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SHIELDED, MULTICONDUCTOR WATERPROOF CONNECTOR

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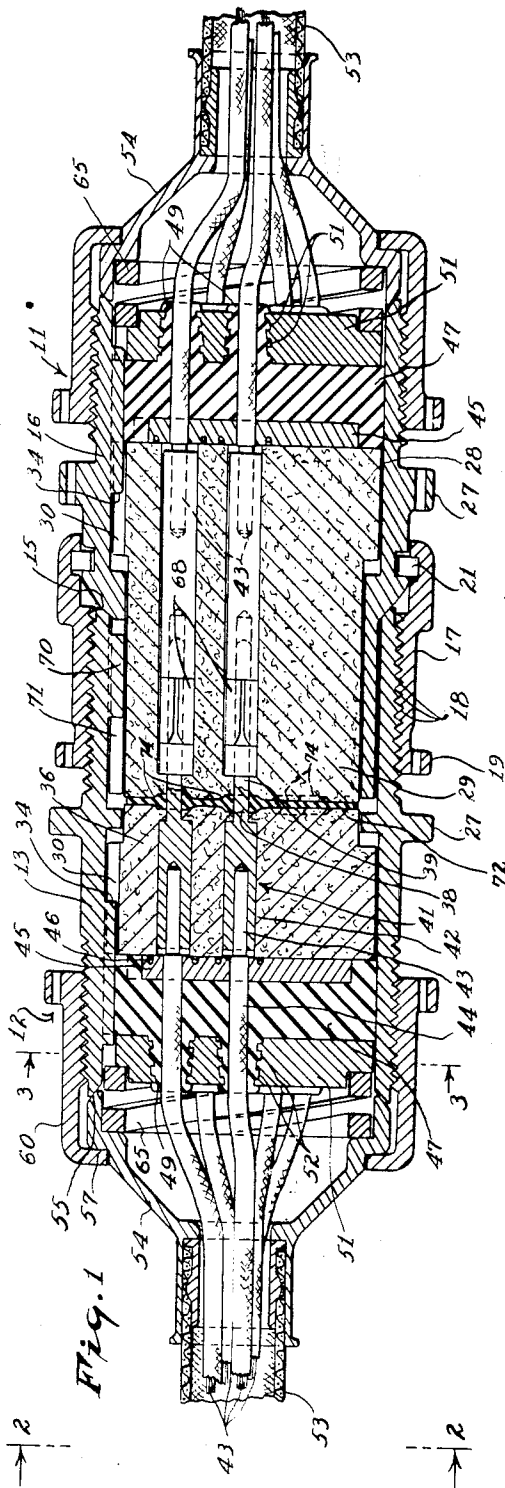


Fig. 3

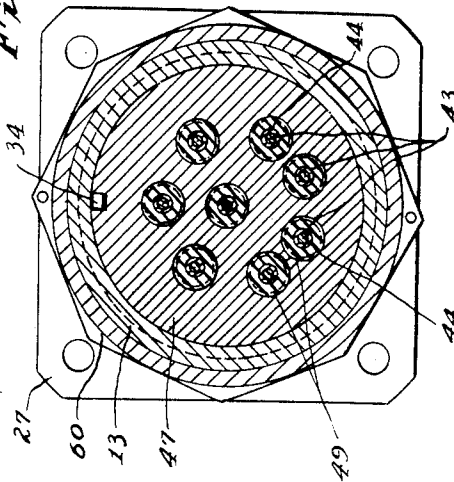


Fig. 2

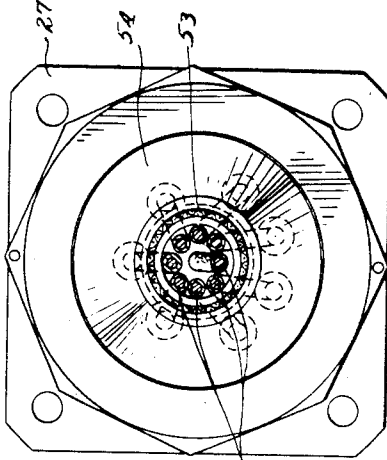
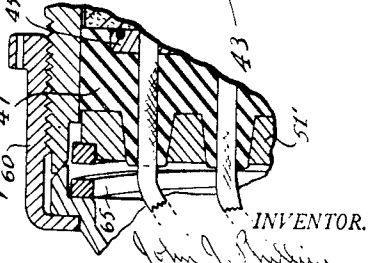


Fig. 4



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SHIELDED, MULTICONDUCTOR WATERPROOF CONNECTOR

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13 Claims. (Cl. 339—94)

This invention relates to electrical connectors which are used for connecting a plurality of conductors by means of complementary pin and socket connections. The invention relates more particularly to fluid tight connections provided with complete radio shielding.

One object of the invention is to provide an improved multiple conductor pin-and-socket connector in which all of the individual conductors are provided with sealing means within the connector, and in which the ends of the pin and socket elements are also provided with sealing means.

One feature of the invention relates to a construction which provides soft resilient sealing material around the individual conductors with a construction that permits more convenient and more rapid assembly than comparable connectors of the prior art. Another feature of the invention relates to a construction for preventing the pin and socket elements from being pulled back through the soft sealing material when a conductor is subjected to a substantial pull in a direction away from the connector.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views,

Fig. 1 is a longitudinal, sectional view through a multi-conductor, pin-and-socket connector made in accordance with this invention;

Fig. 2 is an end view of the connector shown in Fig. 1, the view being taken at the line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1; and

Fig. 4 is a fragmentary detail view showing a modified construction.

The multi-conductor connector shown in Fig. 1 has two complementary sections, including a socket section 11 and a pin section 12. The pin section includes a metal shell 13 with a frusto-conical end face 15 which abuts against a complementary end face of metal shell 16 of the socket section 11.

The sections 11 and 12 are held together by a nut 17 having threads 18 that screw over corresponding threads on the end portion of the metal shell 13. This nut 17 has a polygonal flange 19 for receiving a wrench; and the nut is rotatably connected to the shell 16 by a ring 21 which fits into channels in confronting faces of the shell 16 and an end portion of the nut 17. The ring 21 prevents longitudinal movement of the nut 17 with respect to the shell 16, but leaves the nut free to rotate with respect to the shell.

When the nut 17 is screwed on the metal shell 13, it draws the frusto-conical end face of the shell 16 into contact with the complementary end face of the shell 13 to provide a firm contact between the faces to provide a positive moisture-proof seal between the shells; and to provide effective radio shielding of the conductors enclosed within the shells. There is a polygonal flange 27 on each of the shells 13 and 16 for connecting the pin section of the connector to a bulkhead.

The shell 16 encloses a core 28 which has a cylindrical section 29, of reduced diameter, slidably fitting in a bore in the shell 16. The right hand end of the core 28, which is of larger diameter, has a slot 30 for receiving a key or fin 34 which extends inwardly from the wall of the metal shell 16. This fin or key 34 prevents rota-

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tion of the core 28 in the shell 16 and it makes necessary the assembly of the core and shell with the conductors in the core always in the same angular position within the shell.

There is a core 36 in the shell 13 corresponding to the core 28 in the shell 16, but of shorter length because of the different nature of the electrical elements which extend through it. This core 36 is prevented from turning, and is maintained always in the same angular relation in the shell 13, by a fin or key 34 extending into a slot 30 in the core 36, the construction being similar to that already described for the core 28.

The core 36 has as many parallel bores 38 as there are circuits to be included in the connector. Each of the bores 38 receives a pin 39 of an electrical element 41. At one end of the pin 39 the electrical element has a head portion 42 which is of somewhat larger diameter than the pin, and this head portion 42 fits slidably into a counterbore at one end of the bore 38. The head portion 42 abuts against the shoulder at the inner end of the counterbore.

There is a recess in the outer end of the head portion 42 for receiving a wire 43. The wire is soldered, or otherwise secured, within the recess in the head portion 42. There is insulation 44 around the wire 43 beyond the end of the electrical elements 41. The end portion of the insulation 44 extends through an opening in a face plate 45.

In the preferred construction there is an O ring 46 confined in a circular recess around each of the wires 43 at the location where the face plate 45 abuts against the core 36.

This provides an individual seal around each of the wires. Another seal around all of the wires and the face plate 45 is provided by a body of soft sealing material 47 located behind the face plate 45. The face plate fits into a recess in the material 47 so that there is an annular face of this material, beyond the periphery of the face plate 45, in sealing contact with the face of the core 36. The wires 43, with their insulation covering 44, extend through the soft material 47, and in the preferred construction there are individual sleeves 49 extending from the main body of the soft material 47 along the insulation 44 of each wire.

A clamping plate 51 extends across substantially the entire cross section of the interior of the shell 13 and presses against the rearward face of the soft material 47. This clamping plate 51 has openings which surround the sleeves 49. These holes which surround the sleeves are preferably made with a slight taper, and the illustrated construction shows them also made with circular grooves 52 that act as dams for retarding extrusion of the soft material 47 along the insulation 44 as the pressure of the plate 51 is exerted against the body of the soft material 47. The tapered faces of the openings in the clamping plate 51 which surround the sleeves 49, exert substantial radial pressure against the soft material 47 to provide fluid tight seals around the insulation of each of the wires.

Figure 4 shows a modified construction which is used when the connector is made with a sealing material 47' which is a higher durometer material from that used for the sleeves 49 in Fig. 1. There is a clamping plate 51' in Fig. 4 which has smooth frusto-conical surfaces in place of the dams formed by the grooves 52 in Fig. 1.

Soft silicone rubber may be used for the material 47 or similar material which will provide a fluid tight seal. The consistency of the rubber may be soft enough to approach a viscous liquid if the grooves 52 are used, but it must not be actually liquid since sufficient tension must exist to prevent flow through the openings in the clamping plate 51.

Although only a few wires 43 are shown in the drawing, it will be understood that these are merely representative of a plurality of conductors; and the cable which contains these conductors is surrounded by a metal braid or shielding 53 having an end fitting 54 with an end face which abuts against a complementary face 55 at one end of the metal shell 13. There is a shoulder 57 on the end fitting 54; and a clamping nut 60 has

an inwardly extending flange which engages behind the shoulder 57 of the fitting 54.

The clamping nut 60 has threads which screw over corresponding threads on the outer end portion of the metal shell 13; and when this clamping nut 60 is tightened, it pulls fitting 54 into firm contact with the end face 55 of the metal shell to provide a tight connection that is a positive moisture seal and that provides highly effective radio shielding. This construction is similar at both ends of the connector.

The clamping plate 51 is held against the soft sealing material 47 by a helical compression spring 65. One end of this spring is in contact with an annular shoulder on the clamping plate 51, and the other end of the spring bears against a complementary shoulder in the end fitting 54. This spring 65 transmits a strong pressure from the fitting 54 to the clamping plate 51.

The construction of the socket section 11 is generally similar to that of the pin section 12 already described. The only essential difference is that the electrical elements connected to the wires 43, in the socket section, have end portions 68 providing sockets for receiving the pins 39. These sockets 68 are enclosed within the core 28 throughout their entire lengths, and this makes the core 28 substantially longer than the core 36 from which the pins 39 protrude. Parts of the socket section 11, which are the same as the pin section 12, are indicated by the same reference characters as in the pin section 12.

In order to have the same pins 39 always engage the same sockets 68, the shell 13 is provided with an inwardly extending fin or key 70 which engages in a slot 71 in the other shell 16. This construction requires that the complementary sections of the connector always be brought together in the same relation because the shell 16 will not enter the shell 13 unless the slot 71 is in register with the key 70.

Between the end face of the core 28 which confronts the end face of the other core 36, there is a face seal consisting of a disk 72 of resilient rubber, or other soft sealing material. The diameter of the disk 72 is substantially equal to that of the end faces of the cores 28 and 36. There are openings, in the disk 72, through which the pins 39 extend. Each of these openings has a boss 74 around it on both faces of the disk 72, and the bosses extend into shallow counterbores in the confronting end faces of the cores 28 and 36 around each of the pins 39. These counterbores are shallow in proportion to the original uncompressed height of the bosses so that the seal material in the bosses is most strongly compressed when the cores 28 and 36 clamp the disk 72 between them.

The cores 28 and 36 are movable in the shells 16 and 13 in the direction of the longitudinal axis of the connector. The pressure of each of the springs 65 urges the cores to move in the direction of the spring pressure until that pressure is equalized by an opposite pressure reaction from the fitting 54 at the other end of the connector. Although the preferred construction has springs 65 at both ends of the connector, it will be apparent that all of the sealing surfaces can be maintained under pressure by a spring at either end.

The cores 28 and 36 are made of electrical insulating material such as commonly used for electrical connectors. The face plate 45 is also made of electrical insulating material, but a harder material is used for the plate 45 since its function is to act as an abutment for preventing the electrical elements 42 from being pulled back into the soft sealing material 47. This face plate 45 may be made of ceramic or hard plastic material.

The springs 65 are ground off to provide flat parallel faces at both ends for maintaining a uniform pressure around the entire extent of the peripheral portion of the clamping plate 51. The clamping plate 51 is preferably metal, such as brass or stainless steel, and it is of substantial thickness so that there is no consequential distorting of the plate 51 when pressed against the sealing material 47 by pressure applied only around the peripheral portion of the plate 51. With this construction, the pressure of each spring 65 is distributed uniformly across the full transverse cross section of the sealing material 47.

As a further precaution against extrusion of the soft sealing material 47 through the openings in the clamping plate 51, the surface of the sealing material 47 which contacts with the clamping plate is preferably bonded thereto by adhesive, or by heat treatment which will

bond the sealing material to the metal of the clamping plate without the use of an intervening layer of adhesive.

The preferred construction of the invention has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. A multi-conductor electrical connector comprising a pin section and a complementary socket section, each of which sections includes a metal shell and a core within the metal shell, means connecting the sections together with the pins of one section engaged in the sockets of the other section, a sealing element in each of the sections comprising a body of soft electrical insulating material through which all of the conductors pass immediately before entering the core, a clamping plate through which each conductor passes before entering the soft insulating material, and a resilient pressure element behind at least one of the clamping plates urging the clamping plate toward the soft insulating material and deforming said material into intimate sealing contact with the conductors.

2. A multi-conductor connector including a pin section and a complementary socket section, each of which comprises a metal shell and a core of insulating material which is slidable in the shell in the direction of the longitudinal axis of the conductor, fastening means that hold the sections together with pins extending from the core of the pin section engaged in sockets located in the core of the socket section, a mass of sealing material, which comprises an electrical insulation, located adjacent to one end of each core with separate openings through which the respective conductors from the core are passed, a clamping plate adjacent to the sealing material in each socket section and having openings therein through which the conductors pass before entering the sealing material, and a pressure element comprising a spring compressed between the clamping plate and a face which is a unit with the metal shell of at least one of the connector sections for urging the clamping plate against the sealing material and transmitting pressure through the sealing material to slide the cores in the shells toward the clamping plate at the other end of the connector.

3. The multi-conductor connector described in claim 2, characterized by end fittings connected to the ends of the shells which are remote from one another, screw threads by which each of the end fittings is connected to its shell and along which the end fitting advances to apply pressure to compress the spring which loads the clamping plate.

4. A multi-conductor connector including a pin section, and a complementary socket section, each of which comprises a metal shell and a core within the metal shell, the cores being slidable longitudinally within the shells, pins projecting from the inner end face of one of the cores and complementary sockets in the confronting end face of the other core, a mass of sealing material, that is also an electrical insulator, with separate openings therein through which conductors pass immediately before entering the cores, a clamping plate with separate openings therein through which the conductors pass before entering the sealing material, springs at both ends of the connector, and in contact with the outer faces of the clamping plates, and end fittings screwed over the outer ends of the metal shell with shoulders that compress the springs against the clamping plates.

5. A multi-conductor electrical connector including a pin section having a metal shell and a core of insulating material within the metal shell and slidable longitudinally in the shell, a complementary socket section comprising a metal shell and a core of electric insulating material longitudinally slidable in the shell, pins projecting from the inner end face of the core of the pin section, sockets opening through the inner end face of the core of the socket section, electrical connectors extending into both cores to the pins and sockets of the respective cores, a body of soft rubber located adjacent to the outer end of each core and having openings therein through which insulation-covered portions of the conductors extend before entering the adjacent cores, sleeves of rubber material of one-piece construction with the body of rubber material and extending along the outside face of the insulation of the conductors at the side of the body of rubber material which is remote from the core,

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a clamping plate having separate openings for receiving the respective sleeves, the openings in the clamping plate being tapered to smaller size toward the rearward face of the clamping plate, and the walls of the tapered openings having inwardly extending circumferential flanges which serve as dams for preventing extrusion of the rubber sleeves lengthwise along the openings in the clamping plate, pressure elements comprising separate springs at opposite ends of the connector in position to exert an endwise pressure urging the clamping plate against the body of rubber material, and an end fitting connected to each of the shells and screwed on to threads on the end portion of the shell, each end fitting having a surface that contacts with the spring in the connector and that loads the spring when the end fitting is screwed into its intended position on the shell.

6. A multi-conductor electrical connector including complementary pin and socket sections, each of which comprises a metal shell with a core of electrical insulating material therein, electric elements in the core of the pin section with pins extending from one face of the core, other electrical elements in the core of the socket section with sockets opening through the inner face of the core, the electrical elements of each of the sections having recesses in their rearward ends for receiving the bare wire of the respective conductors leading to that section of the connector, and each of the electrical elements having an end face surrounding the recess into which the wire extends, a body of soft sealing material, which is an electrical insulator, located near the rearward end of each of the cores, the soft sealing material having separate openings through which insulation-covered portions of the conductors extend before reaching the core, a face plate of hard material between the soft sealing material and the end face of the core with openings therein through which the conductors pass, the openings in the face plate being smaller than the end faces of the electrical elements of the core to prevent any electrical element which is pulled out of the core from being pulled into the soft sealing material, a clamping plate on the side of the sealing material opposite the face plate, and a pressure element urging the clamping plate toward the face plate so as to maintain a pressure on the sealing material sandwiched between the face plate and the clamping plate.

7. The multi-conductor, electrical connector described in claim 6, characterized by cores which are longitudinally slidable in the metal shells and sealing means between the confronting faces of the cores, and further characterized by pressure elements constituting springs at both ends of the connector pressing against the clamping plates to maintain an equal balanced force against the sealing material which is sandwiched between the clamping plates and face plates of both sections of the connector.

8. A multi-conductor electrical connector including a pin section and a complementary socket section, each of which includes a metal shell and a core of electrical insulating material within the metal shell, electrical elements in the respective cores including elements in the pin section core having pins extending from the front face of the core, and elements in the core of the socket section having sockets opening through the front face of that core, said electrical elements having rearward end faces which project radially beyond conductors to which the respective electrical elements are connected, soft sealing material located near the rearward face of each core with openings therein through which the conductors extend, and a face plate located between said sealing material and the rearward faces of the electrical elements with openings through which the conductors pass and with the cross section of said openings in each face plate smaller than the end faces of the electrical elements to prevent electrical elements that are pulled out of the cores from being pulled into the soft sealing material.

9. The multi-conductor, electrical connector described in claim 8, with the face plate recessed into the front face of the sealing material and an annular portion of

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the sealing material extending beyond the outer circumference of the face plate and in contact with the rearward face of the adjacent core for sealing any clearance between the confronting faces of the face plate and core.

10. The multi-conductor, electrical connector described in claim 8, with cores that are slidable longitudinally in the shells of the socket section, and with the face plate of each section recessed in the front face of the sealing material and surrounded by an annular portion of the sealing material which contacts with the rearward face of the adjacent core to seal any clearance between the confronting faces of the face plate and the core, and springs at both ends of the connector urging the clamping plates against the sealing material to maintain a balanced and equal pressure on the sealing material in both sections of the connector.

11. A multi-conductor, electrical connector including a pin section and a complementary socket section, each section comprising a metal shell, a core of insulating material within the metal shell, and electrical elements extending longitudinally through the cores with pins projecting from the forward face of the pin section core and sockets opening through the front face of the socket section core, each of the electrical elements having its rearward end connected with a conductor and having an end face extending radially beyond the conductor, soft sealing material at the rearward face of each core with openings through which the conductors extend, a clamping plate urging the sealing material toward the core and distorting it into intimate sealing contact with the sides of the respective conductors, a face plate between each core and the adjacent sealing material with openings through which the conductors extend, the openings in the face plate being smaller than the transverse extent of the rearward end faces of the electrical elements so that the portion of the face plate around the respective openings serve as abutments to prevent the electrical elements from being pulled out of the core and into the soft sealing material, and O rings surrounding each of the conductors and sealing any clearance around the conductors between the face plate and the rearward face of the core, at least one of the confronting faces of the face plate and core having a recess therein for receiving the O rings.

12. A multi-conductor, electrical connector, including a pin section and a complementary socket section each of which sections includes a metal shell and a core of insulating material housed within the metal shell and longitudinally slidable in the metal shell, fastening means for clamping the metal shells of the connector together, a spring within the shell of at least one of the sections urging the core of that section toward the other section, the cores having confronting faces through which the pins of one section extend into complementary sockets of the other section, and a face seal between said confronting faces, including a disk of soft, resilient material with separate holes through which the respective pins extend, said disk being compressed between the confronting faces by the pressure of the spring that urges one of the cores toward the other.

13. The connector described in claim 12, characterized by recesses in the confronting end faces around the pins and around the socket openings, and further characterized by bosses on the sealing disk around each of the openings through the disk, the thickness of the bosses being correlated with the size of the recesses and the thickness of the disk so that the bosses are compressed somewhat more tightly than the remainder of the disk when the sealing disk is clamped between the confronting end faces of the cores.

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