June 5, 1962 E. R. HABERLAND 3,038,140

ELECTRICAL CONNECTOR

Filed Nov. 16, 1960 2 Sheets-Sheet 1

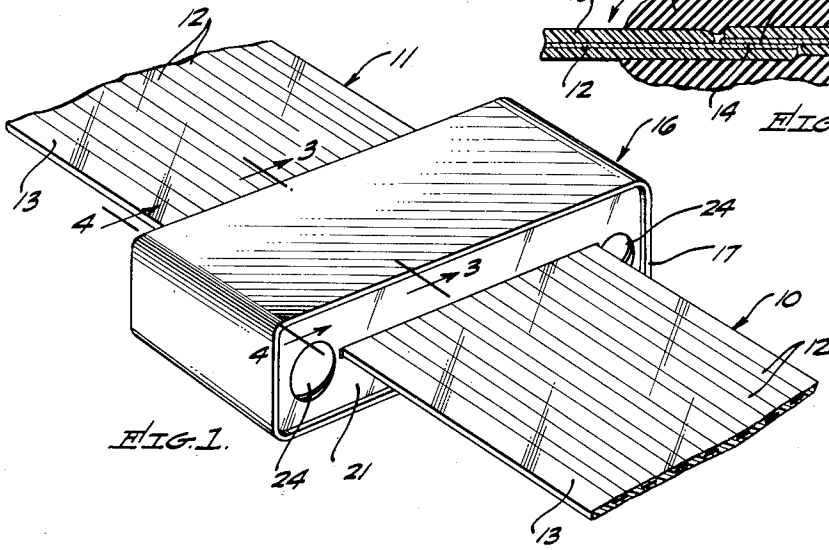


FIG. 1.

FIG. 5.

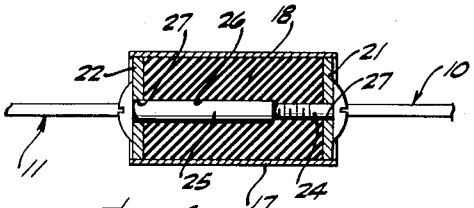


FIG. 4.

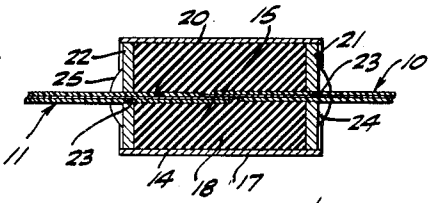


FIG. 3.

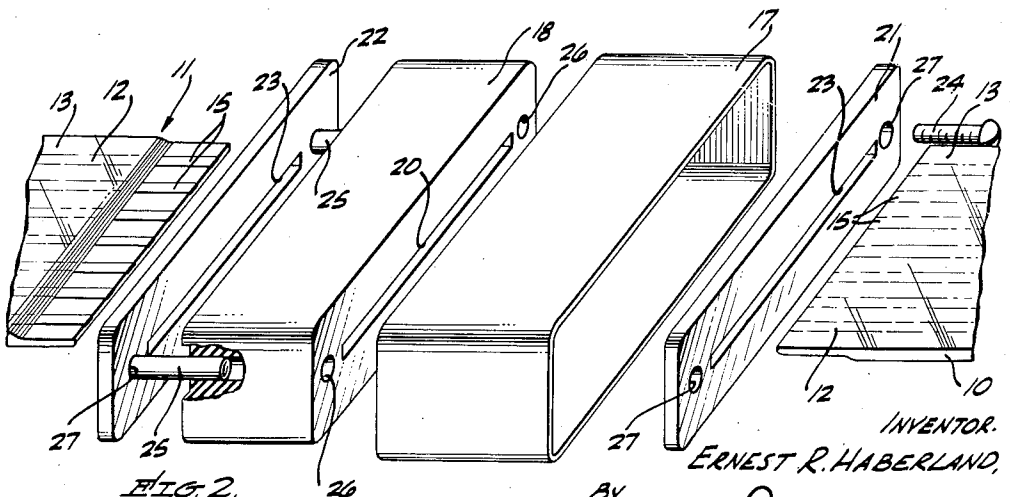


FIG. 2.

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ELECTRICAL CONNECTOR

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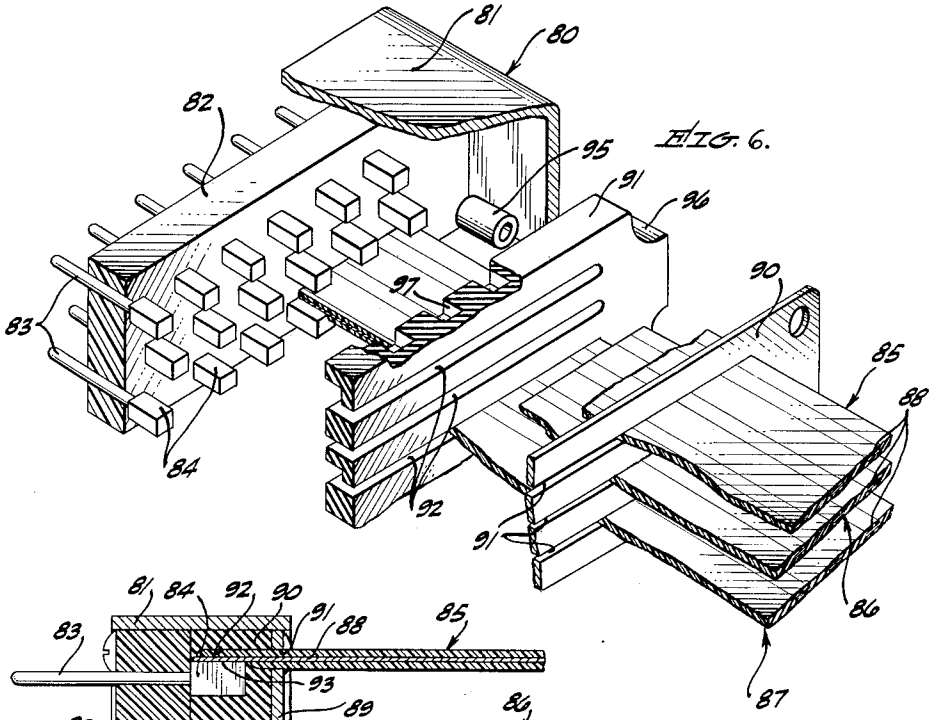


FIG. 6.

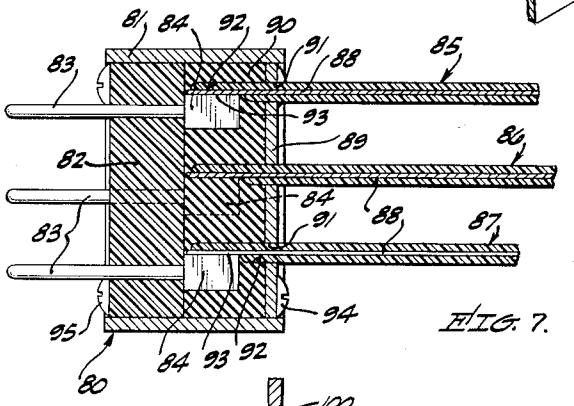


FIG. 7.

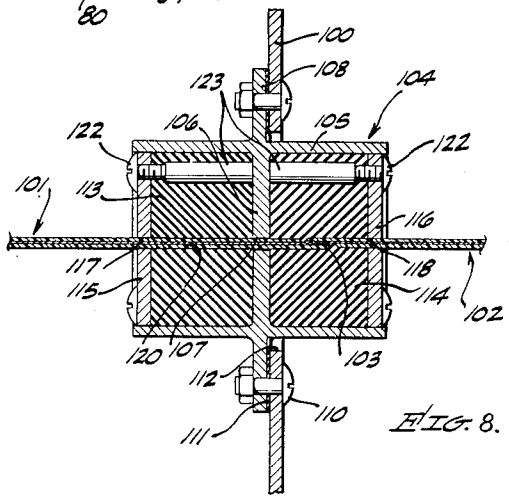


FIG. 8.

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3,038,140

ELECTRICAL CONNECTOR

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5 Claims. (Cl. 339—61)

The present invention relates generally to electrical connectors and relates more specifically to connectors for use with flat multiconductor ribbon cables.

In making a plurality of electrical interconnections, it has been common practice to employ individual wires disposed either individually or in groups between various electrical devices. Contemporary electrical apparatus has employed a type of multiconductor cable that is in the form of a ribbon or tape of an insulating material, such as a flexible plastic, having flat metallic strips embedded therein and disposed in parallel spaced relationship to each other. Ribbon cable of this type may be in the order of a few inches in width, with a thickness of a small fraction of an inch and having in the order of ten to fifty or more conductors. The conductors are generally copper or the like that are provided with a coating or surface treatment which enables adherence of the plastic material thereto.

While the flat tape type of multiconductor cable has been known heretofore, serious disadvantages in the use thereof reside in the ability to connect the individual conductors to sockets or plugs or to enable an interconnection between coextensively disposed ribbon cables. In providing such connections, it has been the practice either to mold or form particular end configurations on the conductors and to produce these and structures in such a manner as to leave surfaces thereof free from insulation. When connecting such cable to connectors or plugs, it has been necessary to solder or otherwise attach each individual conductor to an associated pin or individual connector element. In other instances, the insulation surrounding the conductors has been stripped therefrom and the bared conductors have then been soldered or otherwise affixed to rigid connector elements. It is clearly apparent that these connection techniques used hereinbefore not only require considerable time in the manufacture, preparation and assembly to connectors, but also involves the handling, stripping and soldering of thin, flexible and easily damaged conductors. Accordingly, not only have prior connector arrangements been impractical and expensive in both manufacture and assembly, but the reliability of the connection has left much to be desired in view of the delicate nature of the conductors. Furthermore, this prior type of construction has required the use of separate and distinct conductor strain relief apparatus that has added to the complexity, weight and cost thereof.

In still another instance, attempts have been made to connect the multiconductors of a flat ribbon cable to connectors or to each other by means of mechanical clamps which rely upon a solid bar, rod or plate to urge the conductors into contact with each other or connector elements. These structures have been unsatisfactory, inasmuch as the mechanical pressure exerted on individual conductors may vary between conductors, thus reducing the reliability and effectiveness thereof.

An optimum connector for multiconductor ribbon cable must therefore utilize lengths of standard cable without concern for special terminal end construction or the necessity for individual handling or soldering of the conductors. Furthermore, it must be possible merely to cut a desired length of ribbon cable, strip the insulation therefrom and connect the cable to other lengths of cable or to connectors in a minimum of time, with a minimum of

connector apparatus from both size and weight standpoints, and as rapidly as possible without undue concern for the individual conductors. In so connecting the conductors of ribbon cable, the contact pressure must also be uniform on all of the individual conductors.

It is therefore one important object of the present invention to provide an improved connector for multiconductor ribbon cable of the class described.

It is another important object of the present invention to provide connector arrangements for multiconductor flat ribbon cable that are reliable in use, economical in manufacture, efficient in operation, and relatively small in size and weight.

Still another important object of the invention is to provide a connector for flat multiconductor ribbon cable which employs a resilient material in a hydrostatic manner such that a pressure is exerted uniformly and perpendicularly to all surfaces as an element for simultaneously securing all of the conductors of the cable to connector elements or to conductors of other similar cable.

A still further important object of the invention is to provide means for connecting one length of a flat multiconductor ribbon cable to other similar cable or cables.

Another object of the invention is to provide means for connecting flat multiconductor ribbon cable to plugs or connectors that are considered as being of standard types, whereby to enable use of such ribbon cable in a wide range of installational situations.

A still further important object of the invention is to provide a combination of connection means for conductors of flat multiconductor ribbon cable with other similar cable or with plugs or receptacles, while simultaneously providing relief of any strain which might otherwise be imposed upon the individual conductors.

Another object of the invention is to provide a connector for multiconductor flat ribbon cable which provides the desired interconnection between conductor elements and simultaneously seals the resulting connection against intrusion of environmental elements.

Other and further important objects of the invention will become apparent from the disclosures and the following detailed specification, appended claims and accompanying drawings, wherein:

FIGURE 1 is an isometric view showing a typical simplified form of connector formed in accordance with the present invention;

FIG. 2 is an exploded isometric view of the connector illustrated in FIG. 1;

FIG. 3 is a transverse sectional view taken substantially as indicated by line 3—3, FIG. 1;

FIG. 4 is another transverse sectional view taken substantially as indicated by line 4—4, FIG. 1;

FIG. 5 is an enlarged fragmentary sectional view showing details of the connection between coextensively arranged flat ribbon cable elements;

FIG. 6 is an exploded isometric view showing the present invention as applied to the connection of multiconductor flat ribbon cable to an electrical plug element;

FIG. 7 is a transverse sectional view taken through the assembled electrical plug element of FIG. 6 and showing the ends of the ribbon cable attached to connector elements; and

FIG. 8 is a transverse sectional view through another form of the present invention and including a means for hermetically sealing the ribbon cable and connector relative to an adjacent structure.

With reference to the drawings, the simplified form of the invention shown in FIGS. 1 through 5 embodies the principles hereof in connecting the conductors of one end of a multiconductor ribbon cable to the conductors of another ribbon cable disposed in a coextensive manner.

As shown, the ribbon cable sections are indicated at **10** and **11**. The ribbon cable is shown in detail in FIG. 5 and further includes a plurality of parallel, longitudinally extending, spaced, metallic conductors **12** that are embedded in a suitable plastic insulating material **13**. In preparing the ribbon cables **11** and **12** for attachment of the conductors therein to each other, the insulating material **13** is removed from one side thereof, whereby to expose surfaces of the conductors **12** as at **14** and **15**. The insulating material **13** may be removed by any desired means; however, it has been found that a heated blade serves particularly well to soften and permit removal of the insulating material from the conductors **12**. Any surface coating on the conductors **12** is also removed, thus to expose the base copper material thereof.

The connector used in this specific instance is indicated generally at **16** and includes an outer generally rectangular tnd tubular housing or shell **17** that is circumferentially continuous, may be made from any suitable rigid material and is preferably metallic. The shell **17** serves to enclose and completely surround a resilient compression member **18**. The member **18** is constructed as by molding from a suitable resilient material, such as rubber, neoprene, or the like, and is provided with a longitudinal slot **20**, FIG. 3, for reception of the ribbon cables **10** and **11**. As shown primarily in FIGS. 3 and 4, a pair of end plates **21** and **22** are disposed within opposite ends of the shell **17** and in contact with planar outer end surfaces of the resilient member **18**. The plates **21** and **22** are each provided with a longitudinal slot **23** that is coextensively disposed relative to the slot **20** in the resilient member **18** and adapted for reception of the ribbon cables **10** and **11**. The plates **21** and **22** may be made from any suitable material such as a rigid metal or plastic and are secured in position in the shell **17** by means of a pair of screws **24** and elongated tubular nuts **25**. The screws **24** and nuts **25** are disposed through suitable openings **26** and **27** in the resilient member **18** and plates **21** and **22** respectively. It may be seen that while the plates **21** and **22** are both shown as being independent members, one of these plates may be formed as a portion of the housing or shell **17** without departing from the spirit and scope hereof.

It may be seen that when the screws **24** are threadably engaged in the tubular nuts **25**, the plates **21** and **22** will be moved in a direction to tend to compress the resilient member **18**. The resilient member **18** thereafter acts in a manner similar to a hydrostatic fluid by exerting a pressure uniformly and perpendicularly to all surfaces to force the exposed surfaces **14** and **15** of the conductors **12** into intimate contact with each other. It is further to be noted that the disposition of forces is substantially equal over the entire number of conductors, thereby establishing equal contact pressure and equal electrical connection therebetween. Additionally, it is to be noted that the resilient member **18** engages the outer surface of the insulating material **13** of the ribbon cables **11** and **12** for a substantial distance from the joint formed by the interconnection of the bared surfaces **14** and **15** of the conductors. When the plates **21** and **22** are moved toward each other, the resilient member **18** thereby grips the cables **10** and **11** and serves to provide strain relief to prevent separation of the connected conductors upon application of longitudinal forces to the cables. The resilient member **18** also firmly engages the interior surface of the shell **17** and prevents any inadvertent movement of the resilient member **18** relative to the shell **17**.

As shown in FIGS. 6 and 7, the principles of the present invention may also be applied to the attachment of one of more multiconductor ribbon cables of the class described to a connector or plug arrangement. A typical connector is illustrated at **80** and includes an outer tubular shell **81** having a transverse partition **82** disposed therein. The partition **82** may be made from any suitable non-electrically conductive material and serves to support a plurality of connector pins **83** which extend from one side of the partition **82** and which have blocks **84** formed thereon and disposed from the other side of the partition **82**. The blocks **84** are arranged in equally spaced parallel rows.

While the illustrations in FIGS. 6 and 7 show the attachment of a plurality of cables to the plug **80**, it is to be understood that a similar arrangement may be used for connecting a single cable to a similar rectangular or circular plug arrangement. In the particular illustrated form, ribbon cables indicated generally at **85**, **86** and **87**, each having a plurality of conductors **88**, are adapted for connection to the blocks **84**. The connectors **80** includes an end plate **89** and a resilient member **90**. In this instance, the cables **85**, **86** and **87** are adapted to extend through suitable slots **91** in the end plate **89** and through suitable slots **92** in the resilient member **90**. The cables **85**, **86** and **87** have the insulation removed from one side of the conductors **88** as at **93**, with the bared conductors individually engaging surfaces of the blocks **84**. The plate **89** and partition **82** are retained within the shell **81** and urged in a direction to compress the resilient member **90** by means of a suitable screw and nut arrangements **94** and **95** that are positioned adjacent corners of the shell **81**, there being suitable cutouts **96** in the resilient member **90** for reception of the tubular nuts **95**. The resilient member **90** is further provided with molded rectangular recesses **97** which serve to receive the blocks **84**. As by the principles previously described, the resilient member **90** acts in a hydrostatic manner, that is, exerts a pressure uniformly and perpendicularly to all surfaces to urge the bared surfaces **93** of the conductors **88** into tight contact with the blocks **84**, serves to retain the tape cables **85**, **86** and **87** in connection with the plug **80** and further to maintain plate **89** and partition **82**, as well as the resilient member **90**, in position within the tubular shell **81**.

With reference to FIG. 8, it may be seen that the principles of the present invention may also be employed to provide an environmentally sealed arrangement for a feedthrough relative to a panel or partition **100**. In the arrangement of FIG. 8, a pair of multiconductor ribbon cables, indicated generally at **101** and **102**, are adapted for connection together as at **103** in a manner similar to that described in connection with the arrangement illustrated in FIGS. 1 through 5. In this particular arrangement, the connector or feedthrough arrangement is indicated generally at **104** and includes a tubular shell **105** having a central partition **106** formed as a portion thereof. This partition **106** has a central slot **107** for reception of the ribbon cable **101**. The shell **105** further has an outwardly extending flange **108** that is substantially radially coextensive with the partition **106**. The flange **108** is adapted for connection to the panel or partition **100** as by suitable screws and nuts **110** there being a gasket or seal **111** disposed between the flange **108** and the panel **100**. The panel **100** is further provided with a suitable opening **112** for reception of the connector and/or feedthrough arrangement **104**. The partition **106** serves to divide the connector **104** into a pair of chambers in which resilient members **113** and **114** are disposed. Compression plates **115** and **116** engage outer surfaces of the resilient members **113** and **114** respectively, there being slots **117** and **118** in the plates **115** and **116** for reception of the ribbon cables **101** and **102**. The resilient members **113** and **114** are also provided with slots **120** and **121** for reception of the ribbon cables. The plates **115** and **116** are retained in position and urged in a direction to compress the resilient members **113** and **114** by means of suitable screws **122** and tubular nuts **123**, the nuts **123** being carried by and extending from the partition **106**.

It may thus be seen that the resilient member **113** serves to provide a hermetic seal for feedthrough of the cables **101** and **102** relative to the panel **100**. The resilient member **114** serves in a similar manner and fur-

ther acts to establish the connection **103** between the cables **101** and **102**. In this connection, it is to be understood that the connector **104** may be used as a simple feedthrough arrangement for a single cable with no connections made therein.

In accordance with the several described arrangements of the present invention, it is to be noted that a simplified, highly effective, reliable and inexpensive interconnection method and apparatus is provided for specific use with flat, multiconductor, electrical ribbon cable. It may also be seen that the pressure exerted on the interconnected ends of the conductors is equal for all the conductors. It may also be seen that the ribbon cables may be removed, disconnected and reconnected without damage thereto upon removal of the screw and nut arrangements serving to retain the end plates in compressive relationship relative to the internal resilient members. The resilient members thus serve a plurality of functions as described, there being the necessity for only a single easily constructed and inexpensive element for these several functions.

It is to be understood that, for purposes of description, the exposed conductors may all be considered as connection elements whether in the form of the blocks in a plug or conductor strips exposed on one or both sides thereof.

Having thus described the invention and the present several arrangements thereof, it is desired to emphasize the fact that many further modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

I claim:

1. An electrical connector for use with flat multiconductor ribbon cable having a bare conductor end portion, said connector comprising: an enclosure shell having at least one open end; a transverse nonelectrically conducting partition positioned in said shell; a plurality of laterally spaced and aligned contact members fixed in and disposed through said partition, said contact members each having a longitudinally planar portion extending into said shell from an inner surface of said partition; a preformed resilient member positioned in and in contact with an inner surface of said shell, said resilient member having at least one transverse, ribbon cable receiving slot therein and preformed recesses for reception of portions of said contact members, an end surface of said resilient member engaging said inner surface of said partition; a rigid end plate positioned within said shell and in engagement with the other end surface of said resilient member, said plate having at least one transverse slot therethrough and in coextensive alignment with said slot in said resilient member, said ribbon cable being adapted for disposition through said slots in said end plate and said resilient member, said bare conductor portions being positioned in lateral contact with said planar portions of said contact members; and screw means positioned between said partition and said end plate and through said resilient member for applying a force to move said end plate toward said partition and in a direction to compress said resilient member to force and maintain said conductor portions of said ribbon cable in intimate contact with said contact members.

2. An electrical connector according to claim 1 wherein said screw means comprises a tubular nut carried by and disposed from said partition and elongated screws threadably engaging said tubular nuts, said tubular nuts and screws being positioned about the periphery of said end plate, said resilient member having cut-out portions in an area of said nuts and screws.

3. An electrical connector for use with flat multiconductor ribbon cable, said connector comprising, in combination: an enclosure shell having open ends, a transverse partition in a central area of said shell, said partition having a transverse slot therein; a preformed resilient member positioned in each end of said shell, inner end surfaces of said resilient members engaging said partition, said members being positioned in contact with an inner surface of said shell and each having a transverse slot therethrough coextensive with said slot in said partition; a rigid end plate disposed in each open end of said shell and in engagement with outer end surfaces of said resilient members, said plates each having a transverse slot therethrough coextensive with said slots in said resilient members, said ribbon cable being adapted for disposition through said slots in said end plates, resilient members and said partition; and screw means disposed between said end plates for applying a force to move said end plates toward each other and said partition and in a direction to compress said resilient members to force said resilient members into intimate contact with said ribbon cable.

4. An electrical connector according to claim 3 wherein said ribbon cable is in two sections with bare conductor end portions thereon and disposed with said end portions in contact with each other within confines of said slot in one of said resilient members, said compression of said one of said resilient members serving to force said conductor end portions into intimate contact with each other.

5. An electrical connector according to claim 4 wherein said screw means comprises tubular nuts carried by said partition and elongated screws engaging said end plates and threadably engaging said nuts, there being preformed openings in said resilient members for reception of said nuts and screws.

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