

[54] ELECTRICAL CONNECTOR

3,480,905 11/1969 Toedtman.....339/213

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[57] ABSTRACT

Related U.S. Application Data

[62] Division of Ser. No. 661,318, Aug. 17, 1967, Pat. No. 3,480,905.

The connector includes a terminal having an outer insulating cover and an inner conducting portion and a conductor having an outer insulating cover and a conductor lug detachably connected to the inner conducting portion of the terminal. A resilient waterproof sheath extends between and is in sealing engagement with the insulating covers of both the terminal and the conductor. Each sheath end includes internal, annular ribs having a smaller diameter than the diameter of the engaged insulating cover material, thus deforming the insulating material into indentations. The resulting pressure from the sheath combined with the heat environment within the sheath provides a bonded seal between the sheath and the insulation material. The terminal outer insulating cover is formed into a retaining boss which is engageable by one of the internal, annular ribs at the terminal end of the sheath.

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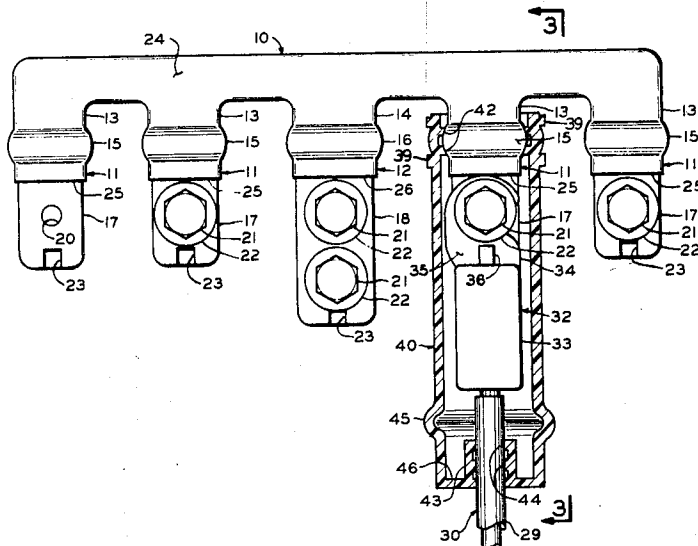
[58] Field of Search.....339/213, 251, 26, 101, 126

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10 Claims, 4 Drawing Figures



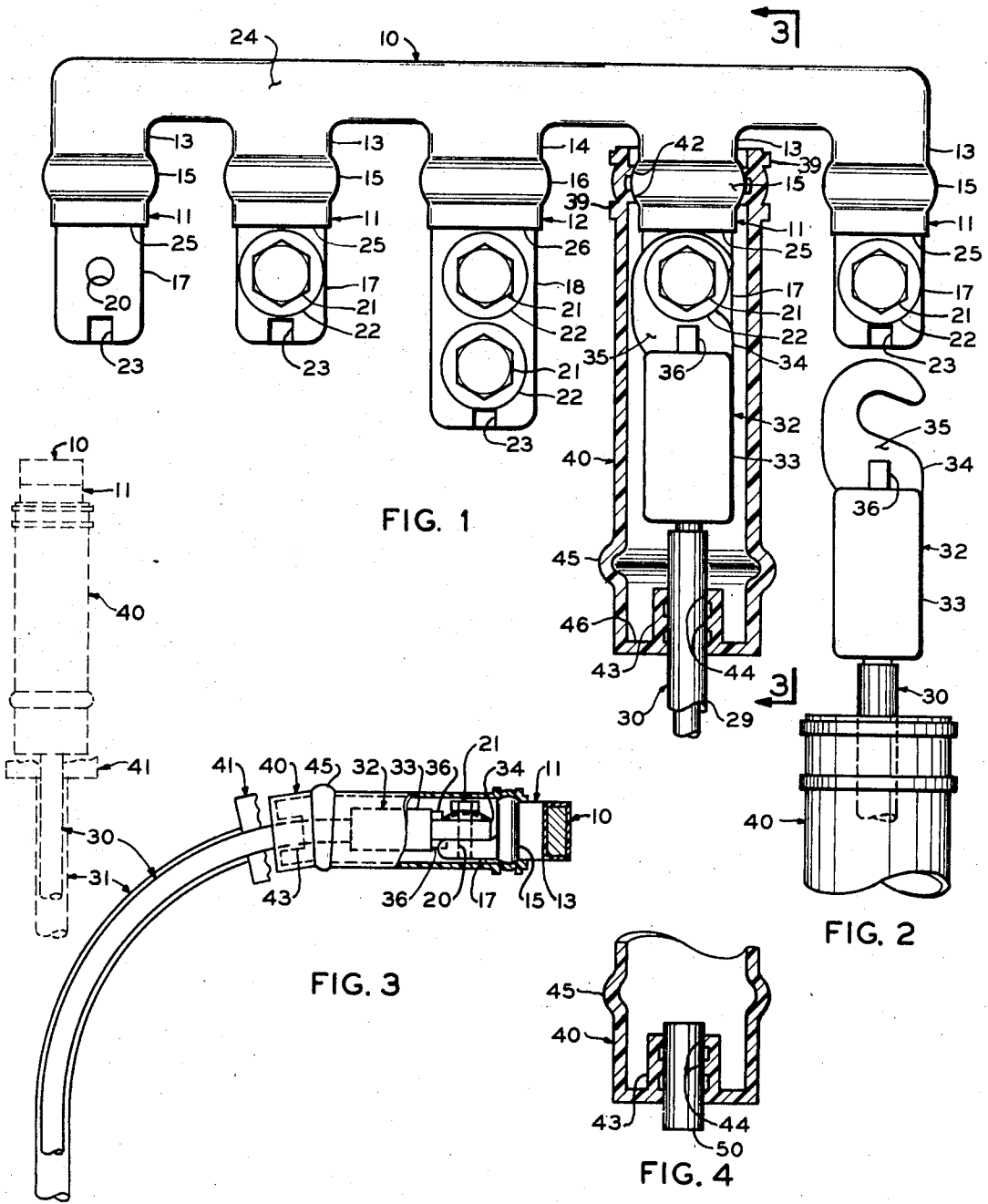


FIG. 1

FIG. 2

FIG. 3

FIG. 4

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## ELECTRICAL CONNECTOR

## CROSS-REFERENCE TO RELATED APPLICATION

This is a division of copending application, Ser. No. 661,318, filed on Aug. 17, 1967, now U.S. Pat. No. 3,480,905.

## BACKGROUND OF THE INVENTION

This invention relates to an electrical connector, and more particularly, to a waterproof electrical connector having attached flexible conductors.

Of the problems which arise in the construction of underground conductor connections, none is more serious than providing the joint with waterproof protection. Failure to provide adequate waterproofing results in the necessity to provide connection replacements because of destruction by corrosion. Further, a potentially severe safety hazard is possible, especially in the vicinity of the connection if the connection is submerged in ground water.

Many of the waterproof connections which are currently used, achieve their waterproof capability at the expense of flexibility of the conductors. Since the connectors are at times placed in relatively small containers, this flexibility is of great importance since it facilitates the bending of the conductors to suit a particular container.

The use of individual sheaths allows each connection to be waterproof without the necessity for having an overall waterproof container. In addition, individual sheaths permit each connection to be "made" or "unmade" without disturbing the remaining connections. This fact has particularly important ramifications in corrosive atmosphere. With an overall cover, it is more difficult to maintain the waterproofing seal because, once the seal is broken, all the connections are vulnerable. Individual covers which have been used in the past, usually for sparkplugs and the like, have not required the high degree of sealing necessary to maintain the connection in a completely dry condition during extended periods of submersion. Bonded sealing has not been provided on such connections.

## SUMMARY OF THE INVENTION

This connector is completely waterproofed by a rubber sheath extending between each terminal and conductor.

Each terminal includes an outer insulated portion and an inner conductor portion. Each conductor includes an outer insulated portion and an end conductor lug. Fastening means between each conductor lug and the associated inner conductor portion secure the conductor lug to the terminal.

Each sheath is resilient and constructed from a water-impervious material and overfits the connection between the conductor portion of the terminal and the conductor lug. Each sheath includes a terminal end having an internal, peripherally continuous pressure portion engaging the outer, insulating portion of the associated terminal in stretched relation and a conductor end having an internal, peripherally continuous pressure contact portion engaging the outer insulated portion of the associated conductor.

The peripherally continuous pressure contact portion of at least one end of each sheath includes an annular rib having a minimum diameter smaller than the diameter of the engaged terminal and the material of the outer insulated cover is of a yieldable plastic material which is deformed into a plurality of annular indentations by the pressure from said rib and the heat environment. The pressure and heat between the sheath ribs and the terminal cover material form an adhesive molecular bond which resists displacement of the sheath on the terminal.

Each terminal includes a boss formed from the terminal insulating cover material. The peripherally continuous pressure portion of the terminal end of the sheath includes a plurality of annular ribs, at least one of which has a minimum diameter smaller than the diameter of the boss to provide a shoulder engaging the boss. Said one rib is spaced from the remote end of the terminal in the installed condition, and the crown of the boss is disposed between said one rib and the end of the terminal to retain the sheath on the terminal.

The pressure contact portion at each end of the sheath includes a plurality of annular ribs creating a groove between adjacent ribs providing an annular lubricant retention cell.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational view including a section through an assembled connection;

FIG. 2 is an exploded view of the connection, the sheath being shown in fragmentary form;

FIG. 3 is a fragmentary view illustrating the bending of the conductors from an upright position, and

FIG. 4 is a fragmentary view illustrating the use of a plug in lieu of a conductor in a sheath.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now by characters of reference to the drawing, and first to FIG. 1, it will be understood that the electrical connector includes an elongate bus bar 10. A plurality of transversely projecting terminals 11 and 12 are disposed in longitudinally spaced relation along the bus bar 10 to form a substantially straight, in-line row. The outer terminals 11 and the central terminal 12 are essentially similar, the central terminal 12 being somewhat larger to accommodate the greater size of the input conductor 31 shown in FIG. 3. For the purpose of this description, one of the terminals 11 will be described, and related numerals, referring respectively to the center terminal 12, will be included in parentheses.

Each terminal 11 (12) includes a substantially cylindrical body portion 13 (14) provided with a peripherally continuous boss 15 (16). The body portion 13 (14) is integrally attached at its upper end to the bus bar 10. The terminal 11 (12) also includes a lug attachment tang 17 (18) which depends from the rear side of the body portion 13 (14). The lug attachment tang 17 (18) is provided with a threaded hole 20 receiving a bolt 21, the bolt 21 holding a conical compression washer 22. An open ended groove 23, constituting a lock means, is provided at the end of each lug attachment tang 17 (18).

The bus bar 10 is coated with a water-impervious, electrically, nonconductive plastic coating 24, such as polyvinylchloride, which is terminated in the preferred embodiment at a point 25 (26) on the lug attachment tang 17 (18) below the boss 15 (16).

Conductors 30 (31) attached to the terminals 11 (12) each each provided with a lug 32. Each conductor lug 32 includes a body portion 33 and a tang 34. Each tang 34 is centrally located with respect to the body portion 33, and has opposite flat faces 35, each of which is provided with a projecting tongue 36, constituting a locking means. The tongue 36 is shaped to interfit and cooperate with the groove 23 on the face of the conductor lug 17 (18). The tongue and groove locking means 36 and 23 preclude rotation of the conductor lug 32 relative to the lug attachment tang 17. The locking means provided by the cooperating tongue 36 and groove 23 are spaced from the center of rotation provided by the fastening bolt 21, and provide a resistance couple against relative rotational movement of lugs 17 and 32.

It will be understood that the bolt 21 exerts a pressure between the faces of the interconnected conductor lug 32 and lug attachment tang 17 (18) which is maintained constant by the use of the conical washer 22.

Each connected joint is provided with a sheath 40 (41) of a resilient water-impervious material. At its upper end, the sheath 40 (41) is provided with internal annular ribs 42, constituting a pressure contact portion, which have a smaller internal diameter than the external diameter of the boss 15, thereby providing a peripheral, continuous seal preventing the ingress of water into the sheath 40.

At its lower end, the sheath 40 (41) is provided with a reentrant internal tube 43. This tube 43 includes internal ribs 44 constituting a pressure contact portion, which contact a waterproof cover 29 of the conductor 30 to form an effective seal preventing the ingress of water into the sheath 40 (41) thereby protecting the electrical connection from corrosion.

The annular ribs 42 and 44 provide a cleaning or wiping action on the components to which they are attached. This is an important function since the work is normally done outdoors where mud and dirt prevail. The ribs 42 and 44 also retain the sealing compound and lubricant that is required for best operation. In addition, a pressure concentration is attained in the ribs 42 and 44 and the total force of the contracting or stretched sheath 40 (41) is directed to a smaller area. This pressure concentration of the ribs 42 and 44 creates a degree of indentation in the insulation over which the sheath 40 (41) is placed so that the sheath 40 (41) is more firmly affixed and resists movement. This pressure concentration, together with the generation of heat in the conductor which is referred to below and which assists in creating the indentations, produces a tight sealing adherence of the rubber sheath material to the yieldable plastic insulating material. The resulting molecular adhesion between the parts produces a weldlike bond between the contacting materials.

The sheath 40 (41) is provided with a bellows 45, constituting a relative flexible portion, to allow bending of the conductor 30 (31) in the vicinity of the lower seal between the ribs 44 and conductor 30 (31) without destroying the seal.

As shown in FIG. 3, the flexible conductor 30 (31) may be bent in a curved configuration with part of the curved conductor portion extending in the sheath 40 (41) and the sheath 40 (41) will remain watertight. In the preferred embodiment, the relative stiffness of the reentrant tube 43, as compared with the annular end wall 46, is such that the end wall 46 constitutes a second relatively flexible portion.

Internal pressure in the sheath 40 (41), as may be occasioned by air expansion and caused by heating of the conductor, is exerted on the tube in a manner which increases the sealing capability of ribs 44. The external ribs 39 act as reinforcing hoops and because they resist stretching, aid in maintaining the pressure exerted by the sheath on the terminal. In addition, they assist in dissipating heat generated at the junction.

It is thought that the functional advantages of this electrical connector have become fully apparent from the foregoing detailed description of parts, but for completeness of disclosure, the installation and usage will be briefly described.

The electrical connector described is capable of being totally submerged in water without suffering from corrosive effects caused by the water and without passing current through the surrounding water. Moreover, this waterproof connection is maintained even though the conductors are bent in the manner shown in FIG. 3. In fact, the arrangement of terminals 11 (12) and the locking means 36 and 23 provided, are specifically designed to enable this bending action under watertight conditions.

The conductor connection is made by slipping the tang 34 of the conductor lug 32 over the shank of the bolt 21. When the conductor lug 32 is aligned substantially as shown in FIG. 1, the tongue 36 automatically interfits the groove 23. Tightening the bolt 21 to the conical compression washer 22 brings the opposing faces of the conductor lug 32 and the lug attachment tang 17 into pressure contact. Rotation of the conductor lug 32 relative to the lug attachment tang 17 is effectively prevented by the couple action of the tongue and groove locking means 36 and 23, the tongue and groove locking means 36 and 23 being spaced from the center of rotation defined by bolt 21. The provision of a tongue 36 on each face 35 of the conductor lug 32 permits an operable connection to be made in the manner described regardless of the direction in which the tang 34 faces longitudinally of the bus bar 10. This alternate locking arrangement is a distinct advantage because otherwise the conductor lug 32 might require removal and replacement or the conductor 30 (31) could be severely twisted.

In order to waterproof the connection, the sheath 40 (41) is pushed upwards until the ribs 42 at the upper end of the sheath embrace and engage the boss 15 under pressure, thereby providing a waterproof seal. The lower waterproof seal is formed as soon as the reentrant tube 43 is placed over

the outer waterproof cover 29 of the conductor 30 (31) so that annular ribs 44 engage the cover 29 under pressure. The pressure and the heat environment about the junction creates an adhesive, bonded joint which increases the efficiency of the seal considerably.

Although only one of the outer terminals 11 is shown fitted with a waterproof sheath 40, it will be understood that all terminals 11 (12) may be so fitted. In the event that a terminal 11 (12) is not provided with a conductor 30 (31), that terminal may nevertheless be easily waterproofed by inserting a sheath 40 (41) over the terminal in the manner described above and by fitting a plug 50 into the tube at the lower end of the sheath 40 (41). The plug 50 takes the place of a conductor 30 (31) which would otherwise be used. This feature is clearly shown in FIG. 4.

It will be clear that the center terminal 12 which is usually the input terminal is shown in the preferred embodiment as having two bolts 21. A conductor lug having a double tang (not shown) would be provided at this location.

By providing the terminals 11 (12) in an aligned disposition along the bus bar 10, and by providing the cooperating locking means 36 and 23 at each terminal connection, the conductors 30 (31) will likewise be substantially aligned in a straight row. By disposing the conductors 30 (31) in-line, rather than in a substantially circular cluster, the force required to bend the group of conductors 30 (31) from the upright position shown in broken lines in FIG. 3 to a substantially horizontal position shown in full lines will merely be the sum of the forces required to bend each conductor 30 (31) individually.

It is a disadvantage to provide conductors arranged in a circular cluster. The resistance of a clustered group is considerably greater than the sum of the individual resistance to bending of the separate conductors. When a push is applied to the bus bar 10 of the present connector, the in-line group of conductors 30 (31), when aligned and locked as described, may be bent to a substantially common configuration. Moreover, the bus bar 10 provides a convenient handle to which the push may be applied. The relatively flexible portions 45 and 46 provided at the lower end of each sheath 40 (41) permits the watertight nature of the connection to be retained even though the curvature of the conductors 30 (31) is rather severe.

It is, of course, a great convenience to be able to make and repair such connections while they are oriented in a vertical position, and then simply bend the in-line group into its downward and final underground location.

I claim as my invention:

1. A waterproof electrical connector comprising:

- a. an insulated terminal including an outer insulated cover of yieldable plastic material, and an inner conductor portion,
- b. a flexible conductor including an outer insulated cover and an end conductor lug,
- c. fastening means between the inner conductor portion of the terminal and the end conductor lug,
- d. an insulating sheath of resilient water-impervious material including:

1. a terminal end having an internal, peripherally continuous rib engaging the outer insulated cover of the terminal in stretched, sealing relation, and
2. a conductor end having an internal, peripherally continuous rib engaging the outer insulated cover of the conductor in sealing relation, and

- e. the minimum diameter of the internal rib at the terminal end is smaller than the diameter of the engaged insulated cover whereby to exert a yielding pressure on said cover creating an annular indentation in the yieldable plastic material,
- f. the relatively small diameter internal rib forms an adhesive bond with the yieldable plastic insulated cover resulting from heat and pressure and resists displacement of the sheath on the terminal.

2. An electrical connector comprising:

- a. an insulated terminal including an outer cover of yieldable plastic insulating material and an inner conductor portion, the terminal including a peripherally continuous boss,
- b. a flexible conductor including an outer cover of insulating material and an end conductor lug, 5
- c. an insulating sheath of resilient water-impervious material including:
  - 1. a terminal end having a plurality of internal annular ribs, at least one of said ribs having a minimum internal diameter smaller than the maximum diameter of the boss to provide a retention shoulder engaging the boss, and 10
  - 2. a conductor end having an internal annular rib engaging the outer insulated cover of the conductor, and 15
- d. fastening means between the inner conductor portion of the terminal and the end conductor lug including threadedly connected male and female elements preventing axial displacement of said conductor when the sheath is installed. 20
- 3. An electrical connector as defined in claim 2, in which:
  - e. the boss is formed from the terminal yieldable plastic insulating cover material.
- 4. An electrical connector as defined in claim 3, in which:
  - f. the internal ribs engage the outer yieldable plastic insulated cover of the terminal in stretched relation, and 25
  - g. the sheath ribs at the terminal end have a smaller diameter than the engaged plastic material to create a degree of indentation in said plastic material and form an adhesive, molecular bond between said ribs and said indented cover material resulting from heat and pressure and resist displacement of the sheath on the terminal. 30
- 5. An electrical connector as defined in claim 3, in which:
  - f. the terminal end of the insulating sheath includes an external annular reinforcing rib disposed about the terminal end insulated cover, and 35
  - g. the boss is disposed between said external reinforcing rib and the remote end of the terminal.
- 6. An electrical connector comprising:
  - a. an insulated elongate bus bar including a cover of yieldable plastic material and a plurality of transverse terminals, each terminal including: 40
    - 1. an outer insulated portion of yieldable plastic material, and
    - 2. an inner conductor portion, 45
  - b. a plurality of flexible conductors each conductor including:
    - 1. an outer insulated portion, and
    - 2. an end conductor lug,
  - c. a plurality of insulating sheaths of resilient water-impervious material overfitting the connection between the conducting portion of the terminal and the conductor lug, each sheath including: 50
    - 1. a terminal end having an internal, peripherally continuous pressure contact portion having a smaller diameter 55

- than and engaging the outer yieldable plastic insulated portion of an associated terminal in stretched relation, and
- 2. a conductor end having an internal peripherally continuous pressure contact portion engaging the outer insulated portion of an associated conductor, and
- d. fastening means between each conductor lug and the inner conductor portion of an associated terminal including threadedly connected male and female elements preventing axial displacement of associated inner conductor lugs and inner conductor portions when the sheath is installed.
- 7. An electrical connector as defined in claim 6, in which:
  - e. each terminal includes a boss of yieldable plastic insulated cover material,
  - f. the pressure contact portion at the terminal end of each sheath includes a plurality of annular ribs, at least one of the ribs having a minimum internal diameter smaller than the maximum diameter of the associated boss providing a retention shoulder engaging the boss, the crown of the boss being disposed between said one rib and the remote end of the terminal.
- 8. An electrical connector as defined in claim 6, in which:
  - e. the peripherally continuous pressure contact portion at the terminal end of each sheath includes a plurality of annular ribs having a smaller diameter than the diameter of the engaged portion of an associated terminal, and
  - f. the plastic material is deformed into a plurality of annular indentations by the pressure from associated ribs, and the sheath environment.
- 9. The method of sealing at least one end of a resilient waterproof sheath to a terminal having an outer cover of yieldable plastic insulating material and a conductor having an outer cover of insulating material, the method comprising the steps of:
  - a. forming an annular rib at the terminal end of the sheath having a minimum diameter smaller than the engaged peripheral portion of an associated terminal yieldable plastic outer cover,
  - b. connecting the conductor to the terminal in fixed relation,
  - c. installing the sheath to pressurize the engaged peripheral portion of an associated terminal yieldable plastic outer cover after connecting the conductor to the terminal,
  - d. passing current through the conductor to create a heat environment, and
  - e. indenting the terminal outer cover by selecting a sufficiently small minimum rib diameter to apply an indenting pressure to the plastic material of the terminal cover.
- 10. The method according to claim 9, including the additional steps of:
  - f. applying sealing compound in the vicinity of the rib, and
  - g. forming an adhesive bond between the rib and the outer terminal cover by the pressure and heat combination.

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