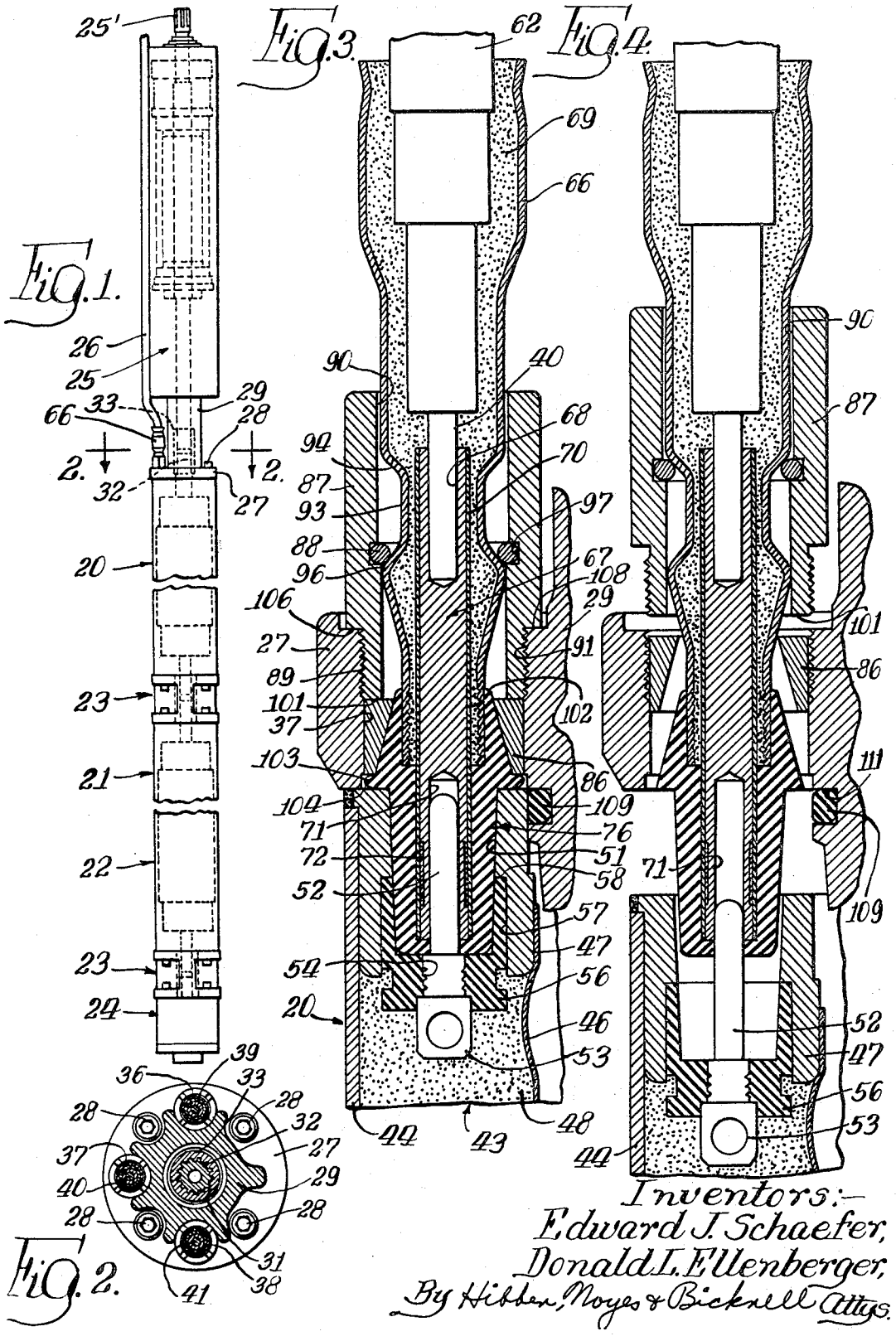
May 21, 1968 E. J. SCHAEFER ET AL 3,384,860

SEALED ELECTRICAL CONNECTOR

Filed Oct. 20, 1965 3 Sheets-Sheet 1



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Fig. 6.

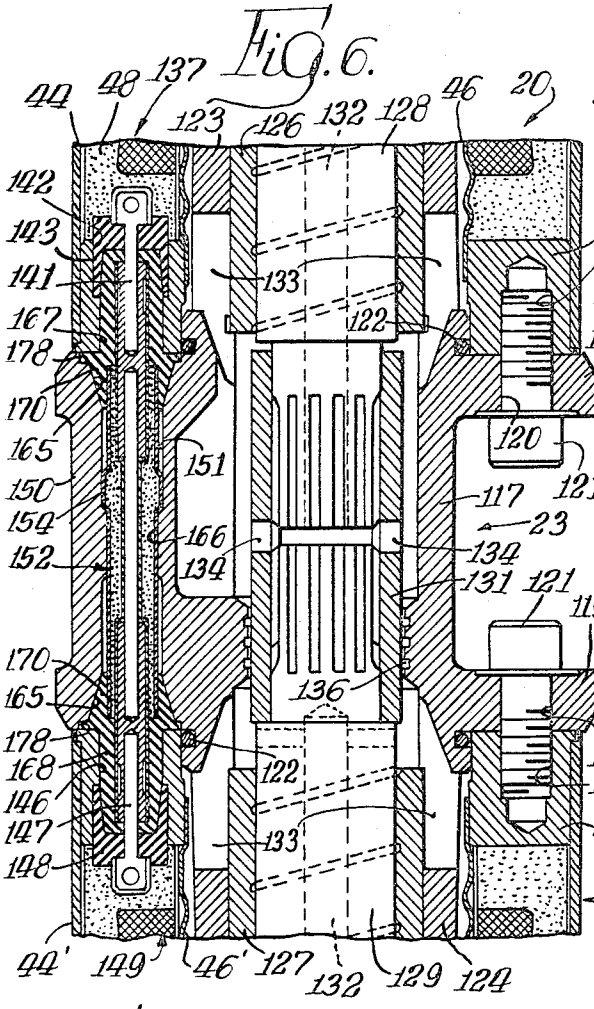


Fig. 7.

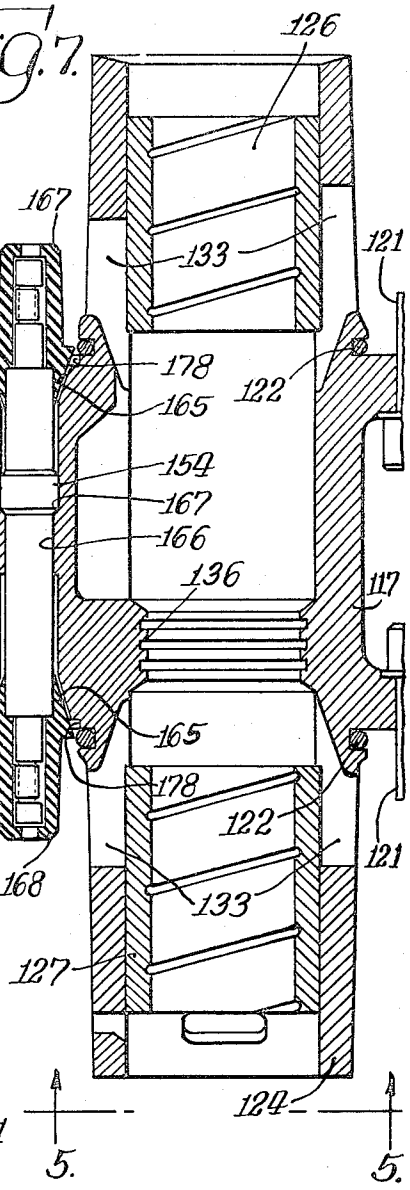
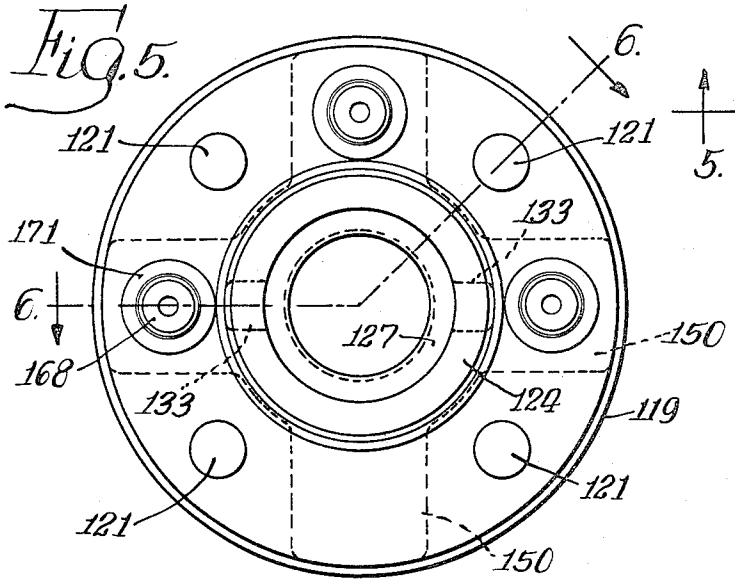


Fig. 5.



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Fig. 9.

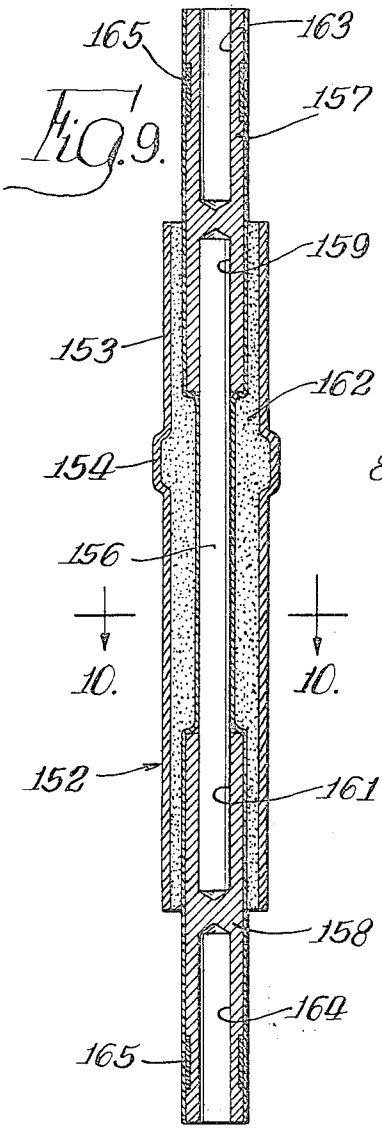


Fig. 10.

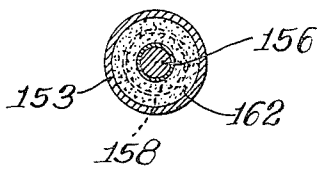


Fig. 8.

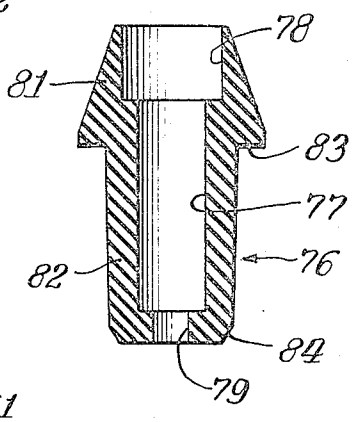


Fig. 12.

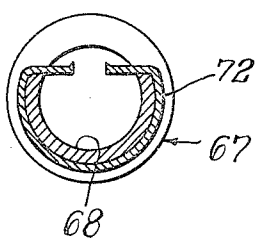
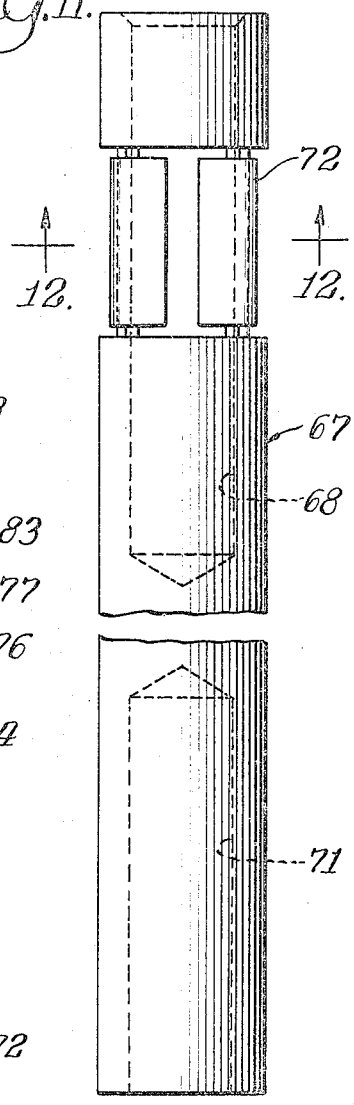


Fig. 11.



United States Patent Office 3,384,860 Patented May 21, 1968

3,384,860

SEALED ELECTRICAL CONNECTOR

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Filed Oct. 20, 1965, Ser. No. 498,805
3 Claims. (Cl. 339—94)

ABSTRACT OF THE DISCLOSURE

This disclosure deals with an electrical connector designed for use while submersed in a high pressure liquid. The connector includes a resilient insulating member made of an incompressable material, which is placed under initial compression by the parts. A portion of the member is left exposed to the high pressure liquid, and the member is shaped such that pressure of the liquid increases the effectiveness of the seal.

It is an object of the present invention to provide an electrical connector for use while submersed in a fluid capable of causing a short circuit if the fluid reached the electrical conductor parts of the connector.

It is another object of the invention to provide an electrical connector of the foregoing character, which is especially suited for use with a submersible motor assembly.

Still another object of the invention is to provide an electrical connector of the foregoing character, which may be used under very high fluid pressure conditions.

Still a further object of the invention is to provide a sealed electrical connector of the foregoing character, wherein the effect of high fluid pressures acting on the connector is to increase the effectiveness of the seal.

A still further object is to provide a sealed electrical connector of the foregoing character, wherein an insulator part of the electrical connector, which cooperates with the other parts to form a seal, may be very easily replaced when necessary.

Still another object is to provide an electrical connector of the foregoing character, which may be used under extreme temperature conditions.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying figures of the drawings, in which:

FIG. 1 is a fragmentary elevational view, on a reduced scale, of a submersible motor assembly including sealed electrical connectors embodying the invention;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view of a portion of the assembly shown in FIG. 1, showing the electrical connector;

FIG. 4 is a view similar to FIG. 3 but showing the parts in partially assembled relation;

FIG. 5 is an enlarged end view taken on the line 5—5 of FIG. 7, and showing another form of the electrical connector;

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 5;

FIG. 7 is an enlarged sectional view similar to FIG. 6 of parts of the apparatus prior to assembly; and

FIGS. 8 to 12 are enlarged views of parts of the electrical connector.

Generally, an electrical connector embodying the invention is adapted for use with first and second units while submersed in a high pressure fluid. The electrical connector comprises a first electrical connector part fastened to the first unit and a second electrical connector part fastened to the second unit. The two units are releasably secured together when in use, and the first and second electrical connector parts include mating conductor portions which are embraced by a sealing plug forming a seal and thereby preventing the high pressure fluid from gaining access to said portions. The sealing plug is pressed by the two units tightly against the portions, and at least one unit is constructed such that a portion of the sealing plug is exposed to the high pressure fluid when the units are secured together. The construction of the connector is such that the pressure of the fluid acting on the sealing plug tends to increase the effectiveness of the seal around the conductor portions of the connector.

Further, the sealing plug may be readily removed from the other parts of the electrical connector and replaced by a different sealing plug when necessary.

In greater detail, FIG. 1 illustrates a submersible motor assembly which may include electrical connectors embodying the invention. The assembly shown in FIG. 1 comprises a plurality of motor units or modules **20**, **21** and **22** which are connected together by intermediate units **23** in vertically stacked end-to-end relation for operation in unison. At the lower end of the assembly a lower end termination unit or module **24** is connected by an intermediate unit **23** to the motor module **22**. The module **24** may, for example, form a seal at the lower end of the assembly and complete the electrical circuit of the motor modules. At the upper end of the assembly is provided an auxiliary unit or module **25** which is secured to the upper end of the uppermost motor module **20**. The auxiliary module **25** may include, for example, pressure equalizing apparatus for the assembly, a vertically extending shaft **25'** which has its lower end connected to the rotor shaft **32** of the motor module **20** and its upper end adapted to be connected to a device to be driven, rotary shaft seals for preventing an ambient fluid from entering the interior of the module **25** around the shaft **25'** and thrust bearings for supporting the thrust of the device being driven.

Power for energizing the motor modules **20**, **21** and **22** is obtained from an electric power supply (not shown), the power supply being connected to the motor modules by means of an electric cable **26**. In the construction shown, the motor modules **20**, **21** and **22** are three phase motors, and consequently the cable **26** includes three wires **39**, **40** and **41** (FIG. 2).

With reference to FIGS. 1 and 2, at its lower end the auxiliary module **25** includes a radially outwardly extending flange **27** having longitudinally extending holes formed therethrough which receive bolts **28** to secure the flange **27** to the upper end of the module **20**. Just above the flange **27**, the auxiliary module **25** comprises a generally tubular portion **29** having a hollow bore **31** (FIG. 2). Within the bore **31** are positioned the upper end of a motor shaft **32** of the motor module **20** and the lower end of the shaft **25'** of the auxiliary module **25**. A sleeve type splined coupling **33** is also provided to connect the two shafts **25'** and **32** together.

The motor module **20**, which may be identical with the modules **21** and **22**, comprises a stator **43** (FIGS. 3 and 4) including a stator winding (not shown) which is enclosed within a sealed housing formed by a cylindrical outer shell **44**, a cylindrical inner liner **46**, and upper and lower end rings **47** and **45** (FIGS. 3 and 6). The shell **44** and the liner **46** are secured as by welding to the outer and inner peripheries, respectively, of the end rings. Further, the space around the stator windings is filled with a potting compound **48** which serves to transfer heat from the stator windings to the surrounding members.

In addition to the holes for the bolts **28**, the flange **27** has formed therethrough three longitudinally extending holes **36**, **37** and **38** which receive parts of the electrical

connectors for connecting the wires 39, 40 and 41 to the windings of the motor module 20. Longitudinally extending holes are also formed through the end ring 47 for parts of the electrical connector, one such hole 51 for the electrical connector associated with the wire 40 being shown in FIGS. 3 and 4.

Each electrical connector comprises a longitudinally extending generally cylindrical metal prong 52 which is centrally located with the cylindrical opening 51 of the end ring 47 of the motor module. The lower end 53 of the prong 52 is electrically connected to the windings of the stator of the motor module 20 and is embedded in the potting compound 48. The prong 52 is held spaced from the end ring 47 by a cup shaped insulating member 56 which is positioned within the hole 51 of the end ring 47. The lower portion of the hole 51 is recessed or counterbored as at 57, and the insulator member 56 is received within the recessed portion 57. The upper end 58 of the insulator member 56 engages a shoulder formed at the upper end of the recess 57, such engagement preventing the insulator member 56 from being pulled upwardly out of the hole 51.

The prong 52 extends through a hole 54 formed in the bottom wall of the member 56, and when the motor module 20 is disconnected from the auxiliary module 25 (FIG. 4) the upper end portion of the prong 52 is exposed.

The wire 40 is covered by insulation 62 which is stripped back in successive layers to bare the end portion of the wire 40. The wire 40 is positioned coaxially within a tubular housing or sheath 66, and a generally cylindrical socket member 67 (FIGS. 3, 4, 11 and 12) is secured to the lower end portion of the wire 49. An axial bore 68 is formed in the upper end of the socket member 67 and the end portion of the wire 40 is positioned within the bore 68 and rigidly secured thereto. The socket member 67 extends from within the sheath 66 downwardly below the lower end of the sheath 66. The wire 40 and the socket member 67 are spaced from the walls of the tubular sheath 66, and the intervening space is filled with a potting and insulating compound 69. The socket member 67 may also be coated with a layer 70 of an insulating material such as Natvar.

At its lower end, the socket member 67 is provided with an axially extending bore 71 which is adapted to receive the upper portion of the prong 52. A spring clip 72 is mounted on the socket member 67, the spring clip 72 extending into the bore 71 as shown in FIG. 12 and ensuring a firm electrical connection between the prong 52 and the socket member 67 when the prong 52 is inserted into the bore 71. The construction of the spring clip is shown in FIGS. 11 and 12 and also in U.S. Patent No. 2,958,842.

The electrical connector further includes a tubular seal or plug member 76 (FIGS. 3, 4 and 8) which is generally cylindrical and has an axially extending bore 77. The diameter of one end portion 78 of the bore 77 is enlarged, while the diameter of the other end portion is reduced. The body of the plug member 76 includes two portions 81 and 82 which are tapered on their outer peripheries. The portion 81 is at the end of the plug member 76 which includes the enlarged portion 78 of the bore 77, and from this end, the outer periphery of the portion 81 tapers radially outwardly and toward the other end of the plug member. The other portion 82 extends from the termination of the portion 81 to the opposite end of the plug member 76, and it tapers radially inward and away from the portion 81. The length of the portion 82 is substantially equal to the distance from the outer surface of the end ring 47 to the bottom of the cup shaped member 56. At the juncture of the two portions 81 and 82, the outer diameter of the portion 81 is greater than the outer diameter of the portion 82 thereby forming a radially extending shoulder 83, and the outer corner of the plug member 76 at the end which is adjacent the reduced diameter portion 7 of the bore 77 is rounded somewhat as shown at 84.

The diameter of the bore portion 78 is normally slightly less than the outer diameter of the lower portion of and receives the housing or sheath 66, and the reduced diameter portion 79 is normally slightly less than the diameter of and receives the prong 52. The remainder of the bore 77 has an internal diameter which is slightly less than the diameter of and receives the socket member 67.

The electrical connector further includes a wedge shaped sleeve 86 and a jam nut 87 for compressing the member 76 and securing the two electrical conductor portions of the electrical connector together. The outer diameter of the sleeve 86 is slightly less than the inner diameter of the hole 37 formed in the flange 27, and the inner periphery of the sleeve 86 is tapered similarly to the taper of the portion 81 of the plug 76.

To compress the plug member 76 during assembly, the sleeve 86 is forced downwardly by means of the jam nut 87, and the socket member 67 is forced downwardly by a split snap ring 88. The outer surface of the jam nut 87 is threaded adjacent its lower end, as indicated at 89, and mating threads 91 are formed on the inner periphery of the opening 37 above the sleeve 86. The ring 88 is located around a reduced diameter section 93 of the sheath 66, the portion 93 having as its boundries two shoulders or humps 94 and 96. The ring 88 is also located within a groove 97 formed in the inner periphery of the jam nut 87, the axial length of the groove 97 being such that the ring 88 is free to radially expand therein. When the ring 88 is located in the groove 97, the radial depth of the groove is such that the inner diameter of the ring 88 is less than the outer diameter of both of the humps 94 and 96.

To assemble the electrical connector after the motor module 20 has been secured to the auxiliary module 25 by the bolts 28, the split ring 88 is slipped over the lower end of the socket member 67 and forced over the hump 96 and into the reduced diameter section 93 of the sheath 66. Thereafter, the jam nut 87, the inner diameter of which is slightly greater than the outer diameter of the raised portions or humps 94 and 96, is also slipped over the lower end of the socket member 67 and the lower end of the sheath 66. When the upper end of the jam nut 87 reaches the reduced diameter section 93, the snap ring 88 is forced into the bore 90 of the jam nut 87. With the snap ring 88 within the upper end of the bore 90, the jam nut 87 is moved upwardly relative to the sheath 66, and the snap ring 88 engages the hump 94, and thereby held against continued upward movement relative to the sheath 66. Further upward movement of the jam nut 87 relative to the sheath 88 causes the nut 87 to slide upwardly relative to the ring 88 until the groove 97 reaches a ring 88, after which the ring 88 snaps into the groove 97.

Subsequently, the sleeve 86 is slipped over the lower end of the socket member 67 and the lower end of the sheath 66, and then the plug member 76 is slipped over the lower end of the socket member 67 and the lower end of the sheath 66. Due to the previously described dimensions of the bore portions of the member 76 relative to the outer dimensions of the socket member 66, the bore portion 78 must be stretched slightly to get it over the sheath 66, and the center section of the bore must be stretched slightly to get it over the socket member 67. The stretch fit normally holds the member 67 attached to the socket and sheath members. Further, the bore portion 79 is coaxial with the opening of the bore 71 of the socket member 67. With the jam nut 87, the sleeve 86 and the plug member 76 in place around the sheath 66 and the socket member 67, the socket member 67 is inserted into the hole 37 in the flange 27 and is moved into mating engagement with the prong 52. The plug member 76 is thereby moved into the opening or hole 51 of the end ring 47 and the prong 59 enters the bore

portion 79 of the member 76 and the bore 71 of the socket member 67, and the spring 72 establishes a firm electrical connection between the prong 52 and the socket member 67.

The sleeve 86 is moved downwardly and engages the tapered portion 81 of the plug member 76 and then the jam nut 87 is lowered and rotated to engage the threads 89 and 91. The snap ring 88 engages the hump 96, and as the jam nut 87 is threaded into the hole 37, the snap ring 88 presses downwardly against the hump 96 and forces the socket member 67 and the plug member 76 downwardly, the socket member being forced over the prong 52. Continued turning movement of the jam nut 87 causes its lower end 101 to engage the upper surface of the sleeve 86 and forces the sleeve 86 downwardly.

When the plug member 76 is pushed all the way into the hole 51, the lower end of the plug member 76 engages the bottom wall of the insulator member 56, and the shoulder 83 of the plug member 76 engages the outer surface of the end ring 47. Further downward movement of the sleeve 86 relative to the plug member 76 causes the tapered portion 81 of the plug member 76 to be tightly compressed between the sleeve 86 and the outer surface of the lower end of the sheath 66, and the tapered portion 82 to be tightly compressed between the outer surface of the socket member 67 and the inner walls of the hole 51 and the member 56, the inner walls of the hole 51 and the member 56 thus forming a cavity which receives a portion of the plug member 76. Compression of the plug member 76 may cause a portion 102 of the plug member 76 to be extruded upwardly between the sleeve 86 and the outer surface of the sheath 66, and causes another portion 103 to be extruded radially outwardly into an annular opening 104 provided between the lower end of the sleeve 86 and the upper surface of the end ring 47. Without the annular space 104 and the opening for the portion 102 of the plug member, excessive stress might develop on the parts of the connector because the plug member 76 is preferably made of rubber, which is generally incompressible. To further prevent excessive stress on the parts due to over tightening of the jam nut 87, a shoulder 106 is formed on the outer periphery of the jam nut 87 which engages a ledge 108 of the flange 27 when the parts are completely assembled. The interior of the assembly is preferably filled with a cooling and lubricating fluid, and an O-ring seal 109 (FIGS. 3 and 4) is positioned within a groove 111 formed in the outer periphery of the tubular portion 29 of the module 25, to prevent leakage of the fluid between the tubular portion 29 of the module 25 and the end ring 47 of the motor module 20.

After the electrical connector has been assembled as described, the assembly may be lowered into a deep well containing a liquid, where the assembly is subjected to extremely high pressure, without danger that the liquid will reach the electrical connector parts which carry electricity. The portion 81 of the plug member 76 is firmly pressed against the outer periphery of the sheath 66 by the sleeve 86 and thus prevents leakage of fluid between the sheath 66 and the plug member 76. Further, the shoulder 83 of the plug member 76 is firmly pressed against the upper face of the end ring 47 and thus prevents leakage of fluid between the plug member and the end ring. In addition, the portion 82 of the plug member 76 is in sealing engagement with the wall of the bore 51 and the inner walls of the insulator member 56. These walls are preferably provided with a slight taper which is the same as the taper of the portion 82, and downward pressure on the plug member 76 causes the portion 82 to be jammed or wedged against these walls.

When the high pressure liquid within the hole 37 acts against the sleeve 86 and the portion 102 of the plug member 76, the pressure of the liquid tends to force them downwardly. Such a downward force increases the compressive load on the portion 81 of the plug member 76 and hence the effectiveness of the seal between the plug member 76 and the sheath 66 and between the plug member and the upper face of the end ring 47. Further, the slight taper of the portion 82 of the plug member 76 causes the portion 82 to be more tightly jammed against the walls of the hole 51 and the insulator 56.

Consequently, the plug member 76 provides a seal at relatively low pressure due to the initial compression by the sleeve 86, and it also provides a seal at extremely high pressure because such high pressure increases the effectiveness of the seal. The plug member 76 has the additional advantages in that it serves as an electrical insulator as well as a seal and the plug member 76 may be easily assembled with the other parts of the electrical connector or removed for replacement when necessary. It has been found that, after a material such as a rubber has been in use for a relatively long time it tends to lose its pliability and hence its effectiveness as a seal. By this invention the plug member 76 may be easily removed and replaced with a new plug member if it becomes ineffective.

Instead of assembling the parts as described above, the plug member 76, the sleeve 86 and the nut 88 could be connected to the socket member 67 and the sheath 66 and to the module 25 before the module 25 is secured to the motor module 20 by the bolts 28.Then, the plug member 76 would be compressed as described above when the modules 20 and 25 were secured together by the bolts 28.

In the assembly shown in FIG. 1, the windings of adjacent motors are connected together, either in series or in parallel by the intermediate units 23, and at the lower end of the assembly the electrical circuit is terminated, as by a wire connection in the lower end termination module 24. Electrical connectors constructed in accordance with this invention may also be provided to effect the foregoing electrical connections.

With reference to FIGS. 1, 5 and 6, the two motor modules 20 and 21 are preferably identical and are connected together by the intermediate unit 23. The motor module 20 includes the shell 44, the liner 46, the lower end ring 45 and a rotor shaft 128, and the motor module 21 includes an outer shell 44', a liner 46', an upper end ring 47', and a rotor shaft 129. The intermediate unit 23 comprises a generally tubular member 117 having upper and lower radially extending flanges 118 and 119, respectively. Holes 120 are formed through the flanges 118 and 119, and bolts 121 extend through the holes and are threaded into holes 115 formed in the end rings 45 and 47' to secure the member 117 to the motor modules 20 and 21. Further, O-ring seals 122 are provided between adjacent surfaces of the member 117 and the end rings 45 and 47' seal the connection between these members.

The member 117 includes an upward extension 123 and a downward extension 124 which project into the rotor cavities of the motor module 20 and 21, respectively, and support radial bearings 126 and 127, respectively. The rotor shafts 128 and 129 are positioned within the bearings 126 and 127, and the adjacent ends of the rotor shafts 128 and 129 are connected together by a splined coupling 131.

As previously stated, the motor modules and the intermediate units of the assembly form a sealed inner chamber which is prefilled with a cooling and lubricating fluid, and fluid passageways are provided for circulating the fluid. For example, axial bores 132 are formed in the rotor shafts 128 and 129, openings 133 are formed in the extensions 123 and 124 of the member 117, and radial holes 134 are formed through the coupling 131. A labyrinth seal 136 is preferably also provided between the inner periphery of the member 117 and the outer surface of the coupling 131 below the holes 134, the seal 136 serving to maintain the fluid within the two motor modules 20 and 21 substantially separated but allowing a

limited amount of fluid flow between the motors **20** and **21** to equalize the pressure between them.

At the lower end of the motor module **20**, the stator windings, indicated generally by the numeral **137**, are connected to prongs **141**, only one such prong being shown in FIG. 6. An opening or hole **142** is provided through the end ring **45** through which the prong **141** extends and a cup shaped insulator **143** is positioned around the prong **141** between the prong and the end ring **45**. The prong **141** and the insulator member **143** are identical with the prong **52** and the insulator member **56** shown in FIG. 3.

The construction at the upper end of the motor module **21** is similar to that of the upper end of the motor module **20**. An opening **146** is formed in the end ring **47'**, which receives a prong **147** and an insulating member **148** similar to those previously described. The prong **147** is electrically connected to the stator windings **149** of the motor module **21**.

Four radially outwardly extending projections **150** are fromed on the member **117**, and longitudinally extending bores are provided through three of the four projections **150**, only one such projection **150** and bore **151** being shown in FIG. 6. The bore **151** (FIG. 6) receives a double ended socket assembly **152** shown in detail in FIG. 9, and comprising an outer tube **153** having an outwardly extending shoulder or enlarged portion **154** formed thereon intermediate the ends thereof. Axially located within the tube **153** is a solid connecting rod **156** which has substantially the same length as the tube **153**. At the ends of the connecting rod **156** are secured upper and lower sockets **157** and **158** having bores **159** and **161**, respectively, formed therein at their inner ends, which receive the ends of the connecting rod **156**. The connecting rod **156** is secured to the sockets **157** and **158**, and the three members **156** to **158** are preferably coated with an insulating material such as Natvar, and the space between the member **156** to **158** and the tube **153** is filled with an insulating compound **162**.

At their outer ends the sockets **157** and **158** have axial bores **163** and **164**, respectively, formed therein, the portions of the sockets **157** and **158** having these bores extending outwardly beyond the ends of the tube **153**, and the bores **163** and **164** being adapted to receive the prongs **141** and **147** respectively of the motor modules **20** and **21**. Spring clips **165**, similar to the clips **72**, may be fastened to the sockets **157** and **158**.

The socket assembly **152** shown in FIG. 9 is fastened to the intermediate unit **23** by inserting it into the bore **151** from the upper end thereof as seen in FIGS. 6 and 7. The bore **151** is provided with a reduced diameter section **166** which forms a shoulder **167**, and the increased diameter section **154** of the tube **152** is sized to engage the shoulder **167**. The outer diameter of the portion **154** of the tube **153** is slightly less than the inner diameter of the main portion of the bore **151** so that the socket assembly **152** may be easily inserted into the bore **151** until the portion **154** engages the shoulder **167**. The shoulder **167** is located such that the ends of the assembly **152** extend equal distances out of the ends of the bore **151**, and consequently the portion **154** and the shoulder **167** properly locate the assembly **152** in the bore **151**.

The apparatus shown in FIGS. 6 and 7 further includes two plug members **167** and **168** which are identical with the plug member **76** shown in FIGS. 3 and 8. The radial dimensions of the assembly **152** relative to the plug members **167** and **168** are such that the plug members **167** and **168** must be stretched slightly in order to slip them over the ends of the assembly **152**. Thereafter, the plug members **167** and **168** prevent the assembly **152** from falling out of the bore **151**. The outer end portions of the bores **151** are tapered as at **165** and the tapered portion **170** of the plug members **167** and **168**, which correspond to the portion **81** of the member **76**, extend into the bore portions **165**. The plug members **167** and **168** are also provided with shoulders **169** and **171** which are similar to the shoulder **83** of the plug member **76**, and the shoulders **169** and **171** rest on the outer surfaces of the end rings **45** and **47'** when the intermediate unit **23** is assembled with the motor modules.

When assembling the intermediate unit **23** with the motor modules **20** and **21**, the three socket assemblies **152** are first positioned within the bores **151** of the member **117** from the upper end until the shoulders **167** are engaged by the enlarged portions **154** of the tubes **153**. The plug members **167** and **168** are then slipped over the outer ends of the socket assemblies. Thereafter, the member **117** is preferably positioned under the lower end of the motor module **20**, with the plug members **167** extending through the holes **142** and into the insulator members **143**. As the bolts **121** are tightened, the outer tapered portions **170** of the plug members **167** are compressed between the tapered bore portions **165** and the outer surface of the assembly **152**. The outer ends of the bores **151** are countersunk or enlarged as at **178**, and compression of the plug members **167** during assembly causes the portions of the plug members **167**, adjacent the shoulders **169** to be extruded into the countersinks **178** (FIG. 6). Compression of the plug members **167** also forces the shoulders **169** tightly against upper surface of the end rings **45**, and the remaining portions of the plug members are forced tightly against the walls of the holes **142** and the insulator members **143**. Further, the section **154** of each socket assembly **152** is forced tightly against the associated shoulder **167**.

After the intermediate unit **23** is secured to the motor module **20**, the unit **23** is lowered onto the upper end of the motor module **21** and the prongs **147** are inserted into the bores **164** of the sockets **158**. The sleeve coupling **131** is preferably secured to the lower end of the rotor shaft **128** of the motor module **20**, and as the motor **20** and the intermediate unit **23** are lowered onto the motor **21**, the coupling **131** is slipped over the upper end of the rotor shaft **129** of the motor module **21**. Thereafter, as the bolts **121** are tightened to secure the motor module **21** to the intermediate unit **23**, the plug members **168** are compressed as previously described to effect seals between the shoulders **171** of the plug members **168** and the outer surface of the end ring **47'**, and between the bores of the plug members **168** and the outer surfaces of the socket assemblies **152**. The plug members **168** are also pressed tightly against the walls of the holes **146** and the insulator members **148**.

The motor modules **20** and **21** and the intermediate unit **23** may also be assembled by first securing the intermediate unit **23** to the upper end of the module **21** and then securing the unit **23** to the motor module **20**.

In the foregoing description, it has been pointed out that the plug members **76**, **167** and **168** are replaceable. While this may be advantageous in many instances, in other instances it may be advantageous to have these plug members permanently attached. In such instances, the plug members would be permanently attached as by cementing them to the socket member **67** or the socket assembly **152**, as the case may be.

When the module assembly is lowered into a deep well and the assembly is subjected to extremely high ambient liquid pressures, the ambient fluid may enter the interior of the bores **151** between the end of the shells **44** and **44'** of the motors and the end surfaces of the flanges **118** and **119** of the member **117**, and flow into the bores **151** around the outer surfaces of the tapered portions **170** of the plug members **167** and **168**. Fliud within the bore **151** would be under very high pressure and would exert a compressive force on the plug members **167** and **168** and increase the effectiveness of the seal as previously explained. If the member **117** is a casting and unless special precautions are taken, the casting may be relatively porous under the extremely high liquid pressures contemplated. Therefore, the ambient liquid may also flow into the bores **151**

through the porous casting and compress the plug members as previously explained.

In the event the construction is such that fluid may not readily enter the bores **151**, it may be desirable to form small holes through the member **171** extending from the bores **151** to the exterior of the member **117**, to permit fluid to enter the bores **151** and compress the plug members **167** and **168**.

From the foregoing description, it will be apparent that an electrical connector has been provided which includes means for effecting a liquid tight seal even under extremely high fluid pressures. The electrical connectors may be automatically connected together upon assembly of the modules, and the parts of the electrical connector may be easily serviced or replaced when necessary.

We claim:

1. Electrical apparatus for use while submersed in a high pressure liquid, comprising first and second units releasably secured together, an electrically conductive prong member secured to one of said units, an electrically conductive socket member secured to the other of said units, said prong and socket members having portions which are in engagement when said units are secured together, a sealing plug member made of a resilient electrical insulating material embracing said portions of said prong and socket members, a cavity formed in one of said units, a portion of said sealing plug member being positioned within said cavity, the unit other than the unit having said cavity including compressing means engaging a portion of said sealing plug member which is outside of said cavity and compressing said sealing plug member to provide a seal around said portions of said prong and socket members, and said units being constructed such that a portion of said sealing plug member which is outside of said cavity is exposed to said high pressure liquid and thereby increasing the compressive force on said sealing plug member and thereby increasing the effectiveness of said seal around said prong and socket members, said portion of said sealing member which is engaged by said compression means being tapered, and said compressing means having a corresponding taper.

2. Electrical apparatus for use while submersed in a high pressure liquid, comprising first and second units releasably secured together, an electrically conductive prong member secured to one of said units, an electrically conductive socket member secured to the other of said units, said prong and socket members having portions which are in engagement when said units are secured together, a sealing plug member made of a resilient electrical insulating material embracing said portions of said prong and socket members, a cavity formed in one of said units, a portion of said sealing plug member being positioned within said cavity, the unit other than the unit having said cavity including compressing means engaging a portion of said sealing plug member which is outside of said cavity and compressing said sealing plug member to provide a seal around said portions of said prong and socket members, and said units being constructed such that a portion of said sealing plug member which is outside of said cavity is exposed to said high pressure liquid and thereby increasing the compressive force on said sealing plug member and thereby increasing the effectiveness of said seal around said prong and socket members, said sealing plug member being generally tubular and the outer surfaces of said sealing plug member at the opposite ends thereof being oppositely tapered inwardly toward the respective ends of said sealing plug member, the inner wall of said cavity having a taper which corresponds with the associated portion of said sealing plug member, and said compressing means having a taper which corresponds with the taper of the associated portion of said sealing plug member.

3. Electrical structure for use while submersed in a high presure fluid, comprising a first unit, a first electrical connector part fastened to said first unit, a second unit, a second electrical connector part fastened to said second unit, said first and second units being releasably connected together and said first and second electrical connector parts having conductor portions mating with each other when said first and second units are connected and being separated when said first and second units are disconnected, and a sealing plug embracing said portions and providing a seal around said portions against access by the fluid and being compressed by said units and said portions when said units are connected together, at least one end portion of said sealing plug being compressed by said units and said portions and being tapered, and at least one of said units having a taper mating with said compressed tapered end portion of said sealing plug, and being constructed so that said compressed tapered end portion is exposed exteriorly to the high pressure fluid, whereby the pressure of said fluid acting on said tapered end portion of said sealing plug increases the effectiveness of said seal by pressing said plug member tightly against said units and said conductor portions.

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