March 16, 1965 E. P. BRINKEL ETAL 3,173,736

ELECTRICAL CONNECTOR

Filed Oct. 24, 1960

Fig. 1.

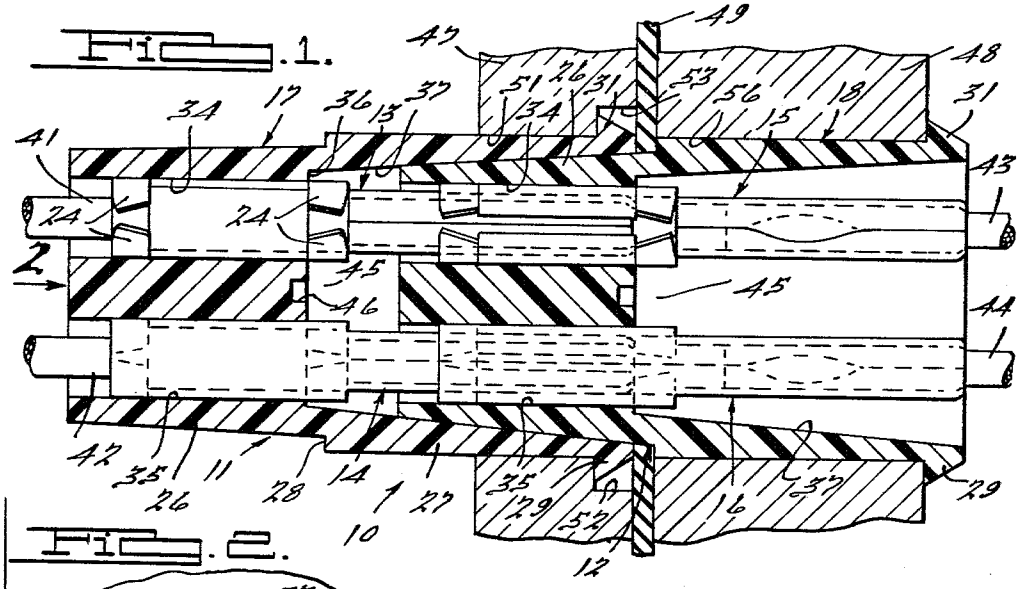
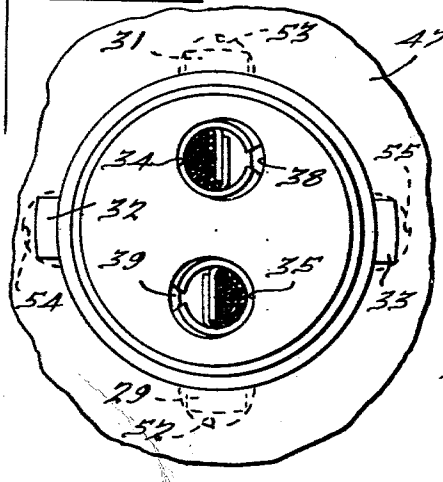


Fig. 2.



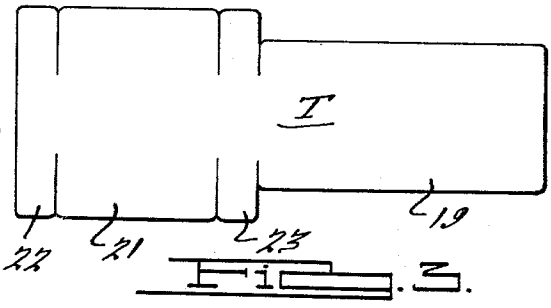


Fig. 3.

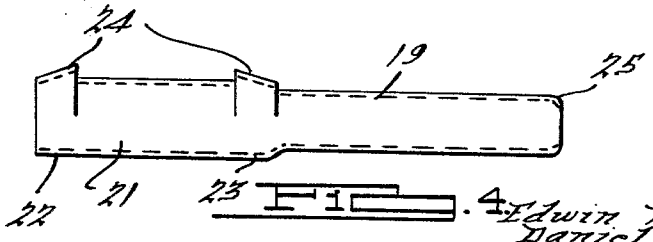


Fig. 4.

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ELECTRICAL CONNECTOR

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This invention relates to electrical connectors and more particularly to separable prong-and-socket connectors carried by supporting structures which are detachably connected.

It is an object of the present invention to provide a novel and improved electrical connector of the prong-and-socket type which is of extremely simple construction, requiring only two basic parts for assembling both the male and female terminals.

It is another object to provide an improved electrical connector of this nature which can be easily assembled and installed in the supporting structures, and which is durable and efficient in use.

It is a further object to provide an improved electrical connector of the above nature which is adapted for various sizes and numbers of wires and in which the terminals can be connected to wires by either soldered or solderless connections.

Another object of the invention is to provide an improved electrical connector construction having the above characteristics, which is adapted to be used in sealed installations, and in which the terminal assemblies will form a fluid and dust-tight seal when united.

Other objects, features and advantages of the present invention will become apparent from the subsequent description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a cross-sectional view in elevation of male and female terminal assemblies of the novel connector mounted in their supporting structures and shown in engagement with each other;

FIGURE 2 is an end elevational view taken in the direction of the arrow 2 of FIGURE 1, the bared wire ends being sectioned, showing the manner in which the terminals and terminal housings are prevented from rotation with respect to their supporting structures;

FIGURE 3 is a plan view of a partially formed blank used in fabricating one of the terminals, and

FIGURE 4 is a side elevational view of a terminal after it has been rolled into circular form.

In general terms, the illustrated embodiment of the invention comprises an electrical connector having male and female terminal assemblies. Both of these assemblies are built up of two basic components—a terminal member and a housing. The terminal member comprises a tubular element of electrically conductive material having a female section and a male section. The housing element likewise comprises an element of generally tubular shape having a female section and a male section.

To assemble the male terminal assembly, wires are secured to the female sections of the desired number of terminal elements and these terminal elements are then mounted in a housing element. Flared tabs are provided at opposite ends of the female terminal section which lock in place on opposite ends of a bore formed within the male housing section, so that the male terminal sections project into the interior of the female housing section.

To fabricate the female terminal assembly, wires are secured to the male sections of the desired number of terminals, and these terminals are then mounted in another housing element in the same manner as the terminals in the male terminal assembly. Means are provided on the exterior of the female section of each housing element for securing this element to a supporting structure in such manner that the male section of one housing element may enter the female section of the other. In so doing, the exposed male terminal sections will enter into and spread apart the female terminal sections of the other assembly.

Referring more particularly to the drawings, the electrical connector in its entirety is generally indicated at **10** and comprises a male terminal assembly generally indicated at **11** and a female terminal assembly generally indicated at **12**. Each of these two assemblies is made up of only two basic components, these two components being identical for both assemblies. For purposes of the description, however, different reference numerals will be used for the parts shown in the illustrated embodiment of the invention.

The first basic component is a terminal, and four such terminals generally indicated at **13**, **14**, **15**, and **16**, are shown. These four terminals are all of identical construction, although they assume different configurations in the assembly shown in the figures because terminals **13** and **14** are used as male terminals whereas terminals **15** and **16** are used as female terminals. The other basic component is a housing, and two such housings generally indicated at **17** and **18** respectively, are shown. Housings **17** and **18** are likewise identical, with housing **17** being used for the male terminal assembly while housing **18** is used for the female terminal assembly.

The construction of a terminal (to be generally referred to as T in the subsequent description) is shown best in FIGURES 3 and 4. Terminal T is fabricated of an electrically conductive material which is originally in the form of a blank as shown in FIGURE 3. This blank has a male section **19** of oblong or rectangular shape, a female section **21** of wider or square shape, and locking sections **22** and **23** comprising transversely extending strips partially severed from the male and female sections, with strip **22** being at one end of the female section and strip **23** being between the male and female sections.

After the blank has been formed as shown in FIGURE 3, it is bent in to a rolled or cylindrical form as shown in FIGURE 4 by any appropriate means. In its final form, male section **19** will be of tubular shape with its opposite edges in abutting relation. Female portion **21** will likewise be of tubular shape with a somewhat larger diameter than male section **19**, but with its opposite edges likewise in abutting relation. Locking strips **22** and **23** will follow the contour of female section **21** through the unsevered portion of these strips, but the severed portions will be bent outwardly in an inclined manner from the female section so as to form locking tabs **24**. These locking tabs will flare from approximately the diameter of female section **21** at the outer edges of the locking tabs, to a somewhat larger diameter at the edges of the locking tabs adjacent female section **21**. As a result, the facing edges of each pair of locking tabs **24** will not be in abutting relation, but will be flared away from each other as shown in FIGURE 1.

The relative sizes of male section **19** and female section **21** of each terminal T are such that a male section of one terminal may be inserted in the free open end of the female section of another terminal. The outer end **25** of each male terminal is rounded as shown in FIGURE 4 to facilitate insertion. When such insertion takes place, the female section will be spread apart, resulting in a gripping force on the male section tending to maintain firm electrical contact.

Each housing **17** or **18** may be referred to as H in this

description. The housing is fabricated of an electrically non-conductive or insulative material, and has a male section 26 and a female section 27. These two sections are in aligned relation so as to form a generally tubular shape for the entire housing. Section 26 is somewhat narrower than section 27 and has an outer surface which tapers toward a narrower diameter at its outer end. A shoulder 28 exists between the two sections, and the outer surface of section 27 is cylindrical. A pair of retaining lugs 29 and 31 are formed on the outer surface of female section 27 at the outer end thereof, these lugs being diametrically opposed and being flared in a direction away from the housing end with square shoulders facing the central housing portion. Another pair of retaining lugs 32 and 33 are formed on the outer surface of female section 27 at shoulder 28 these lugs being displaced 90 degrees from lugs 29 and 31 and having shoulders facing the shoulders of the latter lugs.

Male section 26 is used to support terminals T, and for this purpose the interior of section 26 is provided with a pair of cylindrical bores 34 and 35. These bores extend toward the outer end of male portion 26 from a shoulder 36 at the inner end of a bore 37 formed within female section 27 and having the same taper as the outside of section 26. One side of each bore 34 and 35 is enlarged, however, at the outer end; the enlargement is indicated at 38 in FIGURE 2 and forms a shoulder indicated at 39. The distance between shoulders 36 and 39 is equal to the length of female section 21. Shoulder 39 for bore 34 is formed on the opposite side of the shoulder for bore 35, as seen in FIGURE 2.

Four wires 41, 42, 43 and 44 are shown as being secured to terminals 13 to 16 respectively. In the illustrated embodiment of the invention, the bared ends of these wires are inserted in the terminals, the latter being crimped thereto. Other methods of securing the wires to the terminals may be used within the principles of the invention and the wires may be secured to the terminals either before or after they have been passed through the housings.

Wires 41 and 42 are crimped within the female sections of terminals 13 and 14 respectively, portions of these sections being forced into overlapping relation to create the crimped gripping action. Sufficient uncrimped material will be left on female sections 21 of terminals 13 and 14 to permit the terminals to be supported within bores 34 and 35, as seen in FIGURE 2. Wires 43 and 44 are crimped within the male sections 19 of terminals 15 and 16.

Assuming that the wires are crimped to the terminals before the latter are fitted in the housings, terminals 13 and 14 may be assembled in housing 17 by inserting male sections 19 into the left hand ends of bores 34 and 35, until the narrower portions of tabs 24 between the male and female sections come to shoulder 39. Each terminal may then be forced further into its respective bore, since the narrow ends of tabs 24 will permit the tabs to be squeezed past shoulder 39, the tabs being temporarily collapsed as they pass through bore 34 or 35. When these tabs 24 reach shoulder 36, they will snap back into their unstressed position, engaging this shoulder. At the same time, the tabs 24 at the left hand end of terminal 13 or 14 will come up against shoulder 39. Since it is the wide ends of these tabs which engage shoulder 39, terminals 13 and 14 will be locked in place.

Terminals 15 and 16 may be similarly assembled in housing 18, wires 43 and 44 first being crimped thereto with the terminals inserted from the right hand side. Terminals 15 and 16 will first pass through tapered recess 37 of housing 18 and will then be snapped into position in bores 34 and 35 of housing 18.

As mentioned previously, the shoulders 39 of bores 34 and 35 respectively, preferably extend in opposite directions, as shown in FIGURE 2, in order that the maximum air gap, indicated at 45, be attained between the terminals in recess 37. To increase the electrical leakage path, slot 46 may be formed in shoulder 36 between apertures 34 and 35, as seen in FIGURE 1.

The male and female terminal assemblies may then be mounted on supporting structures 47 and 48 respectively. These supporting structures may, for example, be portions of a solenoid valve housing which are separable to permit maintenance or inspection of the valve component. The structural members are shown as being separated by a gasket 49, support 47 having an aperture 51 with recesses 52 and 53 on the surface of the support facing gasket 49. Support 48 may have similar recesses 54 and 55 spaced 90 degrees apart from recesses 52 and 53, as seen in FIGURE 2. Support 48 is also provided with an aperture 56 of the same diameter as aperture 51. This diameter is substantially the same as the outside diameter of female sections 27 of housings H.

Housings H, or at least lugs 29 to 33 thereof, may be formed of material sufficiently resilient to be capable of being forced through apertures 51 and 56. The housings may thus be mounted in supports 47 and 48, with lugs 29 and 31 being receivable by recesses 52 and 53 respectively, whereas lugs 32 and 33 are receivable by apertures 54 and 55.

Upon bringing supports 47 and 48 together, male section 26 of housing 18 will be inserted into tapered recess 37 of female section 27 of housing 17. At the same time, male sections 19 of terminals 13 and 14 will be received by female sections 21 of terminals 15 and 16. The relative dimensions of these sections are such that female sections 21 will spread apart slightly against the walls of bores 34 and 35, maintaining firm electrical contact with the male terminal sections. The slight degree of lateral shiftability permitted by the terminals with respect to the housing will permit alignment of the male and female terminals when they are brought together despite dimensional variations which may occur. When these parts are in their fully inserted position, as shown in FIGURE 1, a tight seal will be maintained between the housings preventing dust or moisture from entering the spaces occupied by the terminals. Rotation of any terminal within its housing will be prevented by the positions of tabs 24 within spaces 38, and rotation of the housings relative to their respective supports will be prevented by the interengagement of tabs 29 to 33 with their respective recesses.

When supports 47 and 48 are separated, the terminal assemblies will likewise separate, the male section of housing 18 being withdrawn from the female section of housing 17, while the male sections of terminals 13 and 14 are withdrawn from the female sections of terminals 15 and 16. The engagement of tabs 24 with shoulders 39, as well as the engagement of tabs 29 to 33 with their respective supports, will prevent any undesired shifting of the parts during this withdrawal, as well as during a subsequent reassembly of the terminals.

The novel construction also permits removability of the terminals from their housings and of the housings from their supporting structure for maintenance or replacement of parts. As indicated above, housings H may be fabricated of deformable material so that they may be removed from the supporting structure apertures. Any terminal T may be removed by collapsing a set of tabs 24 at one end, using for example a tubular tool forced onto the narrow ends of the tabs to wedge them together.

While it will be apparent that the preferred embodiment herein illustrated is well calculated to fulfill the object above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In combination, two electrical terminals of substantially identical shape, insulative supports for said terminals, each terminal comprising an elongated generally tubular member of integral construction and electrically conductive material, a female section at one end of each terminal, a male section at the other end of each terminal, the male section of one terminal being inserted into the female section of the other terminal, the male section of said one terminal having an outer surface diameter relative to the inner surface diameter of the female section of said other terminal so as to be held in the female section of said other terminal with frictional contact, the outer ends of the male and female sections of each terminal being open, a first wire outwardly of the outer end of the female section of said one terminal and remote from the male section thereof, said first wire having a bared end extending into said female section through the opening in the outer end thereof, a second wire outwardly of the outer end of the male section of said other terminal and remote from the female section thereof, said second wire having a bared end extending into said male section through the opening in the outer end thereof, and means securing said bared wire ends to their respective terminals.

2. The combination according to claim 1, said securing means comprising crimped portions on the male and female sections within which said bared wire ends are disposed.

3. The combination according to claim 1, further provided with at least one tab struck outwardly from each said terminal at opposite ends of said female section.

4. An electrical terminal comprising an elongated strip of electrically conductive material bent into a tubular shape with abutting edges, a male section at one end of said terminal having a relatively small diameter, a female section at the other end of said terminal having a relatively large diameter, the relative sizes of the external male section and the internal female section diameters being such that the male section of one terminal may be inserted in the female section of another identical terminal with frictional contact with the abutting female section edges slightly spread apart, and outstruck locking means formed on said terminal between said male and female sections, said outstruck locking means being formed from and integral with said elongated strip, portions of both said male and female sections being so formed that a bared wire end may be secured to either said male or female section and extend outwardly therefrom.

5. The combination according to claim 4, said locking means comprising a pair of tabs partially severed from said terminal and being tapered toward the terminal centerline in the direction of the male section, and a second pair of locking tabs at the outer end of the female section tapered in a direction opposite to the first pair of locking tabs.

6. In an electrical connector, a unitary and integrally formed housing of generally tubular shape and of insulative material having a male section at one end and a female section at the other end, the outer surface of the male section and the inner surface of the female section having relative dimensions such that the male section of one housing may fit snugly within the female section of another housing constructed identically with said first housing, a terminal of integral generally tubular construction and electrically conductive material having male and female sections, the outer surface of the male terminal section and the inner surface of the female terminal section being so related that the male section of one terminal may fit snugly within the female section of another terminal, and means within the male housing section supporting the female terminal section with the male terminal section disposed within the female housing section.

7. The combination according to claim 6, said last mentioned means comprising a bore within the male housing section within which said female terminal section is disposed, and means on said terminal engageable with opposite ends of said bore to prevent longitudinal movement of the terminal within the bore.

8. The combination according to claim 7, said last mentioned locking means comprising a locking tab struck out from said terminal at each end of said female terminal section, and shoulders at opposite ends of said bore engageable by said tabs.

9. The combination according to claim 8, one of said shoulders extending only to one side of said bore, whereby said terminal will be non-rotatable with respect to the bore when said tabs engage said shoulders.

10. The combination according to claim 8, said tabs being tapered toward the center of the terminal in a direction away from said female terminal section, whereby a tab will be forced inwardly when said terminal is inserted into said bore from either end thereof.

11. The combination according to claim 6, said inner female housing section surface and outer male housing section surface being tapered in the same direction and degree, whereby male and female sections of two housings may be interfitted with a sealing relation.

12. The combination according to claim 6, further provided with outwardly extending lugs on the outer female housing section surface, and a supporting structure for said housing, said lugs and supporting structure having coacting portions to prevent relative movement between the housing and supporting structure.

13. The combination according to claim 12, said housing means for supporting said terminals comprising a pair of bores in said housing of a length corresponding to said female terminal sections and within which the female terminal sections are disposed, said locking elements comprising outstruck tabs at opposite ends of said female terminal sections, and shoulders at opposite ends of said bores engageable by said tabs.

14. The combination according to claim 13, said outstruck tabs comprising a pair of tabs at each end of each female terminal section, said tabs being tapered toward the terminal centerline in a direction away from the female terminal section, the degree of taper of said tabs being such that either pair of tabs may be collapsed to permit removal of the corresponding terminal.

15. In an electrical connector, first and second housings of identical construction, each housing being of electrically insulative material and generally tubular shape and having a female section at one end and a male section at the other end, the inner surface of said female section and the outer surface of said male section having interfittable surfaces, at least one terminal in each housing, said terminals being of identical shape, each terminal comprising an integral member of electrically conductive material and of generally tubular shape having a male section at one end and a female section at the other end, means securing each female terminal section within the male section of its corresponding housing with the male terminal section extending into the space within the female housing section, a first wire secured within and extending outwardly from the female section of one terminal, and a second wire secured within and extending outwardly from the male section of the other terminal, the remaining male and female terminal sections being in interfitting and electrically conductive relation when said two housings are in interfitting relation.

16. In an electrical connector, first and second housings of identical construction, each housing being fabricated of electrically insulative material and having a generally tubular shape, each housing further having aligned male and female sections, the interior of the female section having a tapered recess and the exterior of the male section having a tapered surface interfittable with said recess, a pair of bores within each male housing section extending parallel to the housing axis, a shoulder at the inner end of each housing section recess contiguous with said bores, a second shoulder at the opposite end of each bore, the two last mentioned shoulders in each housing extending in opposite substantially parallel directions, a pair of

terminals within each housing, all four terminals being of identical construction, each terminal having a generally tubular shape and being fabricated of electrically conductive material, an open ended male section at one end of each terminal, a female section adjacent the other end of each terminal having a length equal to said bores, each female terminal section being within a bore, a pair of outstruck tabs at each end of each female terminal section, said tabs tapering toward the terminal centerline in a direction away from said female terminal section and being engageable with said shoulders, access openings leading from the outer ends of said male housing sections to said terminals, whereby the male terminal sections carried by one housing will be insertable in the female terminal sections of the other housing when the housings are in interfitting relation, and locking lugs on the exterior of each female housing section for engaging a supporting structure.

17. In an electrical connector, a housing of generally tubular shape and of insulative material having a male section at one end and a female section at the other end, the outer surface of the male section and the inner surface of the female section having relative dimensions such that the male section of one housing may fit snugly within the female section of another housing, constructed identically with said first housing, a terminal of integral generally tubular construction and electrically conductive material having male and female sections, the outer surface of the male terminal section and the inner surface of the female terminal section being so related that the male section of one terminal may fit snugly within the female section of another terminal, the outer ends of said terminal being open, whereby a wire may be inserted in either end of the terminal and secured thereto, and means within the male housing section supporting the female terminal section with the male terminal section disposed within the female housing section.

18. In an electrical connector, a housing of electrically insulative material and generally tubular shape having a male section at one end and a female section at the other end, means on the outside of said female member for securing the housing to a supporting structure, means on the inside of the male section for supporting a plurality of terminals, terminals supported by last-mentioned means, these terminals each comprising an integral member of generally tubular shape and electrically conductive material having a male section at one end and female section at the other end, said housing means for supporting said terminals comprising a pair of bores in said housing of a length corresponding to said female terminal sections and within which the female terminal sections are disposed, a recess within said female housing section, said male terminal sections being disposed within said last-mentioned recess, the ends of said terminals being open whereby bared wire ends may be inserted and secured

therein, locking elements on said terminals engageable with said housing to prevent relative movement between the terminals and housings, said locking elements comprising outstruck tabs at opposite ends of said female terminal sections, and shoulders at opposite ends of said bores engageable by said tabs.

19. In an electrical connector, a unitary and integrally formed housing of electrically insulative material and generally tubular shape having a male section at one end and a female section at the other end, means on the outside of said female section for securing the housing to a supporting structure, means on the inside of the male section for supporting a plurality of terminals, terminals supported by last-mentioned means, these terminals each comprising an integral member of generally tubular shape and electrically conductive material having a male section at one end and female section at the other end, said female terminal sections being supported by said housing means, a recess within said female housing section, said male terminal sections being disposed within said last-mentioned recess, and locking elements on said terminals engageable with said housing to prevent relative movement between the terminals and housings, the inner surface of said female housing section and the outer surface of said male housing section having corresponding tapered configurations, whereby the male and female sections of two identical housings may be interfitted, the relative sizes of said male and female terminal sections being such that male terminal sections carried by one housing may be received with frictional contact by female terminal sections of identical terminals carried by an interfitting housing.

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