

Dec. 28, 1943.

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2,337,618

ELECTRIC PLUG CONNECTOR

Filed Aug. 1, 1941

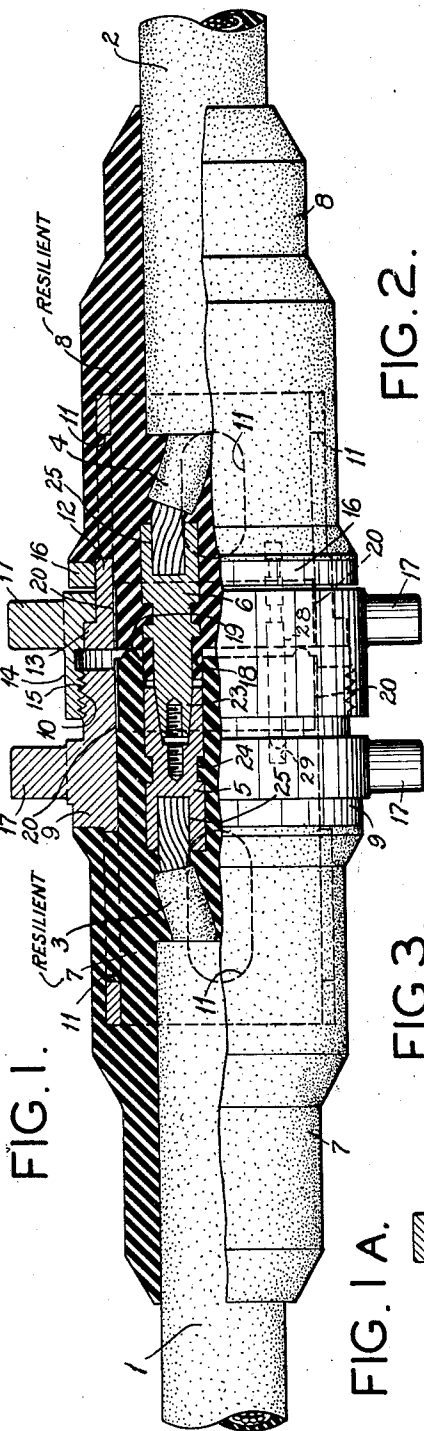


FIG. 1 A.

FIG. 2.

FIG. 3.

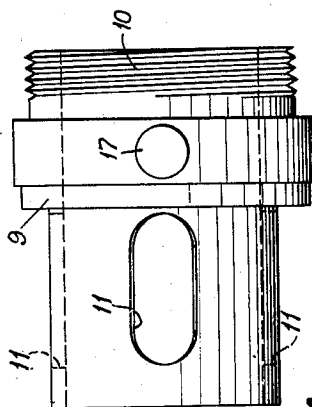
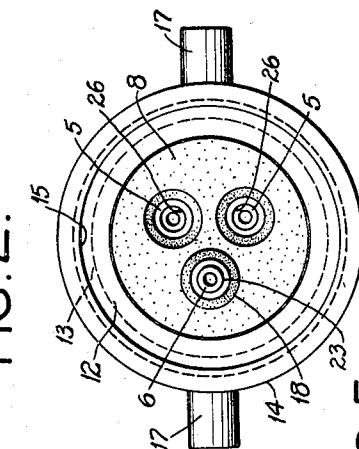
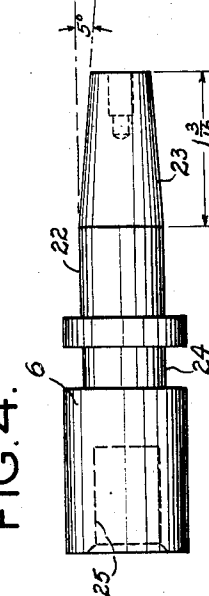
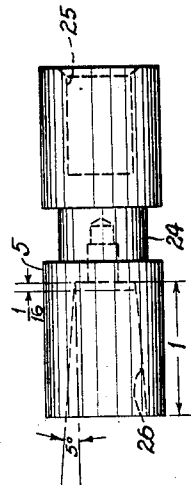


FIG. 5.

FIG. 4.



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2,337,618

ELECTRIC PLUG CONNECTOR

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Application August 1, 1941, Serial No. 405,034

10 Claims. (Cl. 173—328)

This invention pertains to electrical connectors of the plug-and-socket type, and more particularly to connectors adapted to circuits handling fairly heavy currents of the order of several hundred amperes.

It has been found that in providing plug connectors for heavy cables having such currents it is of great importance to provide plug and socket terminals which are capable of making a very intimate contact in order that the contact resistance may be reduced to a minimum and consequent heating of the terminal by the current be also kept at a minimum. The ordinary cylindrical plug-and-socket combination has been found unsatisfactory. This is mainly for the reason that it is very difficult to control the accuracy of the fit of the plug and socket members. If a split plug member is used, it often happens that after some use the prongs are permanently bent so as to close the slots slightly, and when this occurs the plug becomes loose in the socket and a good contact is impossible. Where a solid plug is used, it is very difficult to provide an accurate fit such that a good contact can be maintained and at the same time sufficient looseness provided so that the plug may be pulled out of the socket by the application of a reasonable force.

One of the objects of this invention, therefore, is to provide a plug-and-socket construction by which a proper fit of the plug and socket terminals can be maintained while, at the same time, providing a unit in which the plug and socket members can be assembled and disassembled without difficulty.

In accordance with the present invention the plug and socket members are tapered so that a pressure fit may be obtained. It has been found, however, that where the plug and socket terminals are imbedded in rubber, as in the present construction, the angle of the taper is important, and, in fact, critical. With too small a taper, when the terminals are mounted in a mold for molding the rubber body thereabout, the high molding temperature apparently causes expansion effects which cause the mutually-engaging tapered members of the plug terminal and the mold support to grip each other so tightly that it is almost impossible to separate them when the molding operation has been completed and in many cases the terminals have been torn out of the rubber in an attempt to separate them.

Another object of this invention, therefore, is to provide a plug-socket construction having tapered terminals so organized that they may be

imbedded in a molded rubber body without encountering the above-described difficulties.

Another object is to provide such a tapered plug-socket construction with simple and effective means for drawing the mutually-engaging tapered elements together with sufficient force to insure a low resistance contact.

Another object is to provide such a plug-and-socket construction with improved means for sealing the connection against the entrance of moisture.

It has also been found that where connectors of this type are molded in rubber, it sometimes occurs that the rubber becomes vulcanized to the metal parts, and, upon cooling after vulcanization, the rubber shrinks more than the metal and sometimes becomes distorted on account of its adhesion to the metal. This sometimes has the effect of distorting the rubber elements intended to provide a water-seal, so that those elements fail to make proper engagement with their complementary elements and the devices become defective in not providing a tight seal.

Another object of this invention, therefore, is to provide means for overcoming this difficulty so that upon cooling the rubber parts are not distorted.

Further objects will appear from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a side view, partly in section, showing a plug-and-socket combination embodying this invention.

Figure 1a is a fragmentary detail of the structure of Figure 1, showing another form of seal.

Figure 2 is an end view of the right-hand member of Figure 1.

Figure 3 is a detail view of the sleeve of the left-hand member of Figure 1.

Figure 4 is an enlarged detail of one of the plug members, and

Figure 5 is an enlarged detail of one of the socket members.

Referring now to the drawing, the structure selected for illustration is a plug-and-socket combination intended for making connections between two cables 1 and 2 having separate conductors 3 and 4. The cables 1 and 2 may have any desired number of conductors. For the purpose of illustration 3-wire cables are shown.

The conductor 3 is shown as connected to a socket member 5. The conductor 4 is similarly connected to a plug member 6. The contact end of the plug 6 is tapered, as will be more fully described hereinafter, and engages a tapered

socket in the member 5, as is shown in Figure 1. The terminal members 5 and 6, of which there are three for each cable in the embodiment illustrated, are imbedded in molded rubber bodies 7 and 8. In order to provide for drawing the plug and socket members together, a traction device is provided. In the embodiment illustrated, a screw thread is employed to pull the complementary parts together. For this purpose the body 7 has anchored therein a sleeve or barrel 9, provided at its outer end with a male screw thread 10. In order to provide secure anchorage of the sleeve 9 in the body 7 and to provide for free flow of rubber during the molding operation so as to completely surround all the imbedded parts, the sleeve 9 is provided with one or more enlarged openings 11 therethrough. In the embodiment illustrated, there are four such openings, each of which is traversed by a section of the body material which fills the opening and provides a secure interlock or anchorage between the body and the sleeve 9.

The body 8 has anchored therein in a similar manner a sleeve 12. The sleeve 12 also is provided with perforations 11, serving the same purpose as just described. The sleeve 12 has mounted thereon, and so as to bear against a flange 13 thereof, a movable collar 14 provided with a female thread 15 engageable with the thread 10, as shown in Figure 1. A retaining collar 16 may be fixed to the sleeve 12 so as to retain the collar 14. The sleeve 9 and the collar 14 may be provided with spanner lugs 17 in order to facilitate screwing up the threads 10 and 15. As may be seen from Figure 1, the sleeves 9 and 12 are each separately anchored in the bodies 7 and 8, respectively. The contact members 5 and 6, of course, are also separately mounted and anchored in their respective bodies. Therefore, when the threads 10 and 15 are screwed up, the pressure exerted thereby upon the mutually engaging contacts is transmitted through the resilient rubber bodies, and is, therefore, a resilient pressure. At the same time, the rubber bodies intervene to insulate the sleeves 9 and 12 and the collar 14 from the current-carrying parts, and render said sleeves and collar safe to handle without danger of shock.

Each socket member 5 is set back in the body 7 or 8 so that the rubber extends therebeyond a short distance, and the plug member on the other body is surrounded by a protruding rubber sleeve, shown at 18 in Figure 1. Such a sleeve is provided, surrounding each plug member, and is dimensioned for a snug fit in the corresponding recess surrounding the complementary plug member in order to provide a water-seal. This arrangement is illustrated in Figure 1.

In order to provide an additional seal against moisture, the end face of either or both of the bodies 7 or 8 may be provided with an annular ridge or bead 19, adapted to engage the flat end face of the other body and to be compressed when the two bodies are drawn together so as to provide an effective seal.

It has been found that in molding rubber bodies of this type in contact with the sleeves 9 and 12, the rubber becomes vulcanized to the inside bore of the sleeve and, consequently, adheres thereto. When the rubber cools after vulcanizing, it shrinks more than the sleeve, and as it is held by this adhesion, it will be stretched and distorted so that the end face of the body is no longer flat and the engagement of the bead 19 becomes doubtful. Such distortion may also

pull the contact members 5 and 6 out of alignment. In order to overcome this difficulty, in accordance with this invention a separating strip 20 of paper or other suitable separating material is placed in the mold so as to be interposed between the end portion of the bore of the sleeve 9 or 12 and the molded rubber body therewithin. Such a strip prevents adhesion of the rubber to the metal upon vulcanization and leaves the rubber free to shrink upon cooling. Accordingly, the rubber shrinks normally and retains a substantially flat end face, although a slight clearance may appear between the body and the sleeve where the strip 20 is interposed.

In the arrangement shown in Figure 1a in place of the ridge 19 a plurality of ridges or beads 21 is formed, providing a double or triple seal at this point.

It has been found that the amount of taper given to the contact faces of the plug and socket members is important. The ordinary Morse taper is too small and has been found to be subject to the difficulty of causing the parts to freeze together in the mold so firmly that it is practically impossible to separate them without tearing the rubber. Accordingly, it has been found that a taper of about 5°, as shown in Figure 4, is satisfactory for this purpose as it provides not only good contact between the plug and socket members under a reasonable force exerted by the traction device, but is comparatively easy to release from the mold upon completion of the molding operation. It has also been found that most satisfactory operation is obtained when the length of the tapered portion is made about one-and-one-half times its diameter at the larger end. This ratio of length to greater diameter may be varied from about 1 to about 2 with satisfactory results. Some variation is permissible in the taper. It is believed, however, that it should be maintained between 3½° and 7°.

The plug member of Figure 4 may be formed with a cylindrical body 22 having an extended shank 23 which is tapered, as already described, and which forms the contact portion. An annular recess or groove 24 may be formed in the body to receive a section of the molded rubber so as to form an interlock between the rubber body and the plug. The inner end of the plug may be provided with a suitable socket 25 to receive the end of the conductor 3 or 4, which is usually soldered in said socket. The socket member 5 is similarly constructed, being provided with the groove 24 and socket 25 for the conductor. In this case, however, an inside socket 26, having the same 5° taper as the shank 23, is adapted to receive that shank in making the contact connection.

It will be seen, therefore, that this invention accomplishes its objects in providing a plug-and-socket connector suitable for relatively heavy currents and correspondingly large conductors. When a connection is to be made, the two complementary members may be brought together, as illustrated in Figure 1, so that each plug member 6 enters a socket member 5. These may be forced together by hand sufficiently to engage the threads 10 and 15 with each other or those threads may be positioned to engage before the plug members are seated in their sockets and even before the rubber sleeves 18 enter the corresponding sockets in the other body member. When the threads have been engaged they may be screwed together, thereby providing tractive forces to cause the plugs 6 to enter their sockets

5. As the taper of 5°, given to these members, is substantial, they may be drawn together with considerable force so as to provide a substantial contact pressure, thereby insuring a low resistance contact and an absence of excessive heating at the contact point. At the same time, when it is desired to disengage the contacts, the operation of the threads 10 and 15 in the reverse direction provides an opposite tractive force to separate the contacts.

As the two members are drawn together in making the connection, the sleeves 18 enter the corresponding sockets in the other body and form a water-seal around each contact. In addition to this, the ridges 19 or 21 engage the flat face of the complementary body member and are put under compression by the tractive device so that an effective seal is provided at this point around all of the contacts.

Where it is desired to fix the relative polarity of the plug and socket members, the arrangement shown in Figure 2 may be employed. This figure shows one plug 23 and two sockets 26 on the same member. This can be united with a complementary member only when the latter has one socket and two plugs, and, since they can be put together in only one way, the proper polarity of the several conductors is assured. This arrangement is not, however, always feasible, as it is sometimes desirable to have all sockets on the same member. In such cases a pin 28 may be molded into one body 8 and arranged for insertion into an oppositely-positioned hole 29 molded in the rubber of the other body 7, as indicated in dotted lines in Figure 1. This pin and its hole are so positioned circumferentially as to locate the mutually-engaging plug-and-socket pairs for the desired polarity. This is an economical construction, as it requires only a pin 28 and no metallic socket.

While this invention has been described as embodied in the unitary structure illustrated, it will be understood that individual features or sub-combinations thereof may be employed without reference to other features or the main combination, and the employment of such individual features or sub-combinations is contemplated by this invention when within the scope of the appended claims.

It is obvious that various changes may be made in the details of construction within the scope of the appended claims without departing from the spirit of this invention, and, accordingly, the invention is not limited to the specific details shown and described.

The invention having been described, what is claimed is:

1. A cable unit of the character described having one or more component conductors, metallic plug-socket terminals connected to said conductors, a molded resilient rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having one or more enlarged openings through the wall thereof, said sleeve being molded in said body with an enlarged section of the body material traversing said opening to anchor said sleeve to said body, and a traction device engageable with and movable on said sleeve relatively to said body and engageable with complementary means on another unit for operation to draw the plug elements and socket elements of the different units into pressure-contacting relation to each other.

2. A cable unit of the character described hav-

ing one or more component conductors, plug-socket terminals connected to said conductors, a molded rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having a portion thereof imbedded in said molded body, separating means interposed between the outer end of said sleeve and the outer end of said body to prevent adhesion of the body to the sleeve, and a traction device on said sleeve engageable with a complementary device on another unit and operable to draw the units together.

3. A cable unit of the character described having one or more component conductors, plug-socket terminals connected to said conductors, a molded rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having one or more enlarged openings through the wall thereof, said sleeve being molded in said body with an enlarged section of the body material traversing said opening to anchor said sleeve to said body, an annular ridge formed on the end face of said body positioned for engagement with the end face of a complementary unit to provide a moisture seal, separating means interposed between the outer end of said sleeve and the outer end of said body to prevent adhesion of the body to the sleeve, and a traction device engageable with and movable on said sleeve for operation to draw plug elements and socket elements on different units into pressure-contacting relation to each other.

4. A cable unit of the character described having one or more component conductors, plug-socket terminals connected to said conductors, a molded rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having one or more enlarged openings through the wall thereof, said sleeve being molded in said body with an enlarged section of the body material traversing said opening to anchor said sleeve to said body, an annular ridge formed on the end face of said body positioned for engagement with the end face of a complementary unit to provide a moisture seal, separating means interposed between the outer end of said sleeve and the outer end of said body to prevent adhesion of the body to the sleeve, and a traction device including a screw-threaded collar movable on said sleeve and engageable with a complementary thread on another unit for operation to draw the plug-socket terminals of the two units together into pressure-contacting engagement.

5. A cable unit of the character described having one or more component conductors, metallic plug-socket terminals connected to said conductors, one or more of said terminals having a tapered contact surface of between three and one-half and seven degrees taper, a molded resilient rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having a portion thereof imbedded in said molded body, and a traction device engageable with and movable on said sleeve and engageable with complementary means on another unit for operation to draw plug elements and socket elements on the different units into resilient pressure-contacting relation to each other.

6. A cable unit of the character described having one or more component conductors, solid metallic plug-socket terminals connected to said conductors, one or more of said terminals having a tapered contact surface of between three

and one-half and seven degrees taper and having a length between one and two times its greater diameter, a molded resilient rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having a portion thereof imbedded in said molded body, and a traction device engageable with and movable on said sleeve and engageable with complementary means on another unit for operation to draw plug elements and socket elements on the different units into resilient pressure-contacting relation to each other.

7. A cable unit of the character described having one or more component conductors, plug-socket terminals connected to said conductors, one or more of said terminals having a tapered contact surface of between three and one-half and seven degrees taper, a molded rubber body in which said terminals and the connected portions of said conductors are imbedded, a metallic sleeve having one or more enlarged openings through the wall thereof, said sleeve being molded in said body with an enlarged section of the body material traversing said opening to anchor said sleeve to said body, an annular ridge formed on the end face of said body positioned for engagement with the end face of a complementary unit to provide a moisture seal, separating means interposed between the outer end of said sleeve and the outer end of said body to prevent adhesion of the body to the sleeve, and a traction device engageable with and movable on said sleeve for operation to draw plug elements and socket elements on different units into pressure-contacting relation to each other.

8. A cable unit of the character described having a molded rubber body, one or more metallic plug-socket terminals imbedded in said body, a separate metallic sleeve partly imbedded in said body for anchorage therein and insulated from said terminals, and traction means movable on said sleeve cooperable with relatively movable complementary traction means on another unit whereby to draw said terminals into pressure-contacting relation with complementary terminals of the other unit.

9. A cable unit of the character described having a molded rubber body, a plurality of plug-socket terminals imbedded in said body, a separate metallic sleeve partly imbedded in said body for anchorage therein, and means on said sleeve cooperable with relatively movable traction means whereby to draw said terminals into pressure-contacting relation with complementary terminals of another unit.

10. A cable unit of the character described having one or more component conductors, plug-socket terminals connected to said conductors, a molded resilient rubber body in which said terminals and the connected portions of said conductors are embedded, a separate metallic sleeve having a portion thereof embedded in said body and anchored therein, and a traction device engageable with and movable on said sleeve relatively to said body and engageable with complementary means on another unit for operation to draw the plug elements and socket elements of the different units into pressure-contacting relation to each other.