Oct. 26, 1965 R. A. DE ROSE ETAL 3,214,725

FLEXIBLE RIBBON CABLE CONNECTOR

Filed Dec. 26, 1962 2 Sheets-Sheet 1

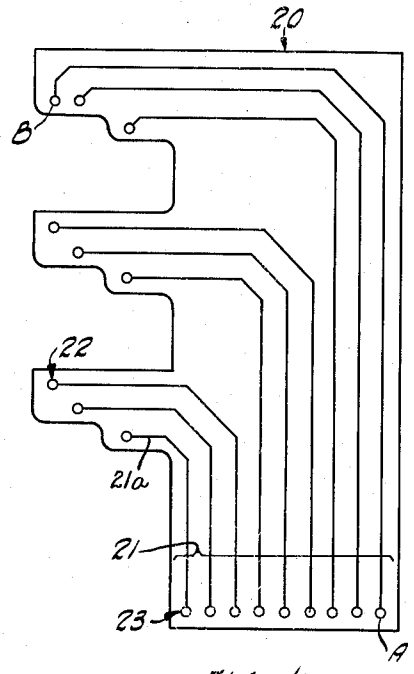

FIG. 1

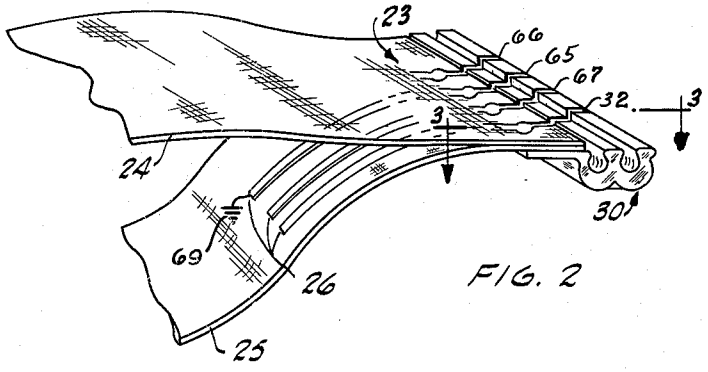

FIG. 2

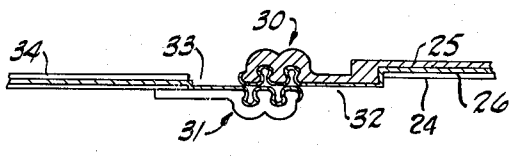

FIG. 3

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Oct. 26, 1965 R. A. DE ROSE ETAL 3,214,725

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Filed Dec. 26, 1962 2 Sheets-Sheet 2

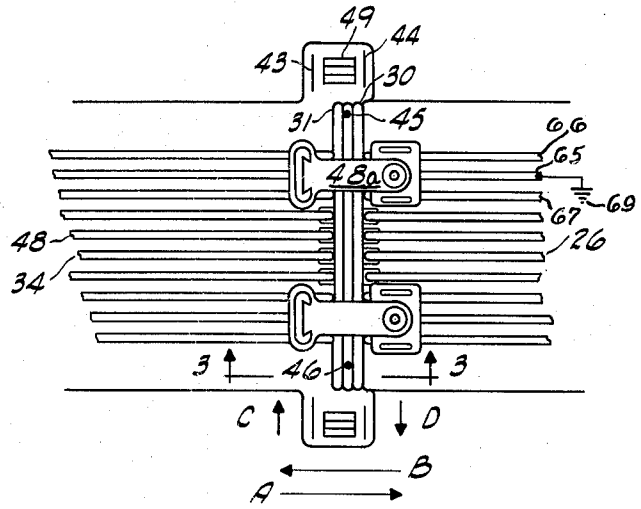

FIG. 4

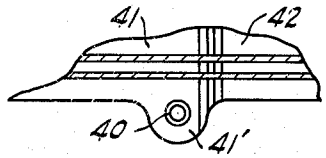

FIG. 5

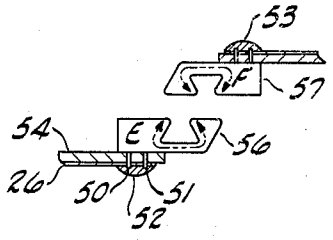

FIG. 6

FIG. 8

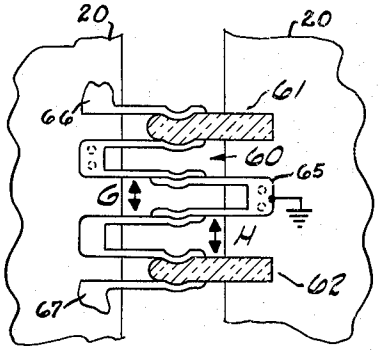

FIG. 7

United States Patent Office 3,214,725 Patented Oct. 26, 1965

3,214,725

FLEXIBLE RIBBON CABLE CONNECTOR

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Filed Dec. 26, 1962, Ser. No. 247,111
10 Claims. (Cl. 339—151)

This invention relates to electrical connectors and more particularly to connectors for flexible ribbon cables.

Recent developments in the electrical arts have brought forth many innovations leading to quicker, less expensive, more precise assembly of components into end products. One of the most important of these innovations involves a combination of photo and etching processes. For example, one such process is used to make printed circuit cards and tape cables.

A flexible ribbon cable is a sandwich of flexible sheets of plastic having circuits printed on a layer of conductive material position between them. One such cable is sold under the trademark "Tape Cable." Usually, the cable is a wiring harness for interconnecting electronic components. When using these cables, the principal troubles encountered center about the connectors which join external electrical circuits to the cable. This trouble comes about because the cable is almost as flexible as a piece of heavy paper. Thus, there is no convenient way of exerting enough force on connectors to complete a friction held plug-and-jack type of connection. The severity of the problem becomes more apparent when one realizes that a desirable cable harness could include thousands of individual conductors and, therefore, many thousands of plug-and-jack connectors.

Accordingly, an object of this invention is to provide new and improved flexible ribbon cable connectors. Another object is to eliminate the need for exerting substantial mechanical forces on cable connectors without simultaneously eliminating the convenience of such connectors.

The above mentioned and other features of this invention and the manner of obtaining them will become more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a top plan view which shows a conventional flexible ribbon cable;

FIG. 2 is a fragmentary view of one end of the cable of FIG. 1 with the component parts fanned out to show the construction thereof and a zipper bead attached to the end of the cable to illustrate one embodiment of the invention;

FIG. 3 is a side view partly in cross section of the embodiment of FIG. 1 which shows two cables posed over each other just before they are zipped together;

FIG. 4 is a top view of two tape cables joined together in accordance with the teaching of this invention;

FIG. 5 shows an alternative embodiment of FIG. 4;

FIG. 6 shows a side view partly in cross section of a second embodiment of the invention;

FIG. 7 shows a side view partly in cross section of a third embodiment of the invention; and

FIG. 8 shows how a unique wiping action occurs when the contacts close.

Although those skilled in the art are familiar with flexible ribbon cables, it may be helpful to review the construction of an exemplary cable so that the invention may be better understood. That exemplary cable (FIG. 1) includes a flexible sheet of material **20** having many strips of conductive material **21** embedded therein. One of the strips is identified as **21***a*, by way of example. Each strip is completely enclosed by the flexible material except at the ends (**22, 23**) where they emerge to form solder lugs. Thus, it should be apparent that a device soldered to the lug A, for example, is electrically connected to a device soldered to lug B.

The cable construction is shown in FIG. 2. It comprises two sheets **24, 25** of mechanically strong, flexible material such as "Mylar," for example. One sheet **25** has strips of conductive material **26** deposited in a predetermined pattern thereon. For example, the sheet **25** could be initially copper clad. Then unwanted copper could be etched away by well known printed circuit techniques. Thereafter, the upper sheet **24** is bonded to the lower sheet **25** in any well known manner, as by cementing or heat treating.

Finally, the lug ends **22** of the strips are brought out from under sheet **24** and formed into solder terminals in any well known manner. For example, the plastic sheets **24, 25** could be perforated at the ends of the strips, and then plating material could be run through the perforations and deposited on at least one outer surface of the cable. The plating material should, of course, provide a good electrical connection, and the plastic sheets **24, 25** should withstand the heat required to solder a connection to the lug surfaces.

The cable described thus far is a well known commercially available product. The problem is that the convenience afforded by the cable is off-set by the inconvenience of having to solder connections to the lugs **22**. Heretofore, efforts have been made to eliminate these solder connections through the use of plug-and-jack connectors of a type primarily designed for use with printed circuit cards. The trouble with these connectors is that excessive forces are required to couple or uncouple the connectors, primarily because all connections are made simultaneously. In fact, many printed circuit card extractors have been designed to provide the required extraction forces without doing damage to the connectors. However, these extractors can not be used conveniently in connection with tape cables owing to the flexible nature of such cables.

In providing our invention, we have eliminated the great forces required heretofore to couple or uncouple the connector. We do this by completing each individual connection sequentially—not simultaneously, as done heretofore. Since only a very small force is required to complete any one connection, and further since only one connection is completed at any given instant, the total forces never exceed an acceptable amount at any given instant. To provide the sequential connections and yet maintain the ease and convenience of plug-and-jack type connectors, we have adopted a zipper principle.

An embodiment of one type of zipper connector is shown in FIG. 3. To orient the reader, the cross hatched part of FIG. 3 is taken along line **3—3** of FIG. 2. This particular embodiment carries forth the printed circuit technique used to manufacture the cable. Essentially the

zipper comprises a pair of continuous beads **30, 31** of interlocking plastic channels. This type of interlocking channel is well known and commonly used to close such things as plastic brief cases, for example. Here, however, either the number of zipper beads or the gauge of the plastic may be increased, as required, to provide added contact pressure.

In construction, the continuous bead or channel **30** is first welded or otherwise joined to the Mylar sheet **25**. Then the entire surface of both the sheet **25** and the bead **30** is plated with copper or other suitable material to form a continuous conductive surface extending from the sheet down into and up over the interlocking surfaces of the beads or channels. Thereafter, printed circuit techniques are used to etch or erode away unwanted copper. This leaves a continuous and unbroken strip of copper extending from the strip **26** of the tape cable, down into the valleys, and up over the hills of the zipper bead, as shown at **32**. Then the second sheet of insulating material **24** is added in any well known manner to complete the cable laminate. A wedge slider (not shown) may be used to force the channel **30** from the position shown in FIG. 3 into the channel **31**, thereby completing an electrical connection between the plating **32** and the plating **33** of a corresponding bead. This joins strip **26** and strip **34**.

FIG. 4 is a top plan view of the two cables joined together. To orient the reader, FIG. 3 is a view, partly in cross section taken along the line **3—3** of FIG. 4. As here shown the two zipper beads **30, 31** are joined together.

One characteristic of this type of zipper is that it is almost impossible to pull the two mating zipper halves apart by forces exerted in the directions of the arrows A–B. However, the zipper easily separates responsive to forces in the directions of the arrows C, D. To forestall such separation, the two cables are preferably secured together against lateral motion.

As shown in FIG. 5 one way of preventing lateral motion is to add snap fasteners **40** at any convenient points on the two cables **41, 42**. For example, as here shown, each cable is provided with outwardly extending tabs **41'** which are snapped together at **40**.

In another embodiment, FIG. 4, the tabs are stapled together as shown at **43, 44**. Still another way of preventing lateral motion is to pin or stable through the zipper channel or bead, as shown at **45, 46**.

Also, indexing means are provided to insure a correct mating of the proper strip lines. For example, the strip **26** should connect with strip **34** and not with strip **48**. In FIG. 5, the snap fastener **40** indexes the two cables. In FIG. 4, a short horizontal section of zipper bead **49** indexes the two cables. For extra-wide cables one or more supplemental snap fasteners are provided as shown at **48***a*. Alternatively, a continuous strip of snap fasteners could be provided.

To increase contact pressure, a bifurcated toothed, metal zipper is used as shown in FIG. 6. Here each bifurcated tooth preferably has two integral pins **50, 51**, which are soldered to the cable strip **26**, as shown at **52, 53**. Preferably the zipper tooth backing material **54** is welded to the cable and the conductive material of the strip is deposited through use of printed circuit technique. As with most zippers, a sliding wedge forces the two tooth parts **56, 57** together, or pulls them apart. In this embodiment, the teeth grip each other under spring tension to provide added contact pressure. This gripping force is here exemplified by the two double ended arrows E, F.

Yet another embodiment of the invention (FIG. 7) adds contact pressure through the use of a bifurcated zipper tooth **60**. Here, the spring tension of each tooth pushes against the spring tension of both of its adjacent teeth, as shown by the double-ended arrows G, H, for example. Insulating teeth **61, 62** separate adjacent electrical circuits. Here nylon teeth are used as insulators; however, other suitable materials may be used also.

In any of the above embodiments, contact shielding may be provided by grounding zipper teeth adjacent current-carrying zipper teeth. Hence, if ground **69** is applied at **65** in any of the figures, it will prevent a capacity coupling between the conductors or zipper teeth **66, 67**.

A particular advantage of this arrangement comes from the wiping action which occurs as the zipper parts are forced together by the sliding wedge. This action can be seen at **70** in FIG. 8 where tooth **71** is wiping against tooth **72**. Another advantage is that each circuit is completed through twin contacts. This redundance of contacts greatly reduces the probability of failures. Upon reflection, it will be apparent that each embodiment of the invention includes both the wiping action and the redundancy of contacts. Moreover, in the embodiment of FIG. 3, redundancy may be multiplied endlessly by the simple expedient of adding sections to the zipper bead.

While the principles of the invention have been described above in connection with specific apparatus and applications, it is to be understood that this description is made only by way of example and not as a limitation on the scope of the invention.

We claim:

1. A flexible ribbon cable comprising at least one sheet of flexible insulating material having strip conductors printed thereon, a plastic zipper bead of interlocking channels joined to said material, and means for electrically extending said strip into said zipper bead, whereby the strips of two flexible ribbon cables may be connected by joining the interlocking channels of two zipper beads.

2. An electrical connector comprising at least one flexible ribbon cable having a zipper half attached thereto, means comprising a mating half of said zipper for conducting electric current to and from said cable, and pressure-applying means for applying a predetermined contact pressure at the points of contacts between said two zipper halves, wherein said means for applying contact pressure comprises a pair of mating beads having a plurality of channels of heavy gauge plastic material.

3. An electrical connector comprising at least one flexible ribbon cable having a zipper half attached thereto, means comprising a mating half of said zipper for conducting electric current to and from said cable, and pressure-applying means for applying a predetermined contact pressure at the point of contacts between said two zipper halves, wherein said means for applying contact pressure comprises bifurcated zipper teeth having a spring tension between the jaws of said bifurcation.

4. The connector of claim **3** and means associated with certain of said teeth for electrically insulating adjacent teeth.

5. The connector of claim **3** and means for electrically shielding certain of said zipper teeth.

6. The connector of claim **5** wherein said shielding comprises ground-potential teeth interposed between current-carrying teeth.

7. The connector of claim **3** and means for indexing the zipper teeth associated with one side of a zipper with respect to the zipper teeth associated with the other side of said zipper.

8. The connector of claim **3** and supplementary fastening means for securing said zipper parts.

9. An electrical connector comprising at least one flexible ribbon cable having a zipper half attached thereto, means comprising a mating half of said zipper for conducting electric current to and from said cable, and pressure-applying means for applying a predetermined contact pressure at the points of contacts between said two zipper halves, wherein said means for applying contact pressure comprises bifurcated zipper teeth which grip each other between the jaws of said bifurcation.

10. An electrical connector comprising at least one flexible ribbon cable having a zipper half attached thereto, means comprising a mating half of said zipper for conducting electric current to and from said cable, and pressure applying means for applying a predetermined contact pressure at the point of contacts between said two zipper halves, wherein said means for applying contact pressure comprises bifurcated zipper teeth of spring-like material which is compressed when the zipper is closed so that each jaw of the bifurcation of one tooth is pushed against the bifurcated jaw of another tooth under spring tension.

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