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COAXIAL CABLE COUPLING

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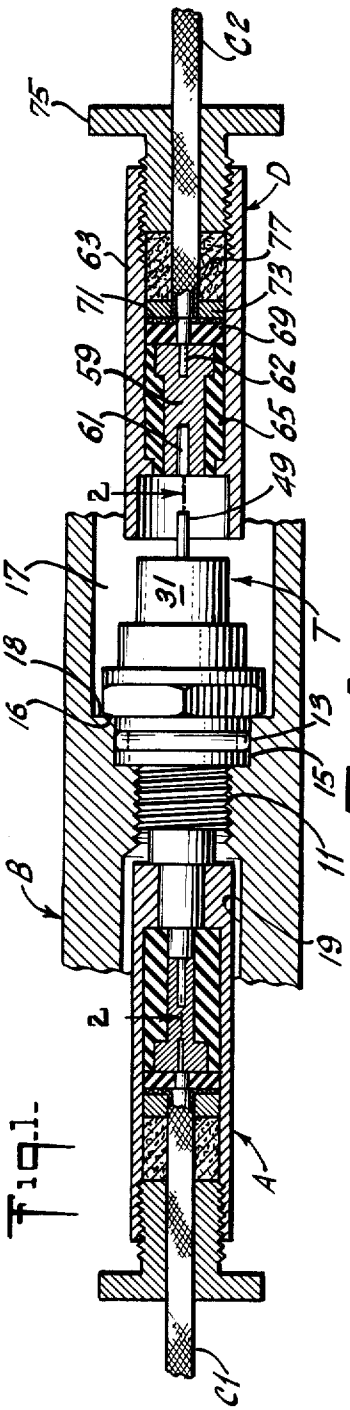

Fig. 1.

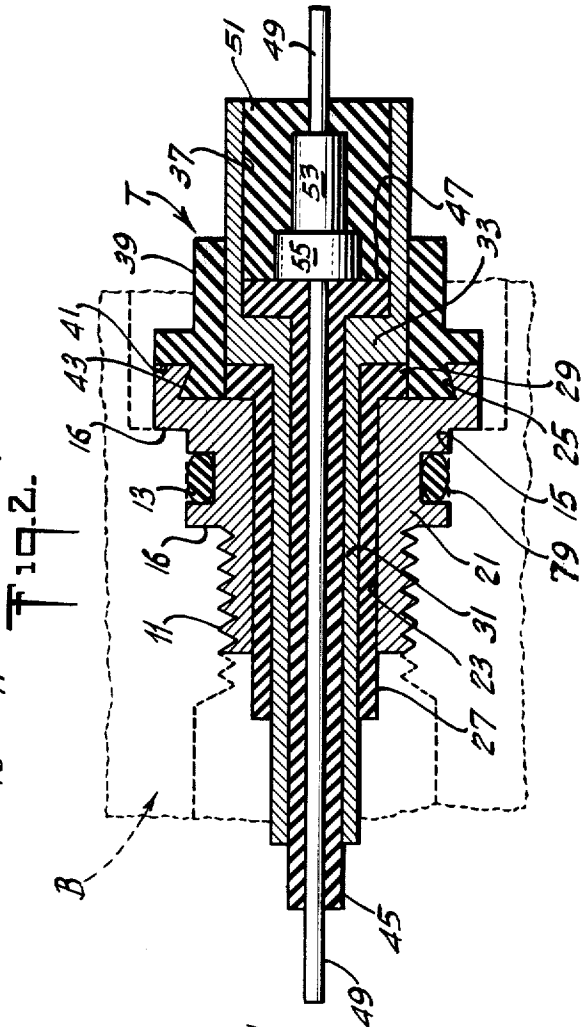

Fig. 2.

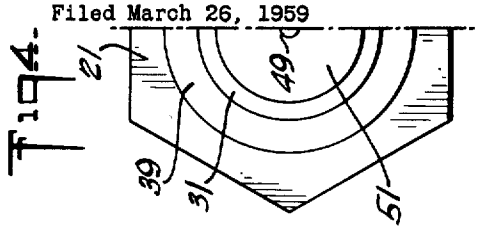

Fig. 4.

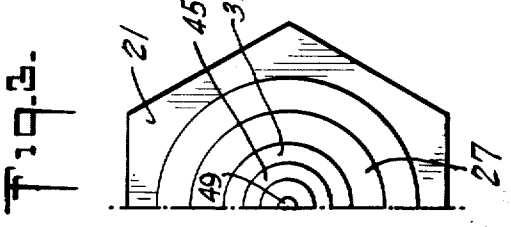

Fig. 3.

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COAXIAL CABLE COUPLING

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The present invention relates to a novel apparatus for coupling together two coaxial cables, and is particularly concerned with such apparatus which is especially adapted for connecting together a first coaxial cable located within a cavity filled with liquid under high pressure and a second coaxial cable outside of the cavity.

In an acoustic well logging tool there is generally provided an acoustic transducer section which includes a cavity filled with oil or other liquid of low acoustical velocity, and a second section containing the electronic equipment which must be connected electrically to the transducers. Continuous cables for conducting current from the transducers to the electronic section ordinarily are not employed because it is difficult to prevent leakage of the liquid into the electronic section under such conditions, and also because it is then difficult to maintain a high pressure in the transducer section and relatively low pressure in the electronic section.

Furthermore, it is essential that when coupled coaxial cables are employed the coupling members should withstand high pressures, high temperatures and high voltages without physical or electrical breakdown.

In accordance with the present invention there is provided novel apparatus for effectively retaining liquid on one side of a coupling, as in the transducer section of a sonde, while maintaining a high pressure. Moreover, the novel apparatus will effectively conduct current from one section to the other even at pressures as high as 10,000 pounds per square inch, temperatures as high as 125° C., and a voltage as high as 1,000 volts D.C. between the inner and outer conductors of a coaxial cable.

Details of the novel electrical coupling apparatus will be described below with reference to the accompanying drawings, wherein:

FIG. 1 is a longitudinal sectional view, parts being in elevation, of an electrical coupling apparatus embodying the principles of the invention;

FIG. 2 is a longitudinal sectional view on an enlarged scale of the terminal member of the coupling apparatus taken along the line 2—2 in FIG. 1, parts being in elevation;

FIG. 3 is an end elevational view of the terminal member seen from the left in FIG. 2; and

FIG. 4 is an end elevation view as seen from the right in FIG. 2.

Referring to FIG. 1, the novel apparatus for coupling together two coaxial cables C1 and C2 on opposite sides of a barrier B comprises a terminal member T secured in the barrier and a pair of cable connectors A and D which fit over the ends of the terminal member.

Terminal member T is threaded into a bore 11 in barrier B (which separates the transducer and electronic sections of an acoustical logging sonde) and is fluid tightly sealed against the walls by an elastic O-ring 13 snugly fitting within a counterbore 15 so as to prevent the leakage of liquid and the reduction of pressure from the interior 17 of the transducer section past the terminal into the electronic section 19. Additionally, a shoulder 16 on the terminal seats tightly on a corresponding shoulder 18 of barrier B.

Referring to FIG. 2, the terminal member T comprises a main body 21 having a first longitudinal bore 23 therethrough, and a first counterbore 25 in the right end thereof. An outer tubular insulator 27 fits within the bore 23, projects beyond the left end thereof, and has a laterally projecting first flange 29 seated on and extending radially part of the way across the bottom of counterbore 25.

An outer tubular conductor 31 fits within the outer tubular insulator 27, projects beyond the left end thereof, has a laterally projecting second flange or shoulder 33 which seats against first flange 29, and projects beyond the right end of body 21. Conductor 31 has a second counterbore 37 in its right end.

A ring 39 of a dielectric material such as a synthetic rubber sold under the trade name of neoprene fits snugly within counterbore 25 between the flange 29 and the internal wall of the counterbore, is bonded to all metal surfaces contacted, and projects longitudinally to the right along the outside of outer tubular conductor 31, making the connector pressure tight. Ring 39 is also provided with a shoulder 41 which overlies the right end of body 21. In order to assure that ring 39 is retained firmly within the counterbore 25 the wall of the latter is undercut or beveled inwardly toward the right so as to provide an inturned lip 43 overlying the ring 39.

Within the outer tubular conductor 31 there is an inner tubular insulator 45 projecting to the left out of the conductor, and having a laterally projecting flange 47 extending radially completely across the bottom of counterbore 37.

An inner conductor member 49 extends completely through inner tubular insulator 45 and projects therefrom at both ends, also projecting at the right through counterbore 37 beyond the rear end of the outer tubular conductor 31. Dielectric material 51, such as synthetic rubber sold under the trade name of neoprene, fills the space within the counterbore 37 surrounding inner conductor 49 to insulate the latter from the other conductor 31, and is bonded to all metal surfaces contacted to seal pressure.

Inner conductor 49 comprises a long wire upon which is secured between its ends, as by silver soldering, a sleeve 53 of larger diameter than the wire and having a laterally extending flange 55 abutting against the flange 47 of insulator member 45. Consequently, the inner conductor 49 is firmly held in position within the terminal by the dielectric material 51 surrounding sleeve 53. Insulators 39 and 51 generally are molded in place within their respective counterbores.

From the foregoing description it will be seen that there are provided two continuous but independent electrically conductive paths from the right end of the terminal or coupling to its left end. The inner conductor 49 is adapted to be connected to the inner wire of each of a pair of coaxial cables. The outer conductor member 31 is adapted to be coupled to the outer electrical sheath of each coaxial cable. Furthermore, adequate electrical insulation exists between the inner and outer conductive paths and between them and the rest of the apparatus.

Referring again to FIG. 1, the manner of connecting the coaxial cable to each end of the terminal T should be readily apparent. The construction of the connector D will be described to exemplify the construction of both connectors A and D since they are basically similar although different in size of parts. Connector D comprises an internal conductive member 59 having sockets 61 and 62 in its ends, socket 61 receiving the projecting end of inner conductor 49. A sleeve 63 of conductive material fits over the outside of conductive member 59 and is adapted to fit snugly over the rear end of the outer conductive member 31 to provide an electrical connection. Between the members 59 and 63 there is a sleeve 65 of insulating material.

Socket 62 receives the inner wire of coaxial cable C2 which has been bared of insulation for a short distance back from its end.

On the right end of conductive member **59** there is located an insulating washer **69** which fits over the insulation of the coaxial cable C2 and effectively spaces and insulates the outer sheath of the cable from member **59**. This sheath is unraveled for a short distance back from the end of the cable and the raveled metallic ends **71** overlies the washer **69**.

A second washer **73** of conductive metallic material fits snugly within sleeve **63** over the outer sheath of cable C2 and presses against the raveled ends **71** so that they are held firmly in position and in electrical contact with sleeve **63**. Washer **73** is held in position by means of a packing nut **75** threaded within the rear end of sleeve **63** and pressing packing material **77** against the washer.

With the described construction an electrical connection can be quickly and easily made between the cables C1 and C2 on the electronics and transducer sides of the logging sonde. The maintainance of liquid and pressure on the transducer side **17** is assured by the threaded connection of the terminal T into the sonde S and between the seal formed by a rubber O-ring **13** which is captured within an annular groove **79** on the outside of the body of the terminal. Moreover, increased pressure in **17** urges the terminal T and its individual parts with increasing force toward the left so that the various parts press more and more firmly against cooperating shoulders.

The insulating materials used in the novel apparatus can be any of those conventionally used in the electrical arts. It has been found that insulators **27**, **45**, **65** and **69** advantageously can be preformed compositions of an epoxy resin containing glass fibers, whereas insulators **39** and **51** desirably are molded in situ from synthetic rubber such as neoprene. The various conductors may be of copper, silver or other conductive metal.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. Apparatus for coupling two coaxial cables comprising a terminal member and a pair of coaxial cable connectors secured one to each end of said terminal member; said terminal member comprising a main body having a first bore therethrough and a first counterbore at a first end thereof, an outer tubular insulator fitting within said bore and having a laterally projecting first flange on one end thereof seated on the bottom of said first counterbore and extending radially part of the way across said bottom, an outer tubular conductor fitting within said outer tubular insulator and having a laterally projecting second flange seating against said first flange, said outer tubular conductor having a second bore therethrough and a second counterbore at a first end of said outer tubular conductor, a ring of dielectric material fitting snugly within said first counterbore of said main body between said first named flange and the wall of said first counterbore of said main body, said dielectric ring also being sleeved over the outside of said outer tubular conductor, an inner tubular insulator within said outer tubular conductor having a laterally projecting third flange extending radially across the bottom of said second counterbore, an inner conductor extending through said inner tubular insulator and projecting at one end from said inner tubular insulator and at the other end projecting through said second counterbore beyond the end of said outer tubular conductor, and dielectric material filling the space within said second counterbore surrounding said inner conductor; each of said connectors comprising a conductive member having a socket in the front end thereof receiving an end of said inner conductor member, a sleeve of conductive material fitting over the outside of said outer conductor member, insulating material between said sleeve and said conductive member, and means for connecting the inner wire of a coaxial cable to said conductive member and for connecting the sheath of said coaxial cable to said sleeve.

2. Apparatus in accordance with claim 1 wherein said main body is externally threaded, and also has an external annular groove and an O-ring of resilient sealing material in said groove.

3. A terminal member for coupling two coaxial cables comprising a main body having a first bore therethrough and a first counterbore at a first end thereof, an outer tubular insulator fitting within said bore and having a laterally projecting first flange on one end thereof seated on the bottom of said first counterbore and extending radially part of the way across said bottom, an outer tubular conductor fitting within said outer tubular insulator and having a laterally projecting second flange seating against said first flange, said outer tubular conductor having a second bore therethrough and a second counterbore at a first end of said outer tubular conductor, a ring of dielectric material fitting snugly within said first counterbore between said first named flange and the wall of said first counterbore of said main body, said dielectric ring also being sleeved over the outside of said outer tubular conductor, an inner tubular insulator within said outer tubular conductor having a laterally projecting third flange extending radially across the bottom of said second counterbore, an inner conductor extending through said inner tubular insulator and projecting at one end from said inner tubular insulator and at the other end projecting through said second counterbore beyond the end of said outer tubular conductor, and dielectric material filling the space within said second counterbore surrounding said inner conductor.

4. Apparatus in accordance with claim 2 wherein said main body is externally threaded for engaging corresponding threads on the inside of a hole through a bulkhead across which said coaxial cables are to be coupled, and also has an external annular groove and an O-ring of resilient sealing material in said groove.

5. Apparatus in accordance with claim 3 wherein said first counterbore has an annular inturned lip for retaining said ring in position therein.

6. Apparatus in accordance with claim 3 wherein said inner conductor comprises a wire, and at least one annular flange projecting laterally therefrom within said second counterbore and coacting with said inner tubular insulator and said dielectric material to prevent longitudinal movement of said wire.

7. Apparatus for connecting two cable members across a bulkhead subjected to relatively high fluid pressure on one side thereof as compared with the pressure on the other side, said apparatus comprising a terminal connector including a tubular main body having first, second and third portions of successively greater outside diameter suited to be inserted in corresponding openings in said bulkhead in such manner that the sides forming shoulders of said second and third portions abut against corresponding shoulders in said bulkhead, the first portion of said body being threaded for mounting in corresponding threads in said bulkhead, the second portion of said body being provided with an annular grove, an O-ring mounted in said annular groove for providing a pressure seal relative to the adjacent side of the bulkhead when mounted therein, said terminal connector being provided with an elongated concentric inner conductor and a concentric outer conductor, said outer conductor being separated from said inner conductor by electrical insulating material, said outer conductor being provided with a region of relatively small diameter disposed in spaced relation within a bore through the first portion of said terminal member and having a region of relatively larger diameter, electrical insulating material disposed between said tubular body and said outer conductor, said larger diameter region of said outer conductor being of greater diameter than the bore through said first portion.

8. Apparatus as defined in claim 7 wherein the elongated inner conductor projects from said terminal connector beyond said concentric outer conductor, and where-

in a respective cable connector is adapted to be connected to each end thereof.

9. Apparatus as defined in claim 8 further comprising first and second coaxial cable connectors each having a pin-receiving inner connector member for receiving a projecting end of said inner conductor and an outer conductive member concentrically mounted in spaced relationship with respect to said pin-receiving member for slidably engaging the outer surface of the corresponding end of said outer conductor, and means for connecting the respective conductors of a coaxial cable to said pin-receiving connector and said outer conductive member, respectively.

10. Apparatus for connecting two cable members across a bulkhead which may be subjected to relatively high fluid pressure on one side thereof as compared with the other side, said apparatus comprising a terminal connector including a generally tubular main body having a plurality of portions of successively greater outside diameter at least one of said portions of said main body being adapted to be inserted in a corresponding opening in said bulkhead in such manner that the sides of at least two of said successive portions abut against corresponding shoulders in said bulkhead, at least one of said portions being threaded for mounting in corresponding threads in said bulkhead, means for providing a pressure seal relative to said bulkhead when said connector is mounted therein, said main body having a bore therethrough, said terminal connector being provided with an elongated concentric inner conductor member concentrically located within said main body and a concentric outer conductor member concentrically located within said main body and separated from said inner conductor member by insulating material, said outer conductor being provided with a region of relatively small diameter within a portion of said terminal member of relatively small diameter and said outer conductor having a region of relatively larger diameter, said larger diameter region of said outer conductor being of greater diameter than the region of said bore through the smallest of said portions of said main body, insulating means for effectively and substantially electrically insulating said outer conductor including said region of relatively larger diameter from said tubular main body, said insulating means including electrical insulating material disposed between said tubular main body and said outer conductor including said region of relatively larger diameter thereof.

11. Apparatus as defined in claim 10 wherein said means for providing a pressure seal relative to the bulkhead comprises an annular groove in one of said portions of said main body and an O-ring mounted in said annular groove for providing a pressure seal relative to the adjacent side of the bulkhead when mounted therein.

12. Apparatus as defined in claim 10 wherein the elongated inner conductor projects from said terminal connector beyond said concentric outer conductor and further comprising first and second coaxial cable connectors each having a pin-receiving inner connector member for receiving a projecting end of said inner conductor and an outer conductive member concentrically mounted in spaced relationship with respect to said pin-receiving member for slidably engaging the outer surface of the corresponding end of said outer conductor, and means for connecting the respective conductors of a coaxial cable to said pin-receiving connector and said outer conductive member, respectively.

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