

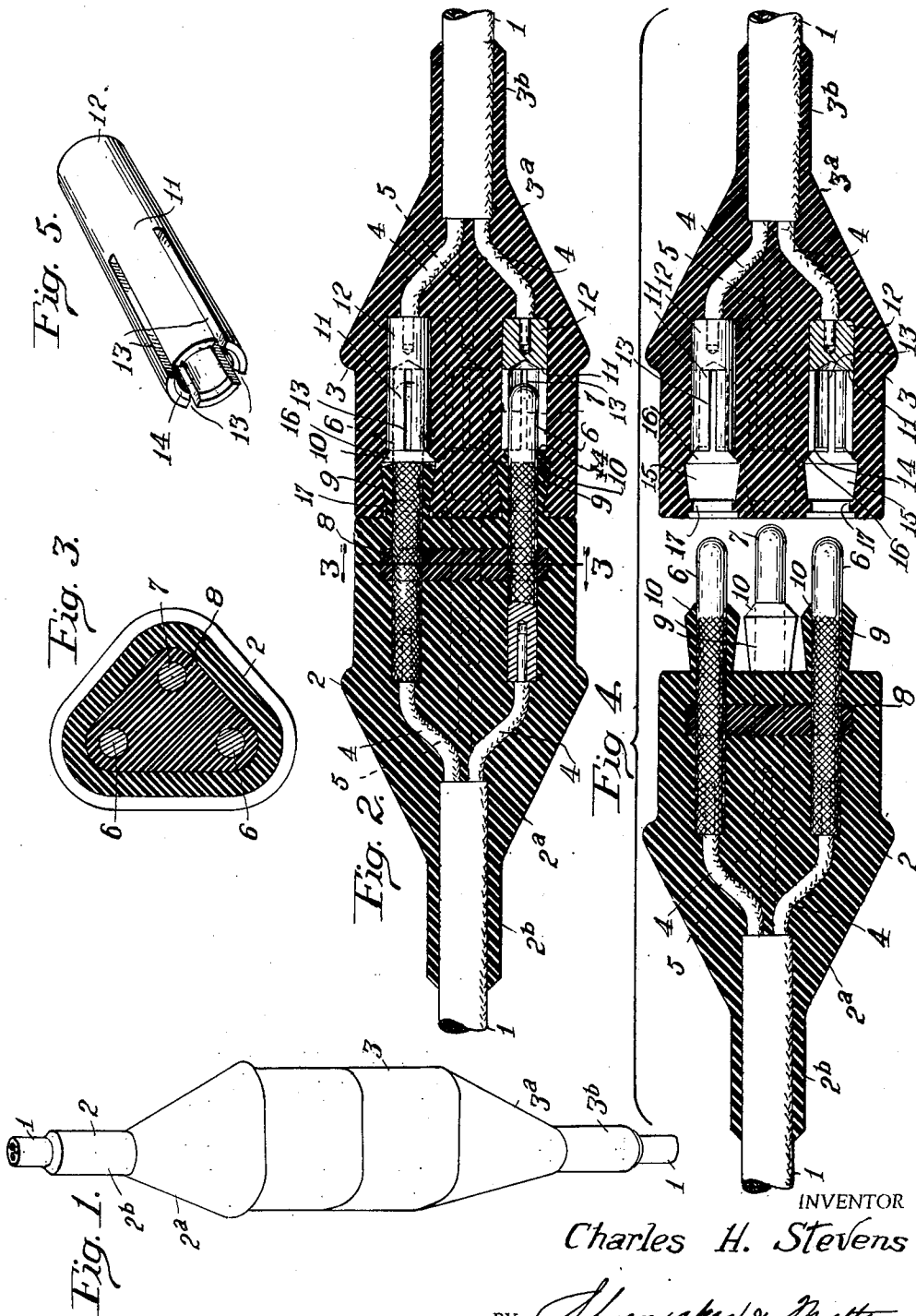
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SEALING JOINT BETWEEN THEIR CONTACTS

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Filed Aug. 13, 1951

2 Sheets-Sheet 1



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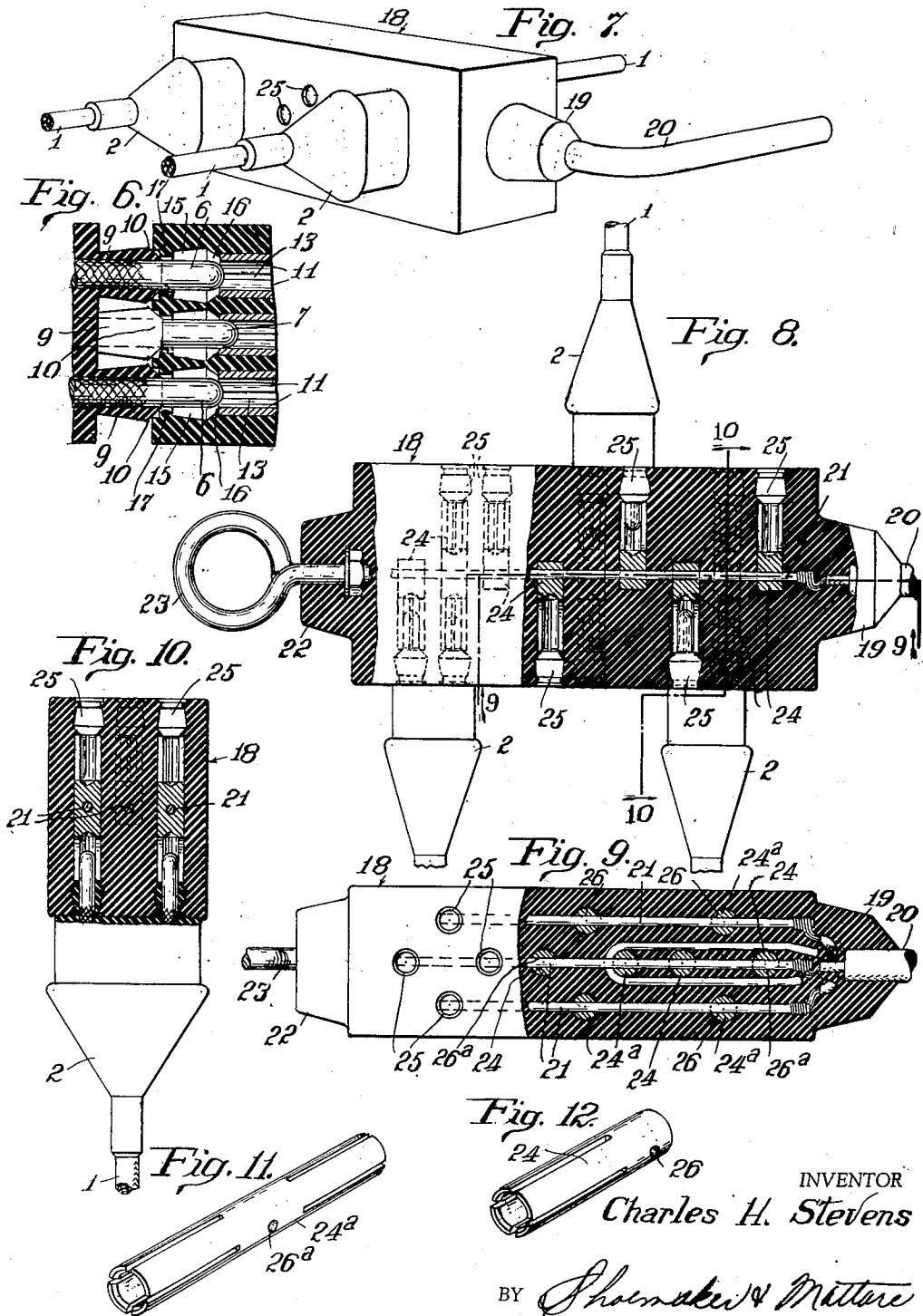
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UNITED STATES PATENT OFFICE

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ELECTRICAL PLUG AND SOCKET CONNECTOR WITH SEALING JOINT BETWEEN THEIR CONTACTS

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7 Claims. (Cl. 339-60)

1 This invention relates to an electrical connection by means of which extension cords may be tightly but detachably connected with each other or with power cables of an electric wiring system and is adapted particularly for use in a wiring system where the cables and wires are liable to be exposed to action of water, vapors or gases which are liable to explode.

The wires and cables of such a system are at the present time installed and used along docks, aboard ships and in buildings where air is liable to become contaminated by chemical fumes and the like and the cables and extension cords are subjected to rough usage such as being thrown from a dock onto a ship or from a main deck of a ship to lower decks. When so used, the cables and the extension cords are liable to become wet or broken and also connections between the cables and sections of extension cords are liable to work loose.

In addition, when a terminal plug of an extension cord or cable is applied to or detached from a companion socket member, arcs are often created during movement of pins of a plug member into or out of engagement with the sockets of a socket member and this creates a dangerous hazard as fumes may be or are liable to be ignited and exploded. This is particularly true upon ships and in buildings where electrically energized apparatus or trouble lights are being used in confined spaces.

It is, therefore, one object of the invention to provide an electrical connection wherein the plug member and the socket member are formed of moulded insulating material of sufficient softness that they are not liable to be broken when subjected to rough usage and, in addition, wherein the body portion of the plug or socket member is moulded about contact members and attached portions of electric cables and thus cause the contacts and the wires to which they are attached to be entirely enclosed in a soft body of insulation.

It is another object of the invention to provide plug and socket members wherein the body of the socket member is formed with open-ended pockets having inner ends exposing ends of contacts of the socket member, the plug member having portions of its pins protruding and having a portion of their lengths encased in jackets formed integral with the body of the plug member and of such dimensions that when the pins are passed through the pockets for engagement with the contacts of the socket member, the outer end of at least one of the pockets will be sealed before

2 the contact pin passing through this pocket engages the companion contact of the socket member. It will thus be seen that since the outer end of the pocket is closed and tightly sealed before one contact has engagement with a companion contact, a spark which may be caused by arcing between the companion contacts will be confined within a tightly closed and sealed space and danger of an explosion will be reduced to a minimum.

It is another object of the invention to so form the pockets of the socket member and the jackets surrounding the pins of the plug member that considerable force is necessary in order to thrust the pins and their jackets into place, the jackets being then very firmly gripped by walls of the pockets which taper toward their outer ends and thereby making it necessary to exert a strong pulling action in order to disconnect the plug member from the socket member. Therefore, the jackets not only serve to seal outer ends of the pockets but also constitute means for securely holding the plug member and the socket member together so that they cannot accidentally work loose and, in addition, water, vapor or gases cannot enter the pockets and cause corroding of the contact pins or the socket contacts mounted in the socket member.

Another object of the invention is to provide the plug member with contact pins so formed and so engaged with the moulded insulation from which the body of the plug member is formed that, when the protruding portions of the pins and their jackets are forced through the pockets of the socket member and the pins engaged with tubular contacts therein, the pins will be prevented from slipping longitudinally in the body of the plug member when the jackets are subjected to strong pushing or pulling action.

Another object of the invention is to provide electrical connecting members of this character wherein the protruding end portion of one of the contact pins is of such length that it may engage and partially enter the companion tubular contact of the socket member in advance of engagement of another pin with its companion tubular contact and thus serves as a guide for directing complete engagement of the shorter pins with their companion tubular contact.

Another object of the invention is to provide the socket member with outwardly tapering pockets leading to the closed ends of its contacts, there being circumferentially extending ribs formed within the outer ends of the pockets and the jackets gradually increasing in diameter or

thickness toward their outer ends and terminating in abruptly tapered end portions which have sealing engagement with the circumferentially extending ribs of the pockets when the pins are thrust through the pockets, the beveled or tapered ends of the jackets not only serving to form preliminary seals for the outer ends of the pockets but also constituting cam surfaces which act upon the ribs and assist in allowing the jackets to be forced into the pockets where they are tightly gripped by expanding action of the jackets and contraction of walls of the pockets.

Another object of the invention is to provide connection members wherein the moulded bodies of the plug member and socket member entirely enclose all metal parts and thus eliminate any danger of an operator receiving an electric shock by contact with metal when the plug member and the socket member are grasped and the two members connected with or separated from each other.

With these and other objects, the invention consists of a special construction and arrangement of parts illustrated in the accompanying drawings wherein:

Fig. 1 is a perspective view showing a plug member and a socket member of the improved construction connected with each other;

Fig. 2 is a sectional view taken longitudinally through the connected plug member and socket member;

Fig. 3 is a transverse sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a group view showing the plug member and the socket member in section and disconnected from each other;

Fig. 5 is a perspective view upon an enlarged scale of one of the tubular contacts of the socket member;

Fig. 6 is a fragmentary sectional view showing the pins of the plug member fitted into the pockets of the socket member with certain of the pins out of engagement with the companion tubular contacts and the pockets in which these pins are located closed and sealed at their outer ends by jackets of the pins;

Fig. 7 is a perspective view of a junction block formed at the outer end of a power cable with the plug members of extension cords or cables connected therewith;

Fig. 8 is a view looking down upon Fig. 7 and showing the body of the junction block partially in longitudinal section;

Fig. 9 is a view showing the junction block partially in side elevation and partially in section along the line 9—9 of Fig. 8;

Fig. 10 is a transverse sectional view taken along the line 10—10 of Fig. 8;

Fig. 11 is a perspective view of a contact which extends entirely through the body of the junction block with open ends of the contact presented toward opposite sides of the block; and

Fig. 12 is a perspective view of a contact extending toward only one side of the junction block.

The extension cords or cables may be of any length and thickness desired and each cable or cord has at one end a terminal member 2 which is a plug member and at its other end a terminal 3 which is a socket member. The cable has been shown of the type including two circuit wires 4 and a ground wire 5 but it will be understood that the cable may have any number of wires therein either a greater number than that shown or a single wire.

The terminal members at opposite ends of the cable each has a body which is formed of moulded insulation which is preferably vulcanized synthetic rubber utilizing polymerized chloroprene as the basic ingredient but it will be understood that other suitable insulation material may be used which is comparatively soft and may expand and contract. The bodies are moulded about the contacts embedded therein and also about portions of the wires extending from the cable and attached to these contacts and, at its inner end, each has a tapered end portion 2a and 3a terminating in an extension 2b and 3b which extends along the cable and firmly anchors the cable within the moulded body 2 or 3.

The contact pins 6 and 7 of the plug member extend longitudinally therein and through openings formed in a contact base 8 which may be formed of hard rubber or other suitable material and is of such dimensions that the contact pins will be spaced from each other to such an extent that there will be no likelihood of strong current passing from one to the other. These contact pins have end portions projecting from the outer end of the body of the plug member and for a portion of their length are surrounded by jackets 9 integral with the body of the plug member. These jackets are reversely tapered in a longitudinal direction. As shown, the jackets gradually increase in thickness or diameter toward their outer ends so that they taper toward their inner ends, and at their outer ends are formed with annular end faces or surfaces 10 which extend at an abrupt angle toward the contact pins. Portions of the pins which are embedded in the body and the jackets 9 are knurled so that when the body of soft insulating material is moulded, the pins will be very tightly gripped and prevented from having longitudinal movement through the body and the jackets and also the jackets prevented from being loosened from the pins and shifted along the same when subjected to strain exerted by force necessary to connect the two terminal members with each other or separate them. These pins are formed of brass and care must be taken to have the protruding portions entirely clean and free from any of the material from which the body is formed.

While the pins are all of the same thickness, the pin 7 protrudes beyond its jacket a greater distance than the pins 6 and, therefore, extends outwardly beyond the ends of the pins 6. The ends of all of the pins are rounded or hemispherical in shape and merge into side surfaces of the pins.

The socket terminal member 3 is of the same length and dimensions as the plug member 2 but the contact members 11 embedded in the soft moulded body of the socket terminal member are each tubular for the major portion of its length but have solid inner end portions 12 to which the wires of the cable are rigidly attached. Each socket contact is slit longitudinally from its front end for the full length of its tubular or hollow forward end portion, as shown at 13, in order to allow the socket contacts to have resiliency and thus effect tight gripping engagement with the pins when the pins are thrust into the hollow contact members or sockets. The inner surfaces of the socket contacts must be clean and entirely free from any insulating material used when forming the moulded body of the socket terminal and thus insure a good conductive engagement between the pins of the

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plug member and the sockets of the socket member.

An annular recess 14 is formed within the forward end portion of each socket contact and thus makes it easier to force the rounded ends of the pins into the sockets. The front ends of the socket contacts are exposed at inner ends of pockets 15 formed in the outer or front end portions of the body of the socket terminal member. These pockets are of duplicate formation and, referring to Fig. 4, it will be seen that each gradually increases in diameter from its outer end for the major portion of its length and at its inner end is formed with an abruptly constricted end portion 16. The walls of the sockets and their constricted inner end portions conform to the reverse taper of the jackets 9 and their outer end portions 10 so that when the pins and their jackets are thrust into the socket contacts 11 and the pockets 15, the jackets will fit tightly into the pockets and completely fill the same as shown in Fig. 2.

About its outer end portion, each pocket is formed with a circumferentially extending internal rib 17 which is integral with the body of insulation and reduces the entrance of the pockets to such an extent that when the pins are thrust into the pockets, the ribs will make contact with the abruptly sloping end faces 10 of the jackets and force must be exerted to move the jackets past the ribs and into the pockets. After the jackets have been forced into the pockets, they tend to expand and the walls of the pockets contract and, since the jackets are tapered toward their inner ends and the pockets are similarly tapered toward their outer ends, the jackets will have a wedging fit in the pockets and a strong pull must be exerted in order to withdraw the jackets and the pins and thus separate the plug terminal member and the socket terminal member from each other.

When the pins are passed inwardly through the pockets and the end faces or shoulders 10 engage with the ribs 17, the pin 7 may engage and fit into the open outer end of its companion socket contact a slight distance but the pins 6 are spaced from the open outer ends of their companion socket contacts. It will be thus seen that the pockets into which the pins 6 are passed will be fully closed and tightly sealed before the pins 6 have conductive engagement with the companion socket contacts and if an arc is formed between these companion pins and sockets, it will be confined in a tightly closed space and explosive gases will not be ignited by the spark.

After the pins and their jackets have been forced fully into place, the jackets serve to very firmly hold the two terminal members in close fitting engagement with each other and water, vapor or gases will not be allowed to seep into the pockets. It will thus be seen that the jackets perform the double function of closing and sealing the pockets before conductive engagement is made between companion contacts and, in addition, serving as securing means for tightly but detachably holding the two terminal members connected.

Instead of connecting a cable or extension cord with an end of another cable or extension cord, one end of a cable or cord may be detachably connected with an outlet unit or junction block shown in Figs. 7 through 12. This outlet unit or junction block 18 is formed of moulded compressible insulation of the same kind used for the two terminal members 2 and 3.

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The junction block has been shown of oblong shape and at one end has a knob 19 extending longitudinally therefrom and enclosing the portion of the insulated power cable 20 which extends into the block. This power cable has its wires connected with bus bars 21 which may be metal strips or rods extending longitudinally in the body of the junction block. At its other end, the body is formed with an integral extension 22 in which is anchored an eye bolt 23 by means of which the junction block may be suspended from a nail or the like or with which a rope may be connected so that the junction block and cables connected therewith may be thrown from a dock onto a ship or from one portion of a ship or building to another.

Socket contacts 24 which are of the same construction as the socket contacts 11 are moulded into the body of the junction block along with the bus bars and the cable and the eye bolt and have their outer ends exposed at inner ends of pockets 25 corresponding to the pockets 15.

The bus bars pass through transversely extending openings 25 formed in socket contacts 24 into which the pins 6 of the terminal members are fitted and one of the bus bars carries double socket contacts 24a by being passed through openings 26a formed midway of their length. These double socket contacts extend across the junction block from opposite sides of the bus bar with which they are connected and communicate with the pockets into which the pins 7 of the plug members fit.

While it has been stated that the cable 20 is a power cable, it is to be understood that this may be of the same construction as the extension cord 1 and connected with a wall panel by one or more extension cords connected with each other or it may be a cable of suitable length having one end plugged into or otherwise connected with a wall panel.

The system having the invention incorporated therein consists of a main panel which is preferably mounted against a wall or other support and cables are plugged into this wall panel. The cables extending from the wall panel may be of any length desired and one is either permanently or detachably connected with a junction box or it may have its outer end plugged into a light or an electrically operated tool or other appliance. The junction block is free except for its connection to the power cable and, in order that it may be thrown from a dock onto a ship or from one ship to another, a rope of suitable length is tied to its eye bolt. In case a junction block becomes wet by falling into water or it is exposed to vapors or fumes, neither the junction block nor connections between the extension cords and the junction block will cause arcing and also the pins of plug sockets and the socket contacts of the socket terminals will be effectively guarded against corroding. There also will be no danger of a junction block or a terminal member being broken if dropped or if they strike hard surfaces when thrown from one place to another. It is also impossible for the terminal members to be broken loose from ends of the cables as the extensions 2b and 3b of the rubber bodies of the terminal members extend along the cables an appreciable distance and when they are formed by moulding of the bodies of the terminal members, they become firmly united with the insulation coatings of the cables.

While the bodies of the plug terminal and the socket terminal may be of different lengths, they

are preferably of such dimensions that they may be firmly grasped in a person's hands for connection with or separation from each other and they are also preferably triangular in cross section so that they will fit the hand and a good grip may be obtained upon them.

When vulcanized, the moulded body of a terminal member or the moulded junction block is form retaining but is yieldable to pressure and preferably has a durometer hardness of $60 \pm 2\frac{1}{2}$, and the insulation resistance of the moulded bodies is preferably 100 megs when measured by a 500 volt megger. The moulded bodies should be capable of withstanding a load of 30 amperes at 250 volts for 30 minutes without excessive heating.

It has been stated that the jackets when fitted into the pockets of the socket terminal member have a very tight sealing fit therein and, in the preferred embodiment of the invention, they are to be watertight when tested under a head of 15 feet of water (6.7 p. s. i.) for 30 minutes. The insulation resistance between leads and leads to ground will preferably not be less than 10 megohms when measured with a 500 volt megger at any time during the submergence test mentioned above and the contacts and attached wires of the cables so insulated that the terminals may be grasped and safely connected with each other by hand at (—) 20° F.

Having thus described the invention, what is claimed is:

1. In an electrical connection, companion terminal members each having a body of resilient moulded insulating material, female contacts of conductive metal embedded in the body of one terminal member, the said terminal member being formed with pockets open at outer ends and having inner ends communicating with said contacts, the walls of the pockets being formed adjacent their open outer ends with circumferentially extending ribs, the other terminal member having contact pins embedded in the body of the other terminal member and each protruding therefrom for a portion of its length, the protruding portion of said pins being surrounded by resilient jackets for a portion of their length with outer end portions of the pins protruding from the jackets, the jackets being integral with the body and gradually increasing in diameter toward their outer ends and terminating in ends tapered toward the pins and engageable with the ribs to effect sealing of outer ends of the pockets when the pins are thrust into the pockets for conductive engagement with the female contacts, at least one jacket having sealing engagement with the rib of the pocket prior to engagement of the pin with the companion female contact.

2. In an electrical connection, companion terminal members each having a body of resilient insulation and conductors extending therein, female contacts in the body of one terminal member exposed at inner ends of pockets formed in the body and open at their outer ends, walls of the pockets being formed with circumferential sealing ribs, male contacts embedded in the body of the other terminal member and having portions protruding therefrom and engageable with companion female contacts when thrust into the pockets, and jackets surrounding protruding portions of said male contacts and formed integral with the body of the second terminal member and adapted to engage the ribs and seal outer ends of the pockets as the jackets are forced into the pockets and prior to engagement of the male contacts with the companion female contacts.

3. The structure of claim 2 wherein the jackets are spaced from outer ends of the male contacts about which they fit and have outer end portions tapered toward the male contacts and constituting cam surfaces engageable with the ribs and applying expanding pressure to the ribs during movement of the male contacts and the jackets inwardly through the pockets.

4. The structure of claim 2 wherein the jackets are circular in cross section and increase in diameter toward their outer ends and terminate in outer ends abruptly tapered toward the male contacts whereby the jackets first have expanding engagement with the ribs and walls of the pockets and the ribs then contracting tightly about the jackets.

5. In an electrical connection, a socket member and a companion plug member, each of said members having a body of resilient insulation having at least one contact and an electrically connected insulated conductor embedded in the body, the body of the socket member being provided with at least one pocket open at its inner and outer ends and at the inner end exposing the end of its embedded contact, the contact of the plug member having a protruding end portion interengageable with the companion contact of the socket member when passed inwardly through the pocket, and a jacket about a protruding portion of the contact of the plug member and extending from the body of the plug member serving as a means for closing and sealing the outer end of the pocket, said jacket increasing in size toward its outer end and the pocket being of corresponding shape and reduced in size toward its open outer end whereby the outer portion of the pocket is of less size than the larger portion of the jacket and compressing force is necessary to effect passage of the larger portion through the open outer end portion of the pocket and the taper of the interfitting jacket and pocket toward the outer end of the pocket resists withdrawal of the jacket and the contact from the pocket.

6. In an electrical connection, companion terminal members each having a body of resilient insulation and a conductor extending therein, a female contact in the body of one terminal member, said one terminal member being formed with a pocket open at its outer end and exposing the female contact at the inner end of the pocket, a male contact partially embedded in the body of the other terminal member and having a portion protruding therefrom for engagement with the female contact in the one terminal member when thrust inwardly through the pocket, and a jacket for a partial length of the protruding portion of the male contact, said jacket extending from the body of the other terminal member and being gradually reduced in cross-sectional area toward its inner end and said pocket having the wall thereof similarly gradually reduced in cross-sectional area toward its outer end with the smallest cross-sectional portion of the pocket being smaller than the largest cross-sectional portion of the jacket.

7. In an electrical connection, a socket member and a companion plug member, each of said members having a body of resilient insulation having at least one contact and an electrically connected insulated conductor embedded in the body, the body of the socket member being provided with at least one pocket open at its inner and outer ends and at the inner end exposing the end of its embedded contact, the contact of the

plug member having a protruding end portion interengageable with the companion contact of the socket member when passed inwardly through the pocket, and a jacket about a protruding portion of the contact of the plug member serving as a means for closing and sealing the outer end of the pocket, said jacket extending from the body of the plug member and having its surface reversely tapered longitudinally thereof and said pocket having the wall thereof formed with a similar reverse taper substantially corresponding as to size and shape so that with the male and female contacts interengaged the reversely

tapered surfaces are tightly sealing interengaged and resist separating movement.

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