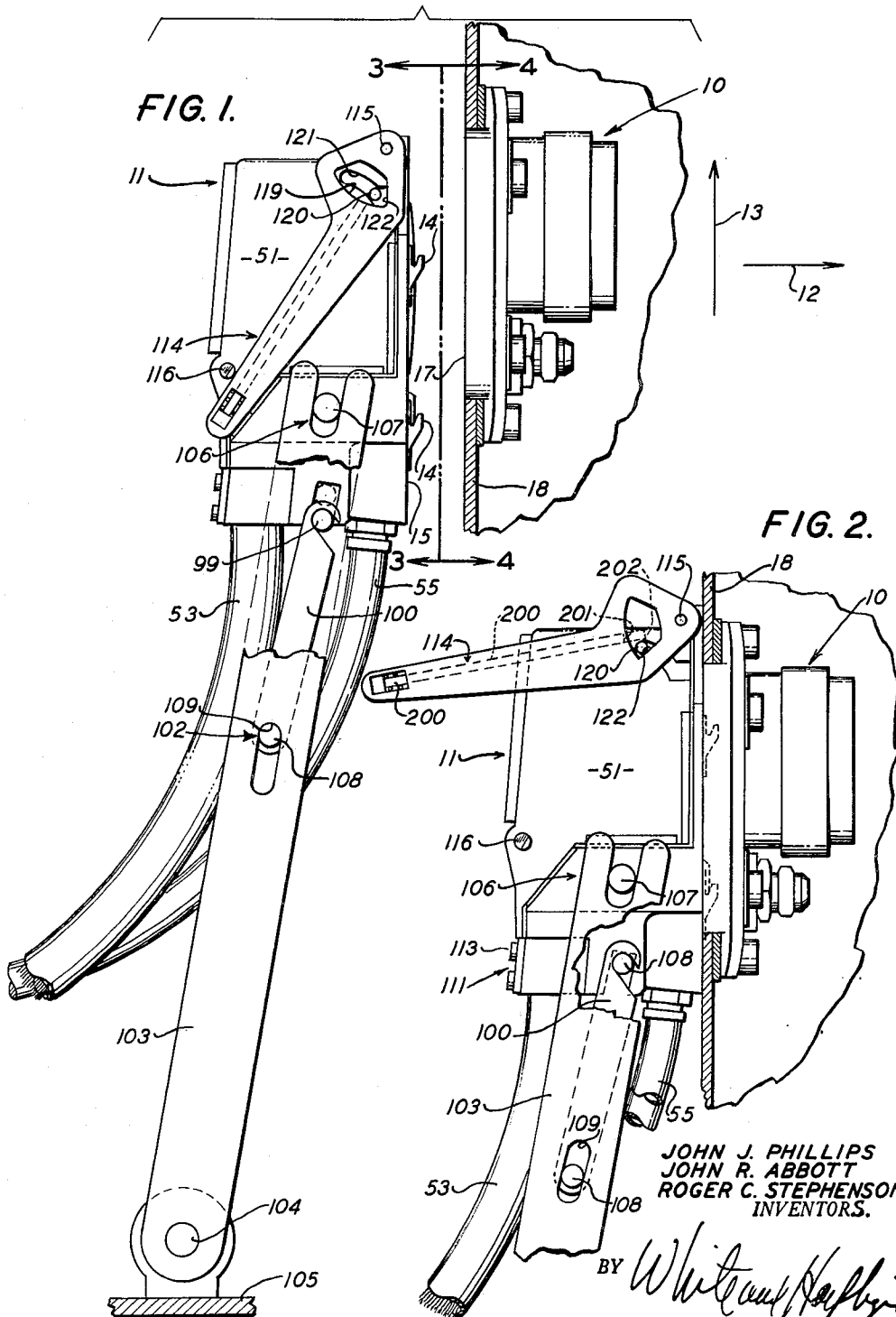
J. R. ABBOTT ET AL

3,119,645

UMBILICAL CONNECTION APPARATUS

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4 Sheets-Sheet 1



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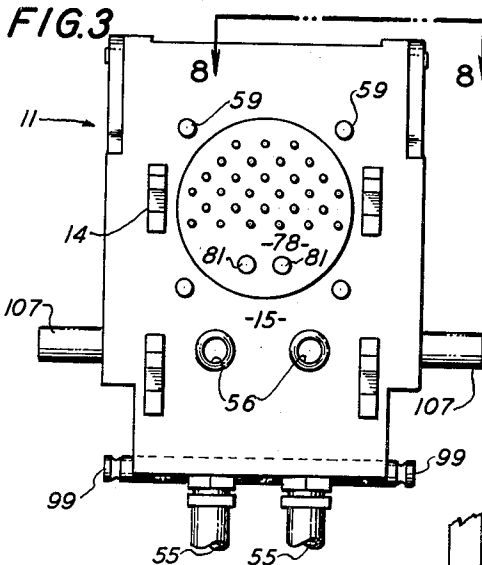
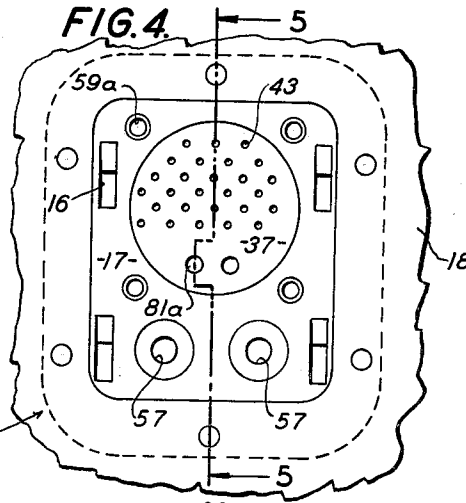
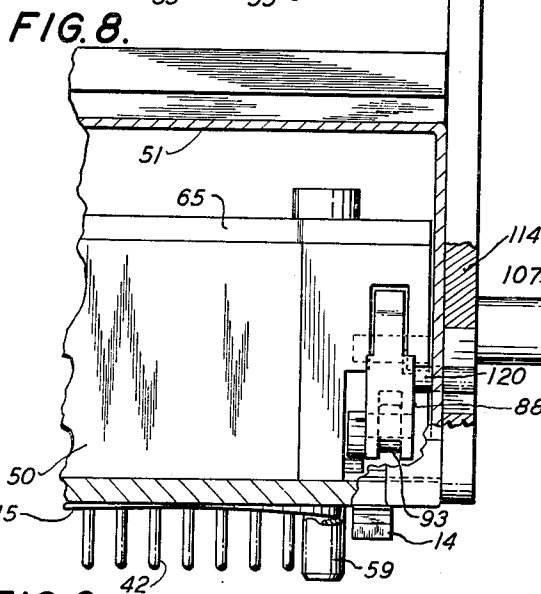
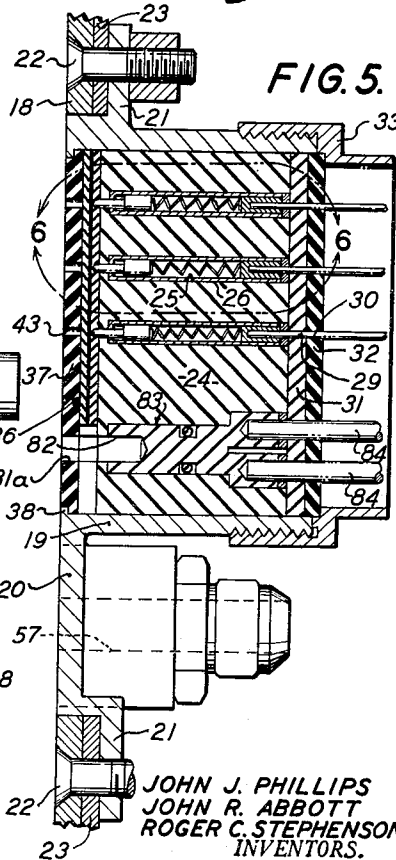
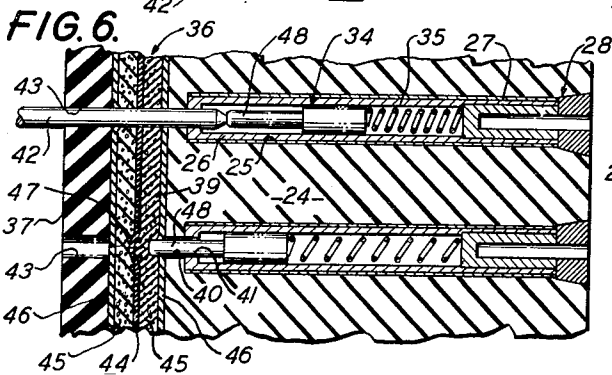
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UMBILICAL CONNECTION APPARATUS

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4 Sheets-Sheet 2



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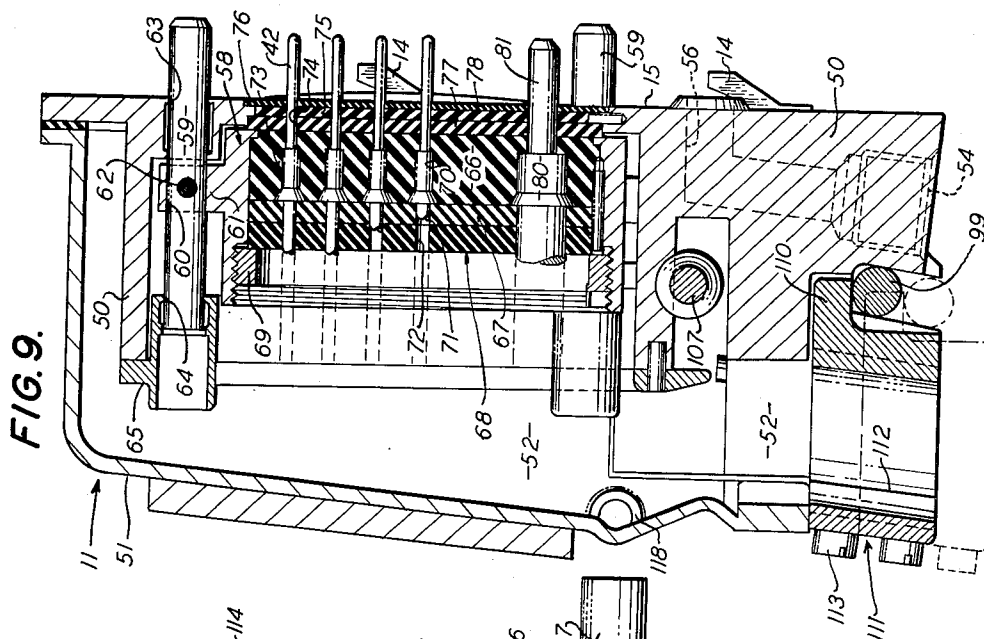
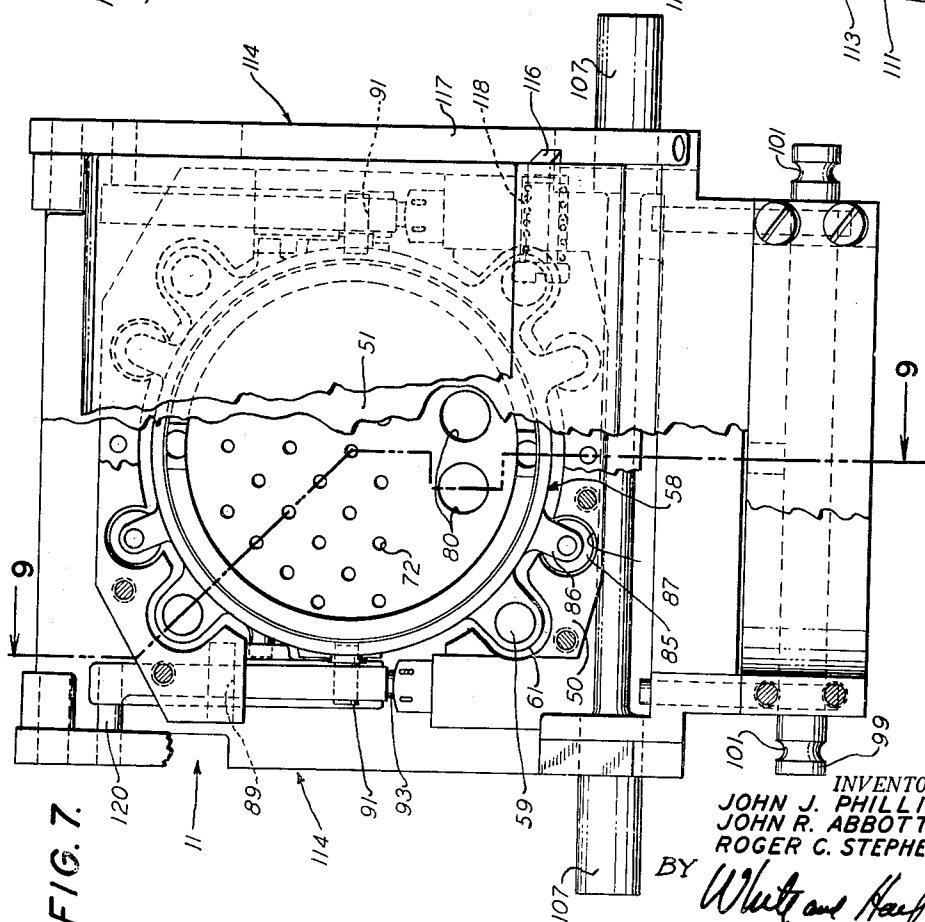
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UMBILICAL CONNECTION APPARATUS

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4 Sheets-Sheet 3



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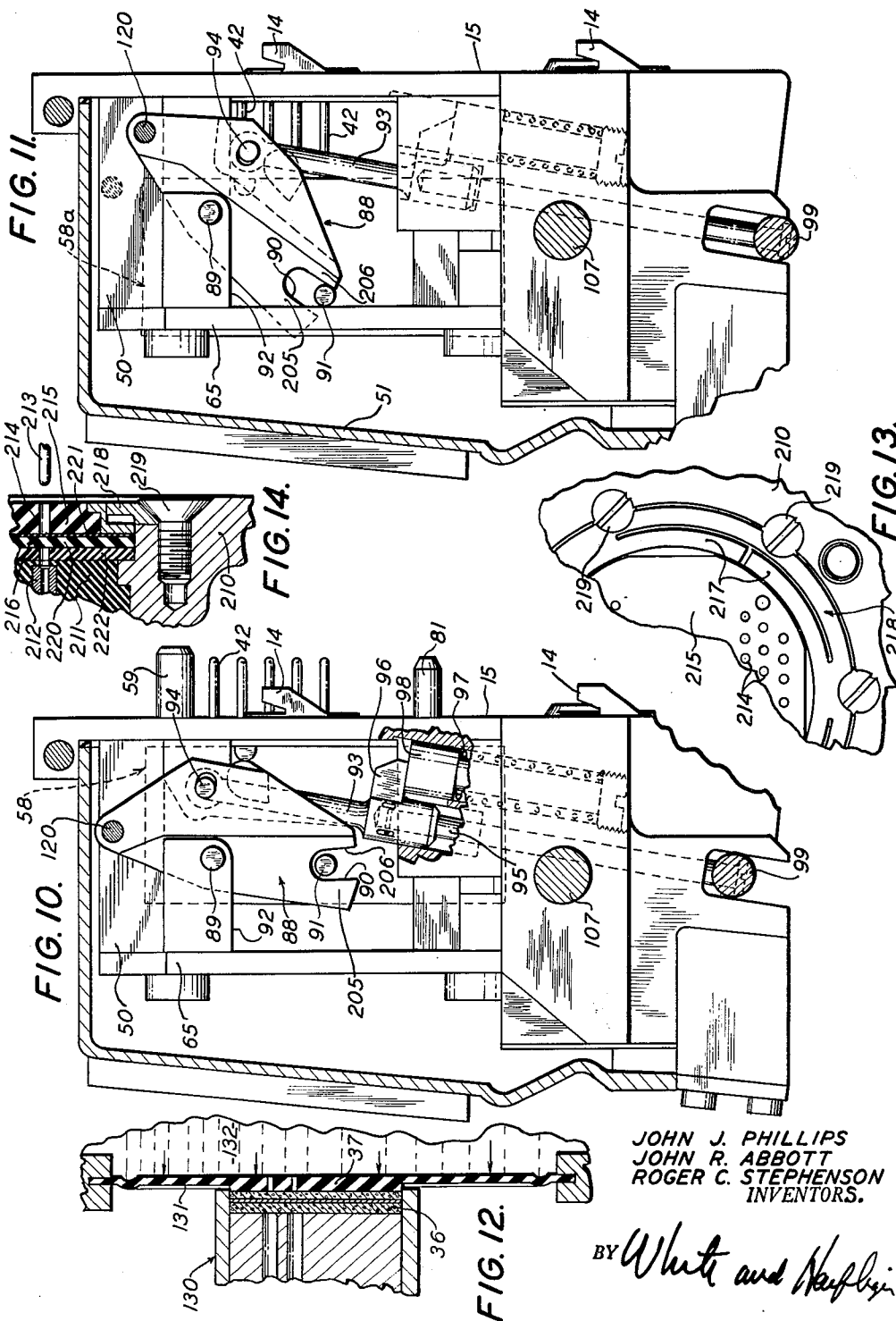
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UMBILICAL CONNECTION APPARATUS

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4 Sheets-Sheet 4



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3,119,645

UMBILICAL CONNECTION APPARATUS

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12 Claims. (Cl. 339-45)

This invention relates generally to umbilical type electrical connectors, and more particularly has to do with improvements in sealing the terminal sockets after withdrawal of terminal pins, and with improvements in actuating means for quickly disconnecting or withdrawing the pins from the sockets.

Apparatus with which the invention is concerned generally includes terminal connection members such as plug and receptacle members having multiple terminal pins and sockets adapted to interfit as the members are brought relatively together. In the past difficult problems have existed as respects sealing off of the sockets when the terminal pins are withdrawn therefrom, and as respects foolproof withdrawal of the pins from the sockets in response to sudden displacement of the plug carrying it free of the receptacle member.

A major object of the present invention has to do with the provision of novel barrier means overlying the terminal sockets on the receptacle member and adapted to be penetrated by the terminal pins, the barrier means being shiftable in response to compression loading thereof to seal off external fluid access to the sockets after withdrawal of the terminal pins therefrom. Typically, and as will be brought out in detail, such barrier means includes a pressurized viscous sealant layer confined or sandwiched between layers of compressed material such as elastomer spongelike material. When the pin members are withdrawn from this barrier means, the sealant layer immediately shifts to seal off access of fluid to the socket member, since the sealant remains under pressure exerted thereon by the confining layers of compressed material. Also, foolproof means is provided in the sockets to pressurize the confining layers of compressed material, as will be explained in detail.

Another major object of the invention has to do with the provision of novel actuating means associated with the plug member for moving the terminal pin carrier away from the receptacle sockets and barrier means, in foolproof manner. As will be brought out, such actuating means includes mechanism for camming the carrier, yieldable means for urging the came mechanism toward pin inserted position and a linkage having a lost motion connection for urging the cam mechanism toward pin retracted or withdrawn position. Also, such actuating means includes a cable holder retained by the linkage so that the cable which is connected to the terminal pins will actuate the linkage to urge the cam mechanism toward pin retracted position in the event the linkage fails of itself to carry out this function when the receptacle and plug start to move and exert tension on the linkage. Finally, the actuating means includes a handle actuator operable to independently move the cam mechanism toward pin inserted position, the handle being movable to allow withdrawal of the pins thereby to permit the receptacle to move away from the plug in a preselected direction, as will be brought out.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following detailed description of the drawings, in which:

FIG. 1 is an external side elevational view of the apparatus in disconnected condition, with plug pins retracted from the receptacle;

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FIG. 2 is an external side elevational view of the apparatus in connected condition, with plug pins inserted into the receptacle;

FIG. 3 is an elevational view of the terminal pin front face of the plug means, and taken on line 3-3 of FIG. 1;

FIG. 4 is an elevational view of the terminal socket face of the receptacle means, and taken on line 4-4 of FIG. 1;

FIG. 5, is an enlarged section taken on line 5-5 of FIG. 4;

FIG. 6 is an enlarged fragmentary showing of that portion of FIG. 5 indicated on line 6-6;

FIG. 7 is a rear face elevational view of the plug means and which is partly broken away to show interior details;

FIG. 8 is a partly broken away fragmentary top plan view of the plug, indicated by line 8-8 of FIG. 3;

FIG. 9 is a section taken on line 9-9 of FIG. 7;

FIG. 10 is a side elevation taken in section through the plug means to show the actuating means for the terminal pin carrier in pin inserted position;

FIG. 11 is a view like FIG. 10 but showing the actuating means in pin retracted position;

FIG. 12 is a side elevation taken in section through a receptacle means like that shown in FIG. 5, but modified to show a diaphragm for pressurizing the barrier means;

FIG. 13 is a fragmental view of the terminal jacket face of a modified receptacle; and

FIG. 14 is a fragmentary section taken on line 14-14 of FIG. 13.

In FIGS. 1 and 2 the umbilical connection apparatus is shown to include a receptacle body means 10 and a plug body means 11 which is adapted to interfit with the receptacle body means as the two are brought together. Locating means is provided for detachably securing the plug means to the receptacle means so as to block separation of the receptacle from the plug in a first direction indicated at 12 in FIG. 1, the locating means on the other hand allowing relative separation in a second direction of the receptacle movement indicated at 13 in FIG. 1, the latter direction being substantially normal to the said first direction 12. One way for accomplishing this purpose is to provide locating lugs 14 projecting outwardly from the face 15 of the plug, these lugs being adapted to interfit recessed locating shoulders 16 provided in the face 17 of the receptacle, these elements being more clearly shown in FIGS. 3 and 4. Since the locating lugs 14 project upwardly as seen in FIG. 1, the locating shoulders of the receptacle are adapted to fit downwardly over the lugs 14 when the faces 15 and 17 of the plug and receptacle are brought relatively together, it being understood that when the receptacle means is carried by a larger structure such as a missile body the skin of which is shown at 18, the plug means will be attached to the receptacle means. Accordingly, the locating means accommodates upward displacement or separation of the receptacle means in the direction 13 away from the plug means.

Referring now to FIGS. 4 through 6, the receptacle means 10 is shown to include a tubular body 19 which is flanged at 20 and 21 for connection to the panel 18 as by means of suitable connectors 22 and spacers 23. Contained within the tubular body 19 is a mass of material 24 which is insulative, and may comprise suitable resin. The latter contains a large number of bores 25 each of which contains a tubular electrical socket 26, the sockets being spaced apart and extending generally parallel as shown. Electrical connection is made to the end portions 27 of the sockets as by means of suitable connectors generally indicated at 28 in FIG. 6, and it will be understood that electrical leads are adapted to be joined to the connectors 28. Lead openings 29 and 30 are provided through elastomer seal 31 and back-up plate 32, the latter being held by a retainer 33 at the

rearward side of the insulative mass 24, as is seen in FIG. 5.

Contained within the forward portions of the tubular sockets are a series of followers 34 which are urged by compressive springs 35 toward a barrier means generally shown at 36. The latter is confined between the insulation 24 and a pressure plate 37 retained in position by the receptacle body at 38, it being understood that the barrier means is pressurized by the plate 37. Furthermore, the barrier means overlies the face 39 of the insulation material 24 and also the entrances 40 and 41 to the sockets 26, it being the purpose of the barrier means to seal off external fluid access to the sockets when terminal pins 42 have been retracted from the sockets.

The terminal pins are adapted to penetrate through openings 43 in the pressure plate and also through the barrier means 36 and the socket entrances 40 and 41 in order to make electrical connection with the sockets at their entrances 41. The barrier means is, in accordance with the invention, shiftable in response to compressive loading exerted by the plate 37, the extent and capability for such shifting being such as to positively insure against fluid access to the socket entrances. As is shown, the barrier means includes a pressurized viscous sealant layer 44 which may comprise a silicone-type grease. Furthermore, the layer 44 is sandwiched between layers of compressed material indicated at 45, the latter typically comprising elastomer sponge sheets or layers. Finally, the barrier means may include elastomer impregnated fabric layers 46 at opposite sides of the sponge layers 45.

The foregoing barrier means is readily penetrated by the terminal pins 42 as the latter are inserted into the sockets. On the other hand, when the pins are withdrawn through the barrier means, the pressure exerted through the sponge layers 45 is transmitted to the viscous sealant layer 44 which shifts or flows sufficiently to seal off the locus 47 of penetration typically as shown in FIG. 6. Furthermore, the projections 48 on the followers 34 are urged toward the terminal pins by the compression springs 35, and follow the pins in contact therewith as the pins are retracted, whereby the barrier means 36 is further pressurized by the followers for insuring a complete seal against fluid access to the sockets 26.

Referring now to FIGS. 3, 7 and 9, the plug body means 11 is shown to include a tubular inner housing 50 contained within an outer housing 51, the latter providing space 52 for the reception of cable means generally shown at 53 in FIG. 1. The outer housing also contains port means 54 for connection with a fluid line or lines 55 better seen in FIG. 1, extensions of such porting being shown in the housing 51 at 56 and in the receptacle housing at 57, all for the purpose of providing passages for fluid flow between the joined plug and receptacle.

FIG. 9 shows the inner housing 50 of the plug means to contain a carrier 58 which is shiftable between pin inserted position as shown in full lines in FIG. 10 and pin retracted or withdrawn position as shown by the full lines 42 in FIG. 11. The carrier is suitably guided between these two positions as by means of parallel guide pins 59 extending through guide openings 60 in flanges 61 integral with the carrier, the pins being attached to the flanges as indicated at 62. Furthermore, the pins extend through guide openings 63 and 64 respectively formed in the inner housing 50 and in a guide plate 65 attached to that housing.

Contained within the carrier 58 are a plug insert 66, a rear face seal 67 and a back-up plate 68 held in position by a retainer nut 69, the latter being threaded into the carrier 58. The elements 66 through 68 contain suitable bores 70 through 72 for the reception of terminal pins 73, the latter having projections 42 as previously

described, and which are adapted to penetrate the receptacle.

The pin projections 42 extend generally in parallel relation, and pass through openings 74 in a guide plate 75 which is retained within a bore 76 of the inner housing 50 and also between sealing layers 77 and 78. Accordingly, as the carrier 58 travels between pin inserted and pin retracted positions, the pin extensions 42 are guided by the plate 75.

FIG. 9 shows the inserts 66 and the elements 67 and 68 as also supporting a special and larger terminal pin 80, the enlarged forward extension 81 of which is adapted to penetrate the openings 81a in the receptacle pressure plate 37 seen in FIG. 5, and 82 in the electrical connector 83 also seen in FIG. 5. It will be understood that the connector is adapted to receive suitable leads shown at 84 in FIG. 5 for conducting current to electrical apparatus not shown. Finally in connection with movement of the carrier 58 in the housing 50, FIG. 7 shows compression springs 85 acting upon ears 86 integral with the carrier 58, the springs being received within guide openings 87 within the inner housing 50, and being endwise confined by the inner housing so as to exert release pressure tending to urge the carrier into pin withdrawn position as shown in FIG. 11.

Coming now to a description of the actuating means for moving the carrier between the positions shown in FIGS. 10 and 11, reference will be made to all of FIGS. 7 through 11. Such actuating means includes cam mechanism operatively connected with the carrier and movable relative to the housing 50 and cover 51 and between what also may be characterized for the cam mechanism as pin inserted position and pin retracted position. Typically such cam mechanism may be formed as shown generally at 88, and comprising two cams each of which is pivoted at locations 89 by suitable cam pins. The two cams contain slots 90 for receiving a pair of follower pins 91 projecting oppositely and at diametrically opposite sides of the carrier 58, the followers 91 being integral with the carrier. Accordingly, when the cams are rotated counterclockwise as seen in FIG. 10, the carrier is displaced toward pin inserted position by cam bosses 205, and when the cams are rotated clockwise, the carrier is displaced by cam bosses 206 to pin retracted position as shown in FIG. 11. The cam pivots 89 are suitably supported by extension 92 on the inner housing 50.

The actuating means also includes yieldable means for urging the cam mechanism toward pin inserted position and a linkage having lost motion connection for urging the cam mechanism toward pin retracted position. A preferred form of such yieldable means and linkage is shown in FIGS. 10 and 11 as including release pull rods 93 coupled to the cams 88 through pins 94, the rod having a lowered extension 95 and a sideward extension 96. A yieldable compression spring 97 urges a spacer 98 against the rod extension 96 to urge the rod 93 generally upwardly for pivoting the cam counterclockwise in FIGS. 10 and 11 and toward pin inserted position.

The lower ends of the release rod extensions 95 are joined to a transverse release shaft 99 adapted to be pulled generally downwardly by a disconnect link 100, the upper end extent of which hooks over the release shaft 99 at the points 101 as seen in FIG. 7. The disconnect links 101 are in turn connected through a lost motion connection generally indicated at 102 with a member 103 which is pivotally connected at 104 to a fixed base 105. The upper end extent of the member 103 is forked at 106 so as to fit trunnions 107 extending sidewardly from the plug housing, the trunnions acting to locate the upper end of the member 103 and also being capable of lifting clear of the member 103 when the plug housing is displaced upwardly. During such upward displacement of the plug housing, the clearance of the lost motion connection 102 is taken up by upward travel of the projection 108 on the link 100 to the upper end of the slot 109 in the member

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103, for the purpose of preventing further upward travel of the link 100. Accordingly, as the plug housing is lifted beyond this point, the release rod 93 is prevented from further upward travel and the cam mechanisms 88 pivot clockwise to displace the terminal pins to retracted position thereby freeing the receptacle 10 for independent upward travel relative to the plug housing 11.

It will be observed in FIG. 9 that the release shaft 99 underlies a lug 110 on a cable holder 111, the latter containing an opening 112 through which the cable 53 extends downwardly from the space 52. Since the cable holder 111 is rigidly attached to the cable 53, as by means of clamping screws 113, any tendency for the cable 53 to stop traveling upward with the plug housing 11 will result in a downward loading of the lug 110 against the release shaft 99, thereby effecting retraction of the terminal pins from the receptacle means 10. Such alternate release of the terminal pins as by cable tension acts as a foolproof disconnect means as respects the plug means and receptacle means, in the event that the link 100 fails to function in cooperation with the release shaft as previously described, such failure perhaps being caused by inadvertent failure to hook the link 100 over the release shaft. In this connection, it will be understood that the cable 53 can stretch upwardly only to limited extent by virtue of its connection to apparatus integral with the base 105.

Finally, the actuating means for the carrier 58 includes a handle actuator 114 operating when swung clockwise as seen in FIGS. 1 and 2 to independently move the cam mechanism 88 toward pin inserted position. For this purpose, the handle actuator is pivoted at 115, and when it is not desired to insert the terminal pins into the receptacle means, the handle is stowed in the position shown in FIG. 1. Under these conditions, the handle is retained in stowed position by stow pins 116 better seen in FIG. 7 as being urged into blocking relation to the handle arm 117 by a compression spring 118. Cutouts 119 in the handles 114 receive cam pins 120 projecting from the cams 88 and through slots 121 in the housing cover 51. The cutouts 119 in the handle actuator are so arranged as to provide shoulders 122 for engaging the cam pins 120 and displacing them to rotate the cams counterclockwise carrying the terminal pins into pin inserted position, the full extent of which corresponds to the full clockwise terminal position of handle rotation shown in FIG. 2. Under these conditions, the operator knows that the terminal pins are fully inserted into the receptacle means. Thereafter, the handle actuator 114 may be rotated back to stowed position, and reliance may be placed upon the aforementioned actuating means for releasing the terminal pins from the receptacle means. Release of the terminal pins may alternately be effected by pushing spring loaded plunger 200 to cause the forward end 201 thereof to move to the position 202 shown in FIG. 2, whereby the plunger will then push pin 120 in a clockwise direction upon counterclockwise swinging of handle 114.

Referring now to FIG. 12, which shows an alternate receptacle means 130, the latter will be understood as being the same as or similar to the receptacle means 10 previously described, with the exception that the pressure plate 37 is made integral with a larger diaphragm 131 which is sufficiently flexible to allow the pressure plate to move toward the barrier means 36 for pressurizing the latter. On the other hand, the diaphragm 131 is sufficiently stiff to transmit the full pressure of the fluid 132 acting against the overall extent of the diaphragm and pressure plate to the latter, whereby the pressure effect is multiplied and accordingly the sealing action of the barrier means is enhanced.

FIGS. 13 and 14 show a modified receptacle which is generally similar to the receptacle means 10, but with certain differences. The receptacle body 210 contains a block of electrically insulative material 211 for housing a large number of tubular electrical sockets 212 with which terminal pins 213 are adapted to make connection.

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Such connection is made when the pins 213 are caused to penetrate through openings 214 in the pressure plate 215, through the barrier means 216 and then into the entrances to the sockets 212.

The barrier means is confined between the insulative block 211 and the pressure plate 215 and is pressurized by plate 215, which is in turn pressurized by spring fingers 217 on a ring 218 attached to body 210 by fasteners 219. The barrier means shown comprises a layer of gelatinous material 220 retained between elastomer sheets 221 and 222, these being subject to penetration by the pins 213. The gel material 220 is dielectric, is capable of flowing under pressure to eliminate the pin formed penetration openings for sealing purposes, and may typically comprise the commercial product known as Silguard #51, which is a silica gel obtainable from Dow Corning Corp., Midland, Michigan. As is clear from FIGS. 13 and 14, the fingers 217 are yieldable to allow movement of plate 215 in a direction away from the barrier means.

We claim:

1. In umbilical connection apparatus, the combination comprising receptacle means, terminal sockets carried within said receptacle means and having entrances near one side of said receptacle means, barrier means overlying said socket entrances, plug means detachably secured to said receptacle means at said side thereof, terminal pins projecting from said plug means and penetrating through said barrier means and into said terminal socket entrances, said barrier means being under compressive loading and being shiftable in response thereto to seal off external fluid access to said entrances after withdrawal of said terminal pins from said socket entrances and from said barrier means upon separation of said plug means from said receptacle means, said plug means including a housing, a terminal pin carrier movable in said housing toward and away from said barrier means, and actuating means for moving said carrier away from the barrier means to withdraw the terminal pins from the socket entrances, said actuating means including cam mechanism operatively connected with the carrier and movable relative to the plug housing and between pin inserted position and pin retracted position, said actuating means including yieldable means for urging said cam mechanism toward pin inserted position and a linkage having a lost motion connection for urging said cam mechanism toward pin retracted position.

2. The invention as defined in claim 1 in which said barrier means includes a viscous sealant layer confined against escape from overlying relation to said receptacle body means side, said viscous layer having openings formed by penetration of said pins therethrough, said layer being pressurized sufficiently as to flow and eliminate said openings upon withdrawal of said pins therefrom.

3. The invention as defined in claim 1 including cable means electrically connected with said terminal pins said actuating means including a cable holder retained by said linkage.

4. The invention as defined in claim 3 in which said actuating means includes a handle actuator carried by the plug housing and operable to independently move said cam mechanism toward pin inserted position and pin retracted position.

5. The invention as defined in claim 1 including locking means detachably securing the plug means to the receptacle means so as to block separation of the receptacle from the plug in first direction parallel to said terminal pin while allowing relative separation in a second direction of receptacle movement substantially normal to said first direction.

6. The invention as defined in claim 5 in which said linkage is operable to urge the cam mechanism toward pin retracted position in response to movement of both said plug means and receptacle means in said second direction sufficient to take up said lost motion connection.

7. Umbilical connection apparatus, comprising a re-

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ceptacle body, electrical sockets carried within the body and having entrances adapted to be penetrated by plug carried pins, barrier means protectively overlying said entrances to be penetrated by said pins, said barrier means including a confined viscous sealant layer, a relatively rigid pressure member overlying said barrier means and mounted to move toward the barrier means, said pressure member containing through openings remaining in alignment with said entrances during said pressure member movement, said openings adapted to receive and pass said pins, and spring means spaced from said openings and acting to transmit force urging the pressure member toward the barrier means for pressurizing same in the region between said entrances and said through openings, said spring means being yieldable to allow movement of the pressure member in a direction away from the barrier means.

8. The invention as defined in claim 7, in which said pressure member comprises a plate, and said spring means comprises fingers at the plate side of the barrier means.

9. The invention as defined in claim 8 including a ring attached to the receptacle body and extending at the periphery of the plate, the ring carrying said fingers.

10. The invention as defined in claim 7 in which said viscous sealant layer comprises a gelatinous material.

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11. The invention as defined in claim 7 in which said barrier means includes elastomer layers at opposite sides of and confining said viscous sealant layer.

12. The invention as defined in claim 7 including followers movable within said sockets and adapted to be contacted by the penetrating ends of the pins, and means in the sockets urging the followers toward and into pressure transmitting engagement with said barrier means.

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