

[54] CONNECTOR FOR THE ELECTRICAL CONNECTION OF FLEXIBLE CONDUCTORS

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[51] Int. Cl. H05k 1/02

[58] Field of Search..... 339/17, 18, 75 MP, 339/176 MF, 206, 205, 107, 174, 103; 317/101

[56] References Cited

UNITED STATES PATENTS

3,319,216 5/1967 McCullough 339/17 F X
3,350,530 10/1967 Fry 339/17 F X

3,638,164 1/1972 Glance et al. 339/49 R
3,214,725 10/1965 DeRose et al. 339/75 MP X
3,159,447 12/1964 Crimmins et al. 339/176 MF
3,154,365 10/1964 Crimmins 339/91 R X

FOREIGN PATENTS OR APPLICATIONS

1,144,663 3/1969 Great Britain 339/75 MP

Primary Examiner—Marvin A. Champion

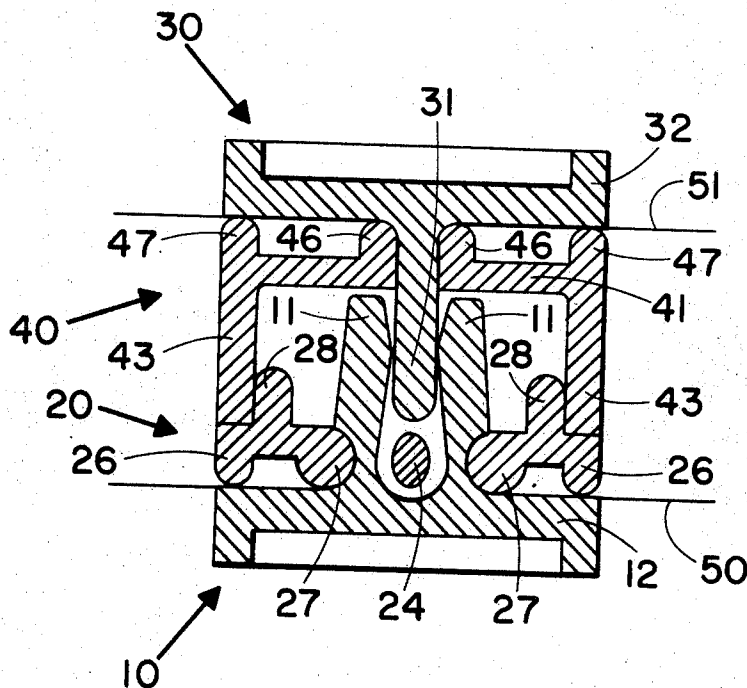
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[57] ABSTRACT

A connector for and method of connecting a flexible conductor, such as a flat flexible cable or flexible circuits, in which the flexible conductor is flexed over at least one rib, the conductor held in position over the rib by a retaining member. In a particular example, a first conductor is flexed over a single rib while a second conductor is flexed over and down between two parallel ribs, both conductors held in place by retaining members. The first conductor and its supporting rib is then inserted between the parallel ribs and the two conductors are electrically connected.

3 Claims, 19 Drawing Figures



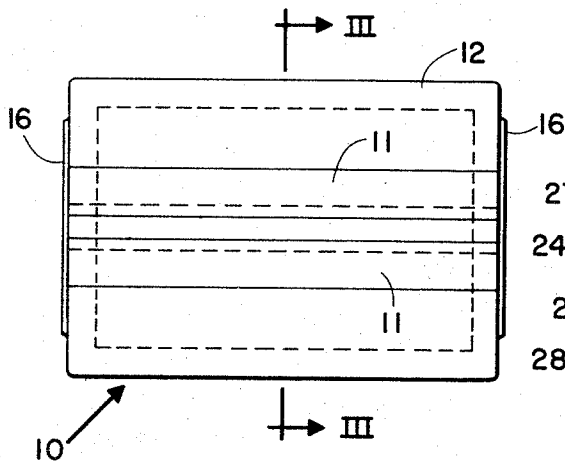


Fig. 1

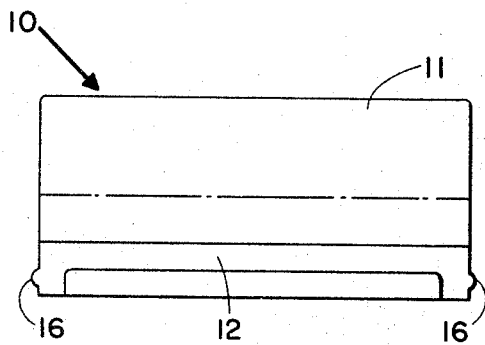


Fig. 2

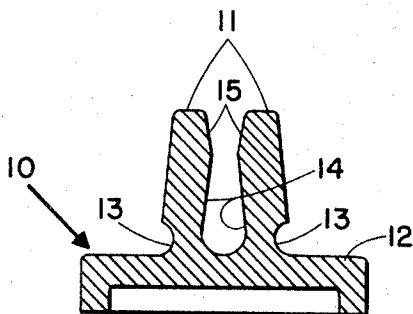


Fig. 3

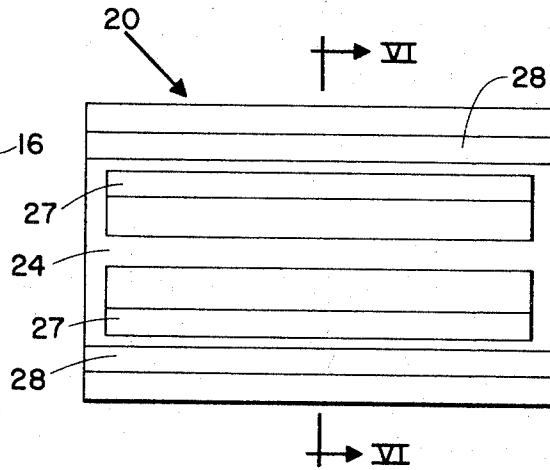


Fig. 4

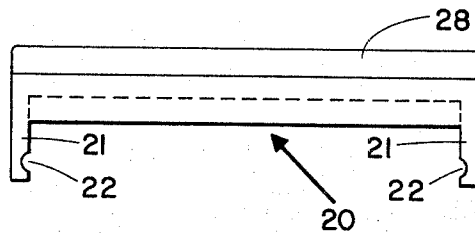


Fig. 5

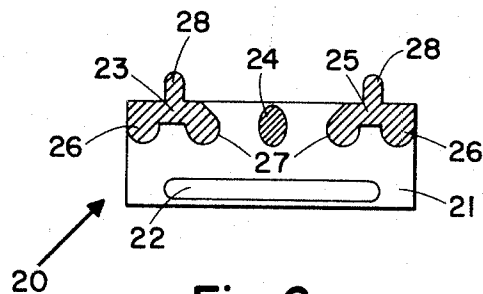


Fig. 6

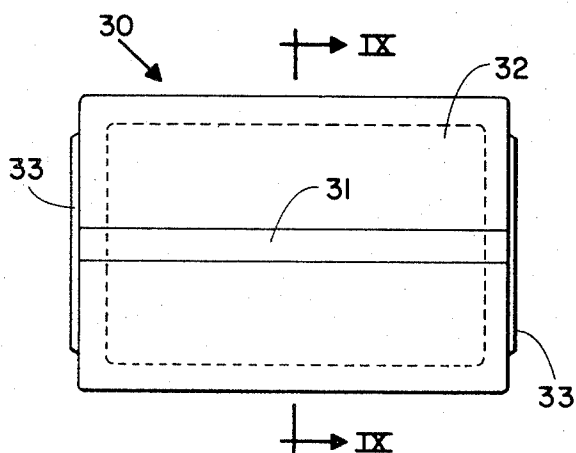


Fig. 7

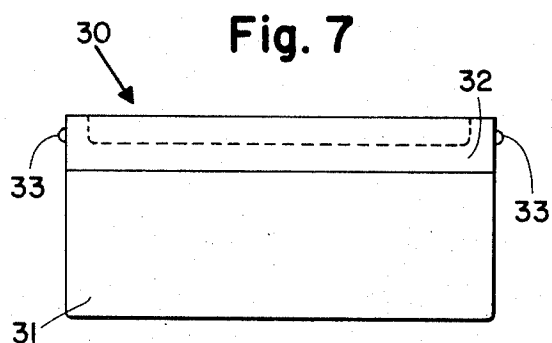


Fig. 8

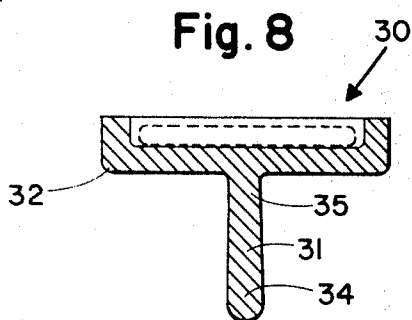


Fig. 9

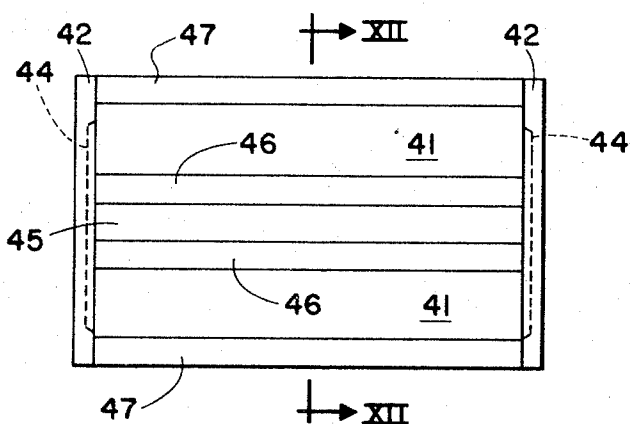


Fig. 10

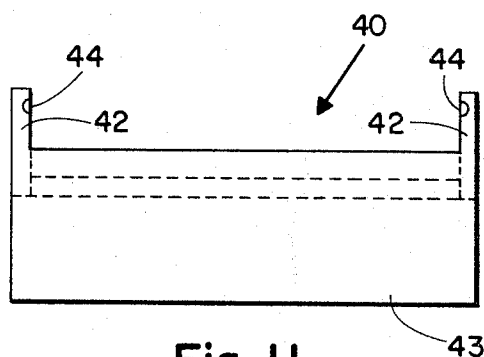


Fig. 11

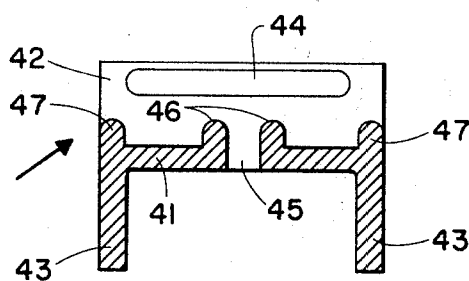


Fig. 12

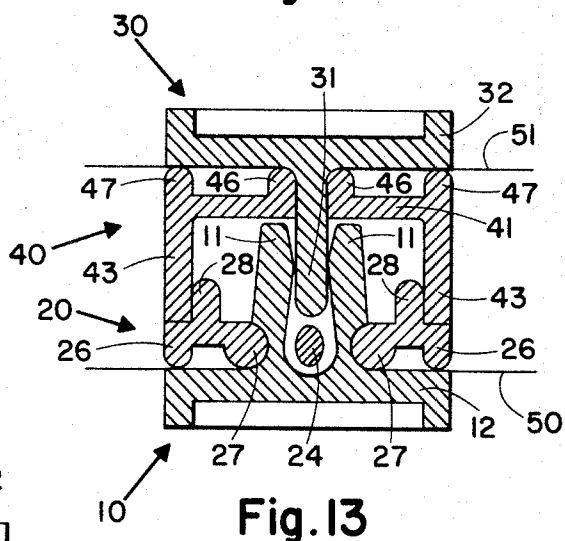


Fig. 13

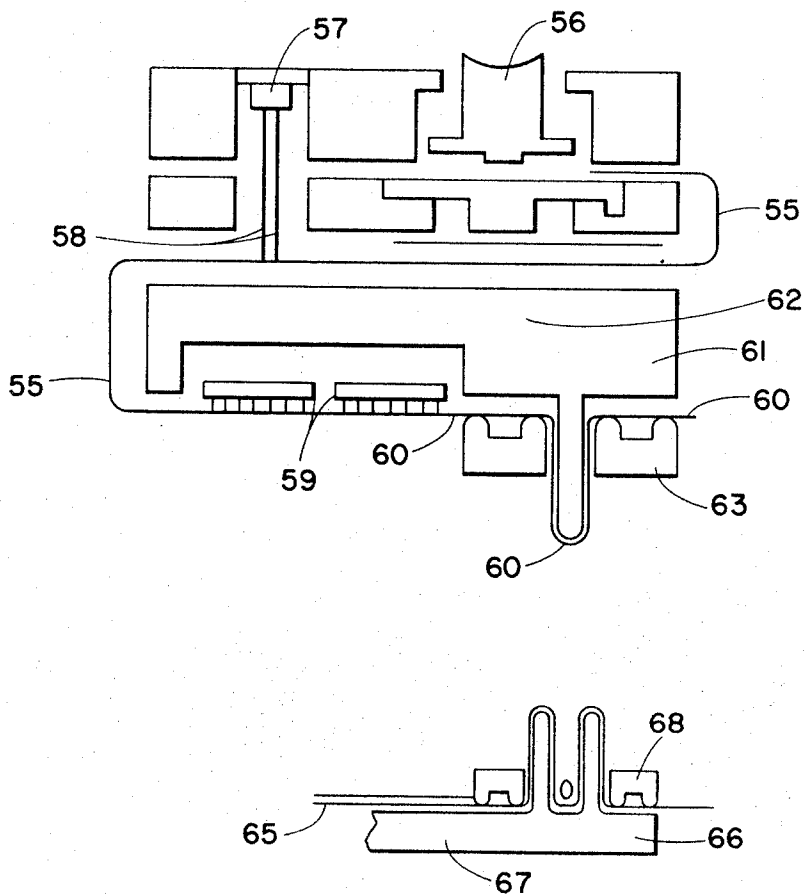
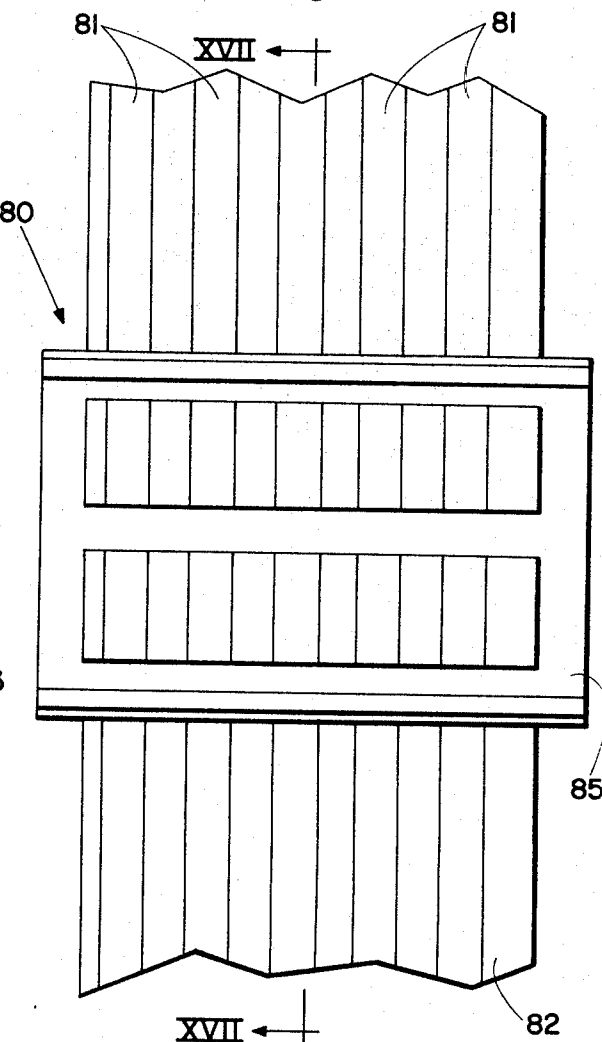
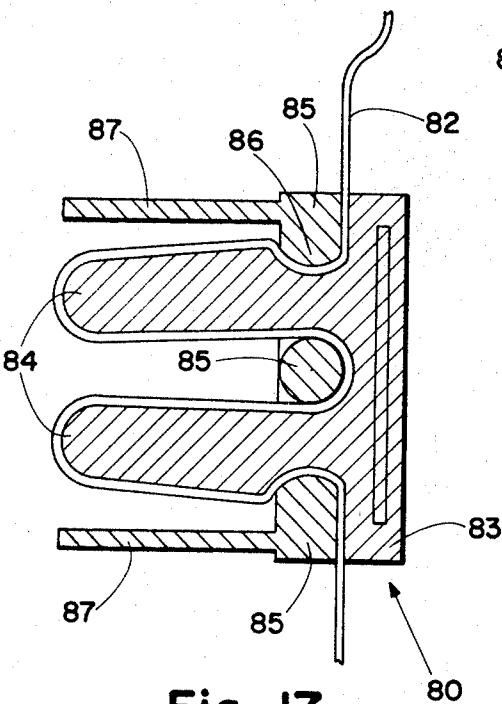
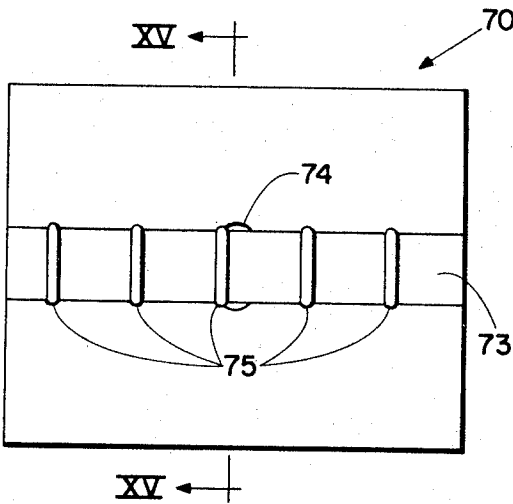
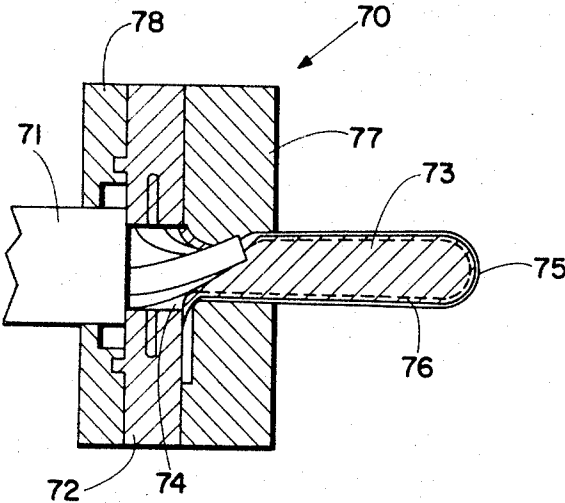


Fig. 14



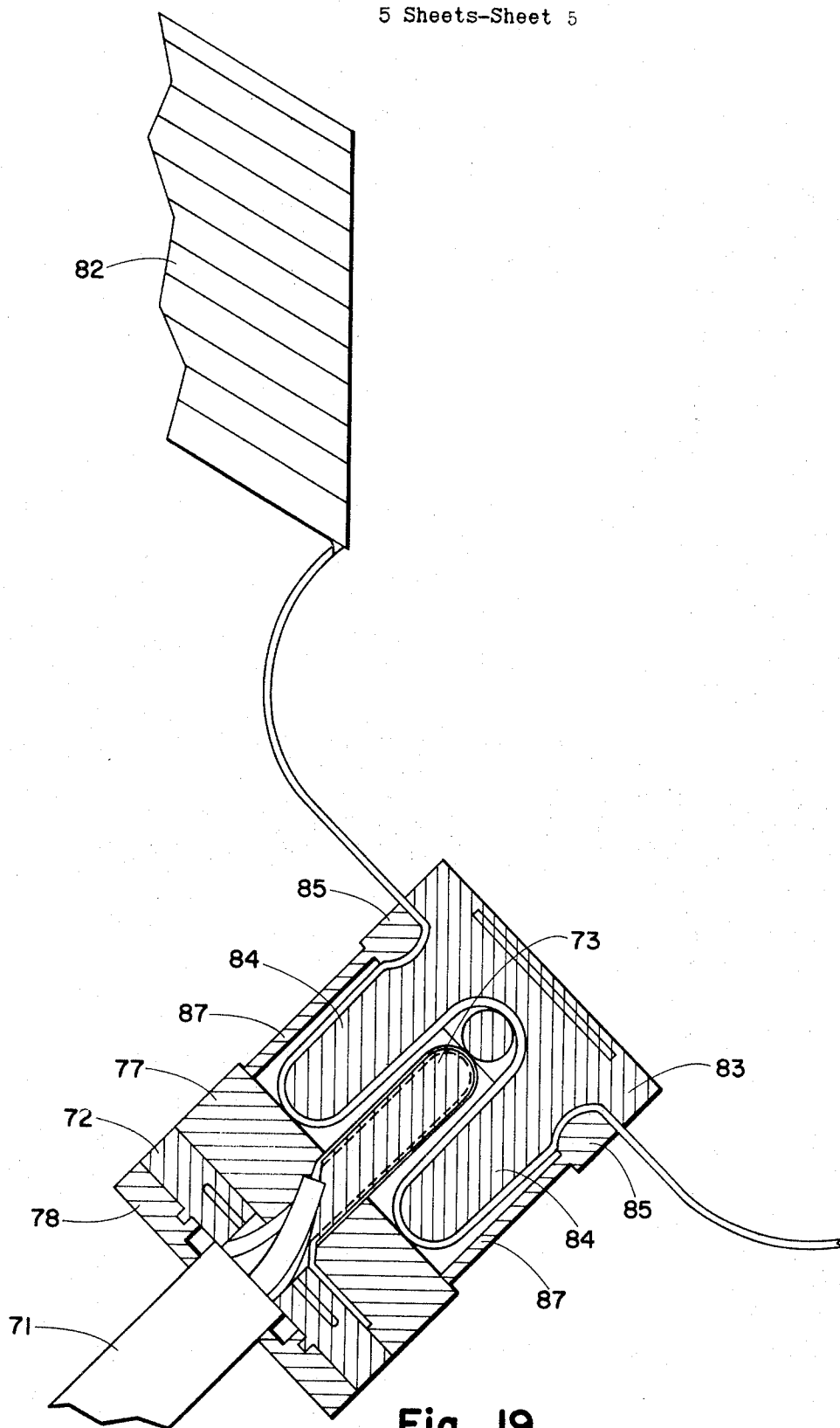


Fig. 19

CONNECTOR FOR THE ELECTRICAL CONNECTION OF FLEXIBLE CONDUCTORS

This invention relates to the electrical connection of flexible conductors, and particularly to the electrical connection of flexible circuits such as flexible flat cables, flexible printed circuits and the like. In particular the invention provides a method of making an electrical connection to a flexible conductor and a connector for such a connection.

The use of flexible conductors is wide spread and increasing, particularly in the use of flexible printed circuits and flexible flat cable. Connections to such conductors is by soldering and by connectors. Connectors used are often bulky, expensive and generally contain a large number of individual contact members often with separate spring members to ensure contact between contact members and conductors.

The present invention provides for the connection of one flexible conductor or circuit to another conductor or circuit which may or may not also be flexible, using only two members for each circuit. The parts are simple and easily made.

For each conductor or circuit there is a base portion and a retainer, the flexible conductor or circuit being flexed over a rib extending from the base portion and retained in position by the retainer.

In accordance with one feature of the invention, a method of connecting a flexible conductor comprises flexing the conductor over a rib member extending from a base portion and pressing a retaining member over the rib member to grip the conductor between the retaining member and the base portion.

In accordance with another feature of the invention, a method of connecting flexible conductors comprises: flexing a first conductor over a rib member extending from a first base portion and pressing a retaining member over the rib member to grip and retain the conductor; flexing a second conductor over a rib member extending from a second base portion and pressing a retaining member over the rib member to grip and retain the second conductor; and pressing the first base portion and conductor into electrically conducting engagement with the second base portion and conductor.

Conveniently two spaced apart ribs extend from one base portion, the flexible conductor flexed over and down between the ribs and retained by the retainer, the rib of the other base portion being pressed between the ribs of the one base portion.

In accordance with a further feature of the invention a connector for a flexible conductor comprises a base portion having a rib member extending substantially normal therefrom and a retaining member adapted to pass over the rib member to retain a flexible conductor over the rib member. Preferably the rib member has a recess formed on one side and said retainer includes a protrusion for engagement with the recess.

In accordance with yet a further feature of the invention there is provided a first connector comprising: a base portion having a rib member extending normal therefrom and a retaining member adapted to pass over the rib member to retain a first flexible conductor over the rib member, and; a second connector comprises a base portion having a rib member extending normal therefrom and a retaining member adapted to pass over the rib member to retain a second flexible conductor over the rib member.

Conveniently one of said connectors has two spaced apart rib members the retainer adapted to pass over and between the rib members to retain the flexible conductor over and down between the rib members, the rib member of the other connector adapted to be pressed between the two rib members of the one connector.

The invention will be understood by the following description of certain embodiments, by way of example, in conjunction with the accompanying drawings, in which:

FIGS. 1, 2 and 3 are respectively a plan view, end view and cross-section on the line III—III of FIG. 1, illustrating one form of base member or portion for a connector;

FIGS. 4, 5 and 6 respectively are plan view, end view and cross-section on the line VI—VI of FIG. 4 of a retainer for the base member or portion of FIGS. 1 to 3;

FIGS. 7, 8 and 9 respectively are plan view, end view and cross-section on the line IX—IX of FIG. 7, illustrating another form of base member or portion for a connector;

FIGS. 10, 11 and 12 respectively are plan view, end view and cross-section on the line XII—XII of FIG. 10 of a retainer for the base member or portion of FIGS. 7, 8 and 9;

FIG. 13 illustrates, in cross-section, an embodiment utilizing connectors of the form illustrated in FIGS. 1 to 6 and 7 to 12 connected together after connection to flexible conductors or circuits;

FIG. 14 is a diagrammatic cross-section through part of a telephone set illustrating one application of the invention; and

FIGS. 15 to 19 illustrate another embodiment of the invention, for connecting wire conductors to flat flexible conductors, FIG. 15 being a cross-section through a connector, on the line XV—XV of FIG. 16, and FIG. 16 being a plan view of the connector of FIG. 15; FIG. 17 being a cross-section through a connector on the line XVII—XVII of FIG. 18, and FIG. 18 being a plan view of the connector of FIG. 17; and FIG. 19 being a cross-section through an assembly comprising the connectors of FIGS. 15 and 16 and of FIG. 17 and 18 connected together.

FIGS. 1 to 3 illustrate a base portion or member 10 having two ribs 11 extending in a direction normal to the plan of the base 12. The two ribs are spaced apart, extending parallel to each other. Formed at the junction of each rib 11 and the base 12, at the outward facing sides, is a recess 13, the purpose of which will be explained later. The sides or faces of the ribs facing towards each other are first inclined toward each other, from the base 12, as indicated at 14, and then incline outwardly at 15. The inclined portions 15 facilitate entry of a cooperating member when a connection is being made and the inclined portions 14 tend to urge the cooperating member into place and retain it in place, as will be described later. Formed along each end of the base 12 is a bead 16. Bead 16 cooperates with the related retaining member, as will be described.

FIGS. 4 to 6 illustrate a retaining member 20 for use with the base portion or member 10. The retaining member is somewhat of channel formation having end flanges 21. Formed in the inner faces of the flanges, adjacent their ends, are grooves 22. In position the flanges 21 fit over the ends of the base 12 of base portion 10 with the grooves 22 fitting over the beads 16. The main body portion of the retainer 20, extending between the

flanges 21, comprises three parallel spaced apart formations 23, 24 and 25.

Formations 23 and 25 are similar but of opposite hand. Each formation has two downwardly extending ribs 26 and 27 and a centrally positioned upwardly extending rib 28. When the retainer 20 is pushed over the base portion 10, the ribs 27 engage with the recesses 13 (FIG. 3) and the bottom surfaces of the ribs 26 and 27 are in engagement with the base 12. Formation 24 passes down between the ribs 11 of the base portion.

In use a flexible conductor or circuit is first folded with the fold pushed down between the ribs 11 of the base portion and then opened up to extend over the tops of the ribs 11. The fold should not put a crack in the conductor or circuit. The retainer 20 is then positioned over the base portion and pushed down. Ribs 26 and 27 push down the flexible conductor, or circuit and when the retainer is pushed fully to its final position the flexible conductor, or circuit, is held securely in place by the ribs 26 and 27 and the formation 24. Complete and satisfactory positioning of the retainer is ensured by the snap action felt by the engagement of the ribs 27 with the recesses 13 and the grooves 22 with the beads 16.

FIGS. 7 to 9 illustrate a further base portion 30 having a single rib 31 extending in a direction normal to the base 32. At each end of the base is a bead 33. The rib 31 may be parallel sided but advantageously may be of slightly tapered form, being slightly thicker at its end 34 than at its base 35. The advantage of this construction will be seen later.

FIGS. 10 to 12 illustrate a retaining member 40 for use with the base portion 30. Base portion 30 is generally in the form of two channel shapes back-to-back, having a common web or main body portion 41. At each end of the body portion 41 and extending normal thereto is a flange 42 and along each side of the body portion 41, extending normal thereto is a flange 43. Flanges 43 extend from the other face of the body portion 41 and in opposite direction relative to flanges 42. On the inner surface of each flange 42 is a recess or groove 44 adapted to engage with the beads 44 on the base portion 30.

The web or main body portion 41 has a slot 45 extending along its centre-line, parallel to flanges 43. On the face of the portion 41 from which extend the flanges 42 are formed four parallel ribs, a pair of ribs 46 along each side of the slot 45 and a further pair 47 along each side of the portion 41. In position the rib 31 (FIG. 9) of the base portion 30 of FIGS. 7 to 9 passes through the slot 45 and the ribs 46 and 47 are in contact with the base 32 of the base portion 30.

In the description of the base portions 10 and 30 these have been considered as individual items. If it is intended that the invention shall be used as a connector for connecting two flexible circuits, or flat flexible cables for example, then, the base portion and its retainer will be made as individual items. However the invention can be used to provide connecting means in an item of apparatus and in such an instance it is possible to make part of the casing, or some other part of the apparatus, of the form of the base portion. Thus, for example, considering the base portion 10 illustrated in FIGS. 1 to 3 the base 12 may be part of the casing of the apparatus with the ribs 11 moulded thereon. In such an example it may not be possible to provide the beads 16 but the retainer will be maintained in position

by its engagement with the recesses 13. Also it would be easy to provide some other form of retaining means if desired.

Similarly the base portion 30 illustrated in FIGS. 7 to 9 can be made as part of the casing or other part of an item of apparatus. Both base portions can be formed as parts of the same item of apparatus such that an assembly of two flexible conductors, or circuits, are connected. A typical example is a telephone set. One part can be moulded to have the flexible lead -in the form of a flat cable- attached thereto, and another part can be moulded to have the circuit of the handset -in the form of a flexible printed circuit- for example, connected thereto. On assembly the two parts engage and connect the circuit to the cable.

FIG. 13 is a cross-section of base portions 10 and 30 pressed together to connect two circuits or conductors, while FIG. 14 is a diagrammatic cross-section through part of a telephone set, illustrating an application of the invention, as an example. In FIG. 13, the two base portions 10 and 30, together with their related retaining members 20 and 40 are shown pressed together as they would be in connecting two conductors or circuits. In assembling a complete connection, a flexible conductor or circuit, indicated at 50, is positioned over the base portion 10 with a fold of the conductor inserted between the ribs 11, and retaining member 20 pushed onto the base portion. Similarly, a flexible conductor or circuit, indicated at 51, is positioned over the base portion 30 and retaining member 40 pushed over the rib 31 and pressed into engagement with the base 32. The two assemblies each of a base portion and a retaining member are then pressed together, the rib 31 and the conductor 51 entering between the ribs 11 and the conductor 50. The distance between the ribs 11 is arranged to be such that they are flexed apart slightly by insertion of the rib 31. This ensures good contact between the conductors 50 and 51. As previously described, rib 31 can be slightly thicker at its end 34 than at its base 35. This will tend to cause the rib 31 to remain between ribs 11 and resist parting. The flanges 43 (FIG. 12) of the retaining member 40 engage the outer surface of the outer retaining member 20 and also the outer edges of ribs 28. Depending upon the application it may be desirable, or even necessary, to plate the contact areas to provide satisfactory contact.

FIG. 14 illustrates an arrangement in which the circuit of the key mechanism for key set telephone is of a flexible circuit type, and indicated generally at 55. Keys are indicated at 56 and light emitting diodes used as signal devices at 57. Leads 58 connect the diodes to the circuit 55. Also connected to the circuit 50 are integrated circuit packages 59. The circuit 55 terminates in a portion 60 which is attached to a base portion 61 moulded as part of the set frame 62, by means of a retainer 63. A flexible cable, or connecting lead, is indicated at 65, being terminated by being held onto a base portion 66, moulded as part of the base 67 of the set, by means of a retainer 68. It will be appreciated that as alignment of the two base portions is ensured by the complimentary nature of the frame and base of the telephone set, the retaining members can be of a more simpler form than those illustrated in FIGS. 4 to 6 and 10 to 12.

FIGS. 15 to 19 illustrate an embodiment of the invention for connecting flat flexible conductors to wire conductors. FIGS. 15 and 16 illustrate a connector, gener-

ally indicated at 70 for the wires of a flexible cable 71. The connector comprises a base portion 72 having a rib member 73 extending normal thereto. A hole 74 extends through the base portion 72, passing at an angle through the base portion of the rib 73 to exit at one side thereof. The individual conductors 75 of the cable 71 pass through the hole 74 and are spread apart, the insulation removed and the conductors situated in grooves 76 formed in the rib member 73. The conductors 75 protrude slightly above the surface of the rib member 73. The conductors 75 are held in position by a retaining member 77 pressed over the rib member 73. The retaining member is held in place by the tapered form of the rib member 73 and by engagement with the exit of the hole 74 in the rib member. However other means of keeping the retaining member 77 in position can be provided. A further retaining member 78 can be provided for holding the cable 71 firmly connected to the base portion 72 and to reduce stresses on the conductors 75.

FIGS. 17 and 18 illustrate a connector, indicated generally at 80 for the conductors 81 of a flat flexible cable, or of a flexible printed circuit, 82. The connector comprises a base portion 83 having two parallel spaced apart ribs 84. The flexible cable 82 is positioned over the ribs 84 with a fold extending down between the ribs. A retaining member 85 is pressed over the ribs 84 to retain the flexible cable firmly in position over the ribs. The retaining member 85 is maintained in position by engagement with recesses 86 formed in the outwardly facing surfaces of the ribs 84.

The two connectors 70 and 80 are connected together as illustrated in FIG. 19. The rib member 73 of connector 70 is pressed between the rib members 84 of the connector 80. The conductors 75 of the cable 71 are thus brought into contact with the conductors 81 of cable 82. The retaining member 85 of connector 80 is formed with a thin flange 87 along each side, the flanges serving to prevent undue flexing of the rib member 73 relative to rib members 84. The connector 70 is retained in connection with connector 80 by the tapered form of the rib member 73. The rib members 84 are given a slight taper at their bases, away from each other, the taper cooperating with the tapered form of the rib member 73.

Although the invention has been described so far in relation to connecting two flexible conductors or circuits, it will be appreciated that the invention can be used to connect a rigid circuit or conductor, to a flexible circuit or conductor. Thus for example, a rigid printed circuit board can be given a cross-section at a particular portion of its periphery similar to the cross-section of the rib 31 of base portion 30 (FIG. 9) although it will not be necessary to provide a tapered cross-section. This could then be pushed into a base portion as in FIGS. 1 to 3 having a flexible circuit fixed thereto by a retainer similar to that of FIGS. 4 to 6. Conversely the rigid circuit could be as base portion 30 and the flexible circuit attached to a base portion similar to base portion 10. The invention can also be used to connect to both sides of a printed circuit board where circuits are applied to both sides of the board. A single flexible conductor, or circuit, can be connected to the board, selected connections being made one side and selected connections to the other side, unwanted connections being prevented by insulating material or other means. Alternatively two flexible conductors or

circuits can be connected to the board, one conductor or circuit to each side, by overlapping the conductors or circuits at the bottom of the recess formed by the two ribs 11, FIG. 3, for example. Various combinations of connections can be made by shorting out conductor strips in one or other or both the conductors or circuits being connected.

One conductor or a series of conductors may terminate at the connectors. Thus in connection with a pair of flat flexible cables a multiplicity of individual conductors in one cable will be connected to a multiplicity of individual conductors in the other cable. The individual conductors will be spaced apart side by side, comprising, for example copper on a Kapton backing, in the known manner. In certain circumstances flat flexible cable is insulated on both sides and it will be necessary to strip the insulation where contact is to be made. These contact areas may also need plating, for example gold or tin plated, to give satisfactory contact.

Using a connector, or a pair of cooperating connectors, in accordance with the invention, rigid circuits can be replaced by flexible circuits, wires can be replaced by flat cable, the housing in which systems are contained can be shaped so as to simulate a connector and eliminate separate connectors, soldered joints are avoided and also wire wrapping. Disconnection and reconnection are readily made, without restriction.

It is also possible to connect components into a flexible circuit by the present invention. The component leads can be of flexible form and fastened to a connector and the circuit is fastened to another connector, the two connectors pressed together. A further example is an integrated circuit pack which can be "plugged" into an assembled female shape.

Instead of two connectors for a connection being separate parts, the two connectors can be hinged together. Thus the two base portions can be hinged together and, after positioning of the retaining members, the two base portions are hinged relative to each other and clipped together. It is possible that the base portions hinged together could be two parts of a housing hinged together.

The invention can be used in many fields. Hitherto the connection of flat flexible cables has been difficult, requiring complex connectors and often difficult soldering operations. The present invention provides for cheap, simple and easy connection of such cables. A further example of use is in the installation of prewired circuits for automobile dashboards. These circuits can be prepared on either flexible or rigid bases and connections made to the circuit by connectors in accordance with the invention.

If desired, to improve the flexibility of the interengaging ribs, ribs 11, FIG. 3, and also rib 31, FIG. 9, can be slit crossways to form separate fingers. This may be particularly advantageous in long connectors for a large number of individual conductors. A finger may be provided for each conductor or for a small number of conductors. By the removal of fingers, an electrical contact at that position can be avoided.

What is claimed is:

1. A connector for connecting two flexible conductors, comprising first and second members, each member for attachment to a flexible conductor; said first member comprising:
 - a base portion of substantially planar formation;
 - a rib extending normal to said base portion;

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a retaining member having a body portion, and an aperture in the body portion positioned over said rib of said base portion, and in close engagement therewith;

interengaging ribs and recesses on said base portion and said retaining member, said ribs on one of said base portion and said retaining member and said recesses on the other of said base portion and said retaining member;

said retaining member constructed and arranged to hold a flexible conductor over and in contact with said ribs extending from said base portion;

said second member comprising:

a base portion of substantially planar formation;

two parallel ribs extending normal to said base portion, said ribs spaced a distance approximately equal to the thickness of the rib of said first member;

a retaining member comprising a central rib and two rib formations extending one on each side of said central rib, and parallel thereto, each rib formation spaced from said central rib a distance substantially equal to the thickness of each of said two parallel ribs, and flanges connecting said central rib and said two rib formations;

interengaging ribs and recesses on said base portion and said retaining member, said ribs on one of said

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base portion and said retaining member and said recesses on the other of said base portion and said retaining member;

said central rib extending between the two parallel ribs of said base portion and said two rib formations extending on either side of the two parallel ribs to hold a flexible conductor over said two parallel ribs and down between said two parallel ribs;

said base portions of said first and second members substantially parallel to each other, the rib of the base portion of said first member extending between the two parallel ribs of the base portion of said second member, the two flexible circuits in electrically contacting engagement.

2. A connector as claimed in claim 1, said rib extending from said base portion of said first member thicker at its end remote from said base portion than at its junction with said base portion; and said two parallel ribs extending from said base portion of said second member spaced a distance approximately equal to the thickness of said rib of said first member at its said junction with said base portion of said first member.

3. A connector as claimed in claim 1 at least one of said base portions formed integrally with a part of an apparatus.

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