May 30, 1967 R. W. BRUSH 3,322,923

ELECTRICAL CONNECTOR WITH AUTOMATIC DISCONNECT

Filed Sept. 1, 1964

FIG.1.

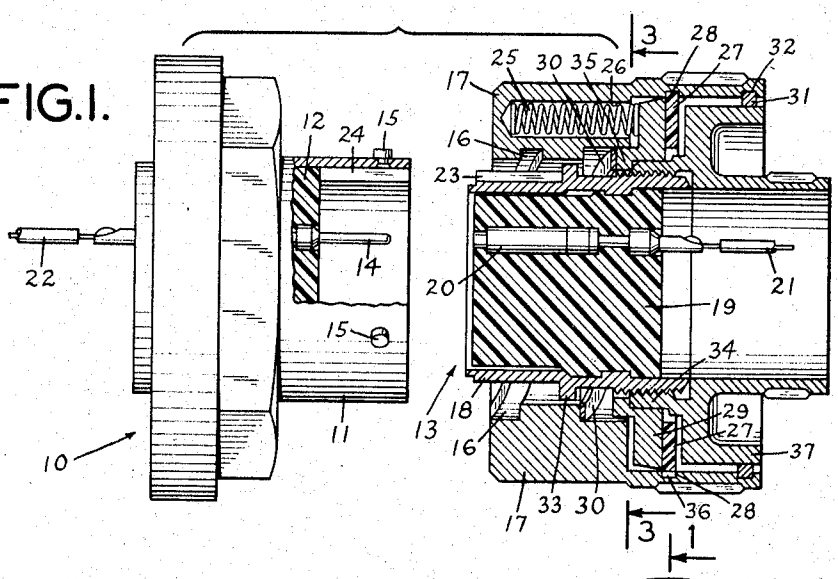


FIG.2.

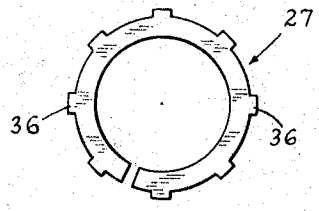


FIG.3.

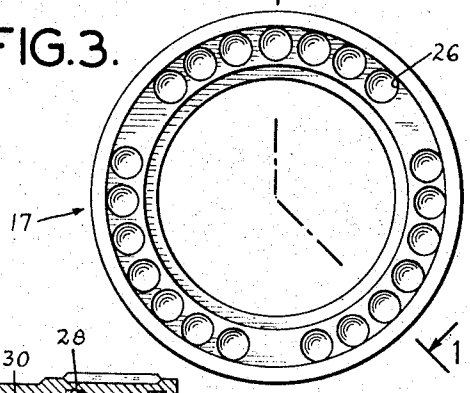
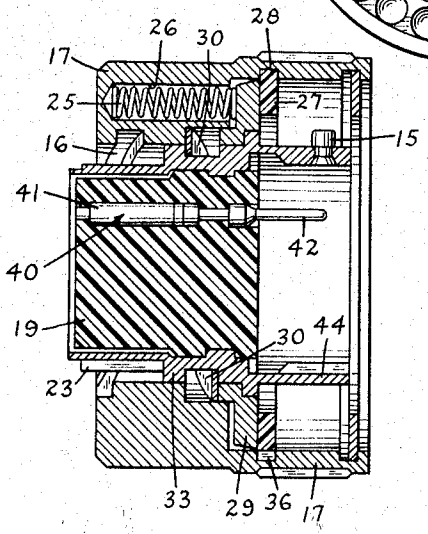


FIG.4.



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ELECTRICAL CONNECTOR WITH AUTOMATIC DISCONNECT

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23 Claims. (Cl. 200—142)

This invention relates to electrical connectors and more particularly to coupling means for connectors of the separable plug and socket type.

One of the objects of the invention is to provide novel means for coupling the separable parts of an electrical connector and retaining the same in mated relation.

Another object of the invention is to provide a novelly constructed coupling assembly for separable connector parts whereby the latter may be automatically separated in response to surrounding temperature conditions.

A further object is to provide a novel heat responsive unit adapted to be interposed between separable electrical connector assemblies, whereby the electrical circuits therethrough may be interrupted upon the occurrence of predetermined temperature conditions.

Still another object is to provide novel means for automatically effecting interruption of electrical circuits through an electrical connector without mechanically disconnecting the separable parts thereof.

The above and further objects and novel features of the invention will more fully appear from the following detail description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is an exploded view on an enlarged scale illustrating the unmated separable parts or assemblies of one form of electrical connector embodying the invention, the receptacle assembly on the left being partially broken away, and the plug assembly on the right being shown in section taken substantially on line 1—1 of FIG. 3;

FIG. 2 is a detail view illustrating the heat responsive element of the plug assembly of FIG. 1;

FIG. 3 is a detail sectional view on a reduced scale taken on line 3—3 of FIG. 1 showing only the coupling nut; and

FIG. 4 is an axial sectional view illustrating an adaptor embodying the invention for connecting the mateable assemblies of an electrical connector which does not embody the invention.

One form of the invention is illustrated in FIG. 1, by way of example, as being embodied in a plug and socket type connector comprising male and female parts or assemblies adapted to be detachably coupled together by a bayonet or pin and slot type coupling nut in the manner generally disclosed in Hennessey et al., U.S. Patent No. 2,984,811. The mechanical coupling of the mateable assemblies may, of course, be effected by cooperating screw threads on the coupling nut and one of the connector parts or by other suitable known means, if desired. As shown, one detachable part or assembly **10** generally known as the receptacle comprises a tubular shell **11** within which is mounted an insert **12** of insulating material for supporting one or more contacts, such as pin contact **14**. The tubular end portion of shell **11** has a plurality of radially projecting lugs **15** adapted to mate with helical grooves **16** in coupling nut **17** to be more fully hereinafter described.

The male or plug assembly illustrated at the right in FIG. 1 comprises a tubular shell **18** in which an insulating insert **19** is mounted for supporting one or more electrical contacts, such as socket contact **20**, mateable with pin contact **14**. When the plug and receptable assemblies are moved together to mate the contacts **14** and **20** and thereby effect an electrical connection between conductors **21** and **22** connected to the remote ends of the contacts, shell **18** is telescopically received by shell **11** with at least one external rib or key **23** mating with an internal groove **24** to thereby orient the assemblies and retain them against relative angular movement.

Novel coupling means are contemplated by the invention for drawing the plug and receptacle assemblies into mated relation and for maintaining the same in mated relation while permitting automatic separation thereof in response to predetermined relatively high temperatures. In the form shown in FIG. 1, said coupling means is constituted by an assembly comprising the tubular body or coupling nut **17**, a plurality of coil springs **25** housed in recesses **26**, a temperature responsive element in the form of a split ring **27** engaging an internal groove **28** in nut **17**, and an annular spacer or force transmitting member **29**. The coupling assembly may also comprise a split annular wavy leaf spring **30** and a split retaining ring or stop **31** in an internal groove **32** in nut **17**.

The novel coupling assembly above described surrounds shell **18** for rotation and limited axial movement relative thereto, the axial movement being limited by an external flange **33** on the shell and a retaining ring or collar **34** threaded onto the end of shell **18**. Flange **33** and the end of ring **34** which may be regarded as part of shell **18** define an external groove into which an inner portion **35** of member **29** extends and is captured with spring **30** to thereby limit the normal relative axial movement between the coupling nut assembly and shell **18, 34**. Another portion of member **29** is preferably piloted on collar **34** and is thereby guided for axial movement thereon. The outer peripheral portion of ring member **29** extends radially between the heat responsive stop **27** and the free ends of springs **25** which are under compression. The outer periphery of member **29** closely approaches the inner surface of nut **17** and is preferably slightly tapered inwardly from the surface thereof which is in contact with heat responsive ring **27**.

When the bayonet type coupling comprising helical grooves **16** and lugs **15** is used between nut **17** and shell **11**, it is desirable to provide suitable resilient means, such as the wavy leaf spring **30**, interposed between flange **33** and ring **29, 35** to yieldably further resist axial movement of the coupling nut assembly relative to the two shells **11** and **18** after the inserts **12** and **19** have been drawn into abutting engagement by rotation of nut **17** while lugs **15** and grooves **16** are engaged. Thus, during the final rotation of nut **17**, the coupling nut assembly moves axially to the left relative to shell **18**, thereby compressing spring **30** as portion **35** of member **29** moves axially away from the end of retaining ring **34**. When cooperable screw threads are provided on nut **17** and shell **11**, the part **35** of ring **29** may have a relatively close fit between flange **33** and collar **34** without the need for spring **30**.

Heat responsive split ring **27** constitutes a stop which normally limits the axial movement of annular member **29** and hence, of shell **18, 34** toward the right (FIG. 1) relative to tubular body or nut **17** and is made of a composition which is capable of withstanding the force exerted by springs **25**, aided somewhat by spring **30**, under normal temperature conditions, but which will soften and yield to said forces at an elevated temperature. One material which has been found to be particularly suitable is a plastic composition sold under the trade name "Delrin." This material has the property of losing its shear strength within a short temperature range begin-

ning at about 350° F. The temperature at which member **27** will yield and be sheared off in line with the outer edge of member **29** may be regulated somewhat by varying the spring pressure applied, varying the thickness of member **27**, or varying the area to be sheared, such as by varying the extent and number of teeth **36** on the outer periphery of member **27** which extend into groove **28**.

It will thus be seen that when the assembled connector and hence, heat responsive ring **27**, are subjected to a predetermined elevated temperature, said ring will be sheared adjacent the inner surface of nut **17** at the roots of teeth **36** by the force of the springs transmitted through annular member **29**. In the illustrated embodiment, the ring portion **35** will be spaced to the left from the inner end of collar **34** with spring **30** under compression so that the entire force of the springs **25** and **30** are acting to shear ring **27** until the flange **35** reengages the end of collar **34**, whereupon the entire plug assembly **13** is moved by springs **25** toward the right relative to nut **17** and receptacle assembly **10** to thereby disengage contacts **14** and **20**.

If desired, this automatic disengagement movement in response to elevated temperature may be limited by stop ring **31** or equivalent means engageable by the sheared portion of ring **27** or by the outer peripheral portion of ring **29** if the former should fall out or collapse. Thus, the plug, receptacle and coupling assemblies will remain mechanically connected after the electrical connection **14**, **20** has been interrupted. To assist in avoidance of any tilting and hence, binding of the receptacle assembly relative to the coupling nut or shell **11** after ring **27** has been sheared, a cylindrical extension **37** may be provided as an integral part of retaining collar **34** to slide in stop ring **31** and thus function as a guide.

In order that the invention may be made readily available for installations already in the field, it may be incorporated in an adaptor which may be sandwiched between a normal plug and receptacle. One form of such an adaptor is illustrated in FIG. 4, wherein the same reference numerals are used to indicate parts which are like or comparable to parts identified with the same numerals in FIG. 1. The contact **40** has a socket **41** at one end and a pin **42** at the other end while the adaptor shell **43** has an extension **44** comparable to the corresponding parts of receptacle assembly **13**.

Thus, the left hand end of the adaptor of FIG. 3 may be mated with and coupled to the receptacle **10** of FIG. 1 in the same manner as plug assembly **13** is coupled therewith. The right hand end of the adaptor is comparable to receptacle assembly **10** and may be mated with and coupled to a plug and coupling nut assembly which does not necessarily embody the features of the invention, such as one illustrated in the above-mentioned U.S. Patent No. 2,984,811. When ring **27** (FIG. 4) yields and is sheared at a predetermined temperature, the central portion **40–44** of the adaptor will be moved to the right with the plug assembly coupled therewith until ring **29** engages stop **31**. This movement of the parts will disengage socket **41** from pin **14** and interrupt the electrical circuit.

Although only a limited number of embodiments of the invention have been illustrated in the drawing and described in the foregoing specification, it is to be expressly understood that the invention is not limited thereto. If desired, for example, the heat responsive element **27** may be mounted on ring **29** and engage an internal shoulder in nut or body **17**, the pin contact **14** may be mounted in the plug assembly **13**, and socket contact **20** may be incorporated in the receptacle assembly **10**. Various other changes may also be made, such as in the specific design and arrangement of the parts illustrated and the materials suggested, without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art.

What is claimed is:

1. An electrical connector comprising two shells, cooperable pin and socket contacts mounted in said shells, and coupling means cooperable with said shells locking the same together with said contacts in mating relationship, said coupling means comprising a nut detachably connected with one of said shells, an annular member rotatable relative to said nut and mounted on the other of said shells for axial movement therewith and heat-responsive means for normally limiting relative axial movement of said member and nut in one direction and for automatically releasing said other shell and member for axial movement relative to said nut and said one shell in said one direction to disengage said contacts.

2. An electrical connector as defined in claim **1**, wherein said heat-responsive means comprises heat softenable retaining means.

3. An electrical connector as defined in claim **1** comprising means for imparting contact-disengaging movement to one of said shells upon release thereof by said heat-responsive means.

4. An electrical connector as defined in claim **1** comprising resilient means carried by said coupling means for imparting contact-disengaging movement to one of said shells upon release thereof by said heat-responsive means.

5. An electrical connector comprising two tubular shells, an insulating insert in each shell, matable pin and socket contacts mounted in said inserts, and coupling means cooperable with said shells for drawing the shells toward each other and detachably locking the same together with said contacts in mating relation, said coupling means comprising a nut detachably connected to one of said shells and temperature-responsive means mounted on and rotatable with said nut for automatically releasing one of said shells to permit axial separation thereof from the other shell to disengage said contacts.

6. A coupling assembly releasably locking two electrical connector parts in mating relation comprising a tubular body member detachably connectable with one of said parts, an annular member slidable axially in said body member rotatable relative to and adapted for interlocking relation with the other of said connector parts for axial movement therewith, force-applying means interposed between said members, and stop means mounted on one of said members and engageable by the other of said members for limiting relative axial movement of said members by said force-applying means while permitting relative rotation of said members, said stop means being ineffective to resist the force of said force-applying means under predetermined operating conditions.

7. A coupling assembly as defined in claim **6**, wherein said stop means comprises an element of heat-softenable material.

8. A coupling assembly as defined in claim **6**, wherein said stop means comprises an element shearable by the force of said force-applying means under said predetermined operating conditions.

9. A coupling assembly as defined in claim **6**, wherein said force-applying means exerts a constant pre-determined force and said stop means becomes ineffective to resist said force when heated to a sufficiently high temperature.

10. An electrical connector comprising two shells, an insulating insert in each shell, matable pin and socket contacts mounted in said inserts, a coupling nut assembly cooperable with said shells for drawing the shells together upon rotation of the coupling means relative to the shells and locking the same together with said contacts in mating relation, said assembly comprising a tubular body member cooperable with one of said shells, an annular member slidable axially in said body member and having interlocking relation with the other of said shells for axial movement therewith, force-applying means interposed between the said members, and stop means

for limiting axial movement of said other shell and annular member relative to said body member in contact disengaging direction by said force-applying means, said stop means being ineffective to resist the force of said force-applying means under predetermined conditions.

11. An electrical connector as defined in claim **10** comprising resilient means interposed between said annular member and said other shell, said resilient means being compressible upon axial movement of said annular member relative to said other shell by axial movement of said body member relative to the shells after the latter have been drawn together.

12. In an electrical connector, the combination comprising a tubular shell, an insulating insert in said shell, a contact supported by said insert and a coupling nut assembly mounted on said shell for rotation relative thereto and axial movement therewith, said assembly comprising a tubular body surrounding said shell, an annular member surrounding said shell within said body, said shell comprising means for limiting axial movement of said annular member relative to the shell in either direction, stop means mounted on and projecting inwardly from the inner surface of said body for normally limiting axial movement of said annular member relative to said body in one direction, and energy storage means for urging movement of said member relative to said body in said one direction and for rendering said stop means ineffective under predetermined operating conditions.

13. The combination defined in claim **12**, wherein said shell comprises a first part having an external abutment and a second part removably mounted on said first part, said abutment and said second part constituting said means for limiting axial movement of said member relative to said shell.

14. The combination defined in claim **12**, wherein said stop means is heat-softenable and shearable by the force of said energy storage means under predetermined temperature conditions.

15. The combination defined in claim **12** comprising a second stop means on said body for limiting axial movement of said member and shell relative to said body when said first-named stop means is rendered ineffective.

16. The combination as defined in claim **15**, wherein said second stop means is an internal annular flange in said body and further comprising a piston-like guide carried by said shell and having a sliding fit in said annular flange.

17. The combination defined in claim **12** comprising resilient means interposed between said annular member and shell for yieldably resisting relative axial movement of said shell and member.

18. The combination as defined in claim **17**, wherein said resilient means comprises a wavy annular spring.

19. The combination defined in claim **12**, wherein said stop means comprises a split ring of plastic material mounted in a groove within said tubular body and rendered readily shearable upon application of heat.

20. The combination as defined in claim **19**, wherein said split ring has an interrupted or toothed periphery which projects into said groove.

21. An electrical connector comprising a tubular shell and a coupling nut assembly mounted on said shell for rotation relative thereto and limited axial movement relative thereto, said assembly comprising a tubular body surrounding said shell, an annular member surrounding said shell within said body, said shell comprising means limiting axial movement of said annular member relative to said shell in either direction, means operatively interposed between said body and member normally limiting axial movement of said member relative to said body in one direction, and force-applying means for imparting axial movement to one of said body and member relative to the other for shearing said last-named means to thereby release said shell for axial movement relative to said body in said one direction.

22. An electrical connector as defined in claim **21**, wherein said force-applying means comprises resilient means under compression.

23. An electrical connector as defined in claim **22**, wherein said resilient means are interposed between said body and member to urge the latter against said means limiting axial movement of said member relative to the body in said one direction.

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