

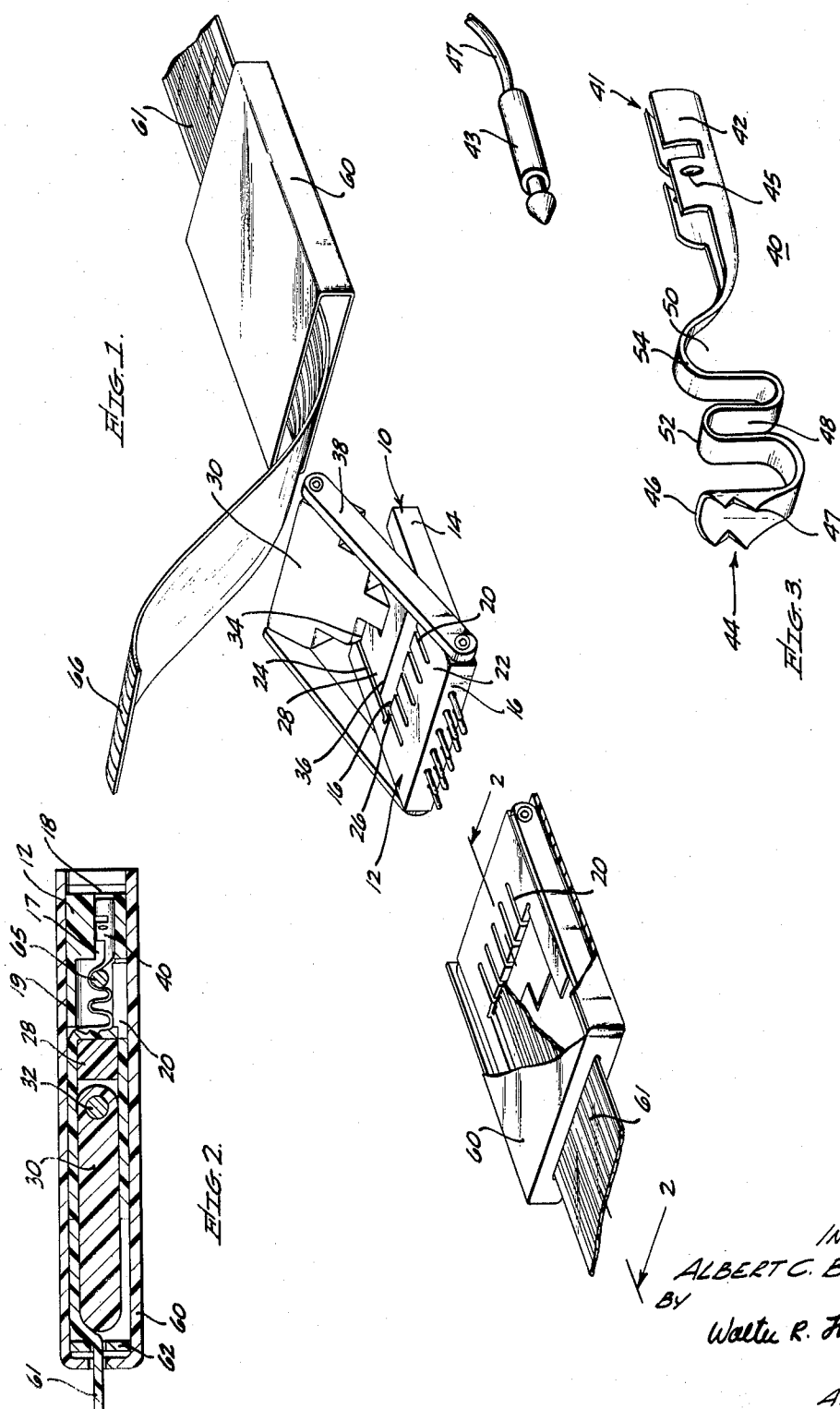
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## ELECTRICAL CONNECTOR

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## ELECTRICAL CONNECTOR

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The present invention relates generally to electrical connectors and 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 typically in the order of ten to fifty conductors. The conductors are generally copper or the like and are provided with a coating or surface treatment which enables adherence of the plastic material.

While the flat tape type of multiconductor cable has been known and used, the interconnection of the individual conductors to sockets or plugs or to the conductors of other cables has been difficult and tedious. In providing such connections, it has been the practice either to mold or form particular end configurations on the conductors and to produce these end structures in such a manner as to leave surfaces free from insulation. When connecting such a 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 and the bared conductors have been soldered, welded or otherwise affixed to rigid connector elements. These connection techniques not only require considerable time in the manufacture, preparation and assembly of connectors, but involve the handling, stripping and soldering of thin, flexible and easily damaged conductors. Furthermore, this prior type of construction has required the use of separate and distinct conductor strain relief apparatus that has added to complexity, weight and cost.

An optimum connector for multiconductor ribbon cable utilizes lengths of standard cable without concern for special terminal end construction or the necessity for individual handling or soldering of the conductors. Furthermore, it should be possible merely to cut a desired length of ribbon cable, and connect it to a connector in a minimum of time, with a minimum of connector apparatus, 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 object of the present invention to provide an improved connector for multiconductor ribbon cable.

It is another 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.

Another object of the invention is to provide means for readily connecting flat multiconductor ribbon cable to plugs or connectors that are considered as being of standard types.

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A further object of the invention is to provide connection means for the conductors of flat multiconductor ribbon cable which minimizes the strain on the individual conductors.

Briefly, a connector for flat multiconductor ribbon cable having a free end in accordance with the present invention comprises a plurality of laterally spaced contact members each including a first end having at least one contact point, a second end having a connectable portion and intermediate thereof a flexible portion, and a clamping member in juxtaposition to said contact members for positioning the end portion of said multiconductor cable. The clamping member includes a movable portion for simultaneously clamping each conductor of said cable in contact with the contact points of a different one of said contact members under a controllable force.

These and other objects and advantages of the invention will become apparent from the following description taken in accordance with the specification when considered in conjunction with the accompanying drawing throughout which like reference characters indicate like parts, and in which:

FIGURE 1 is a perspective view of a preferred embodiment of a connector provided in accordance with the present invention and a portion of two sections of multiconductor ribbon cable illustrating a typical application wherein one connector has the protective hood removed and the other connector has a portion of the hood cut away to illustrate the structure of the connector and the positioning of the cable;

FIG. 2 is a cross-sectional view in elevation taken at 2-2 in FIG. 1 illustrating the contact made between the contact element and the ribbon cable conductor; and

FIG. 3 is an enlarged perspective view of a contact element provided in accordance with the present invention.

Referring to FIGS. 1 and 2, a generally U-shaped contact support member 10 which may be of a plastic dielectric material such as diallyl phthalate, comprises a body portion 12 and leg portions 14. A plurality of generally parallel laterally spaced bores 18 extend between opposite transverse ends or sides 16 of the body portion 12. Each bore 18 includes a first part 17 of one diameter and a second part 19 of a diameter larger than that of the first part 17. A plurality of grooves or slots 20 are provided so that each exposes a portion of a different one of the bores 18; while adjacent bores are exposed by grooves extending from an opposite one of said surfaces 22. On each of the inner or adjacent surfaces 24 of the leg portions 14 is a groove or notch 26 and movably positioned therein is a clamping or pressure pad member 28 of a dielectric material such as that of the support member 10. To impart movement to the clamping member 28, an operating member 30 is rotatably secured by a pin 32, or other conventional fastening means, in a detent in a first end 34 of the clamping member 28. To facilitate the clamping of the cable an opposite or second end 36 of the clamping member 28, adjacent to the bores 18 has a relatively flat surface. The operating member 30 is attached to the contact support member 10 by a pair of rotatable lever arms 38. Thus, by rotation of the operating member 30 the clamping member 28 is caused to reciprocate in the grooves 26.

Referring now to FIGS. 2 and 3, inserted into each of the bores 18 is an elongated contact element 40 made from a spring tempered material such as heat treated beryllium copper. The elements 40 are secured in the bores 18 by a dielectric retaining pin 65 inserted through a bore (not shown) in the body portion 12. Each of the contact elements 40 includes a first end 41 containing a connectable portion such as a clip or socket 42 circum-

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scribing the longitudinal axis of the element and having a detent 45 arranged to secure within the socket or clip a pin connector 43. A second end 44 is arranged perpendicular to the longitudinal axis and includes a plurality of contact portions 46 each having a plurality of relatively blunt tips or points 47. Intermediate the ends 41 and 44 is a flexible portion such as a flexure area 48 including a loop 52 and a retaining portion 50 having a loop 54. The dimensions of the flexure area will vary depending upon the depth of the dielectric material to be pierced by the points 47, the composition of the dielectric material and the size of the conductor. By way of illustration, for a flat conductor cable having a spacing between conductors in the order of .050 inch the loop 52 has a height in the order of .090 inch and a radius in the order of .034 inch, while the loop 54 is of the same height as the loop 52 and has a radius slightly greater than that of the loop 52 and the contact portion 46 has a height slightly larger than that of the loops 52, 54.

To prevent destruction of the contact element 40 when the conductor is carrying current, the cross-sectional area of the element 40 must be at least equal to the cross-sectional area of the smallest conductor to which it is connected. To achieve this, in the present invention the contact portion 46 includes the plurality of contact tips or points 47 illustrated in FIG. 3 as four but not specifically limited thereto. Each of the points 47 has a general blunt configuration to enable a portion of the conductor to form around the point and make contact with a maximum area thereof without piercing the conductor so that a summation of all of the tip areas in contact with a single conductor produces a contact area having a value greater than the value of the cross-sectional area of the smallest conductor. In FIG. 3, the points 47 have been shown to comprise two pairs of points each pair of which is symmetrically positioned about the longitudinal axis of the element 40 at a spacing having a dimension less than the width of the ribbon cable to be contacted by the points. In addition, the parallel arrangement of laterally spaced points minimizes the necessary tolerance requirements for the positioning of the individual conductors in the ribbon cable since each contact portion 46 is designed so that the summation of the minimum area of contact of all of the contact points 47 is sufficient to provide an area of contact greater than the cross-sectional area of the smallest conductor. Therefore, although less than all of the contact points 47 are in engagement with the conductor a good contact will be made.

To convert the connector of this invention from a female type connector to a male type connector a conventional pin contact 56 (shown in FIG. 1) is inserted into each of the sockets 42. If desired, the pin contact 56 may be retained within the socket by conventional securing methods such as welding or soldering. Therefore, with pin type contacts in one connector and socket type contacts in the other, ribbon cable to ribbon cable connections can be made by plugging the two connectors together. If a ribbon cable to round wire conductor connection is desired, a pin 43 (shown in FIG. 3) may be crimped on the end of a wire conductor 47 and inserted into the socket 42. This enables the connector of the present invention to be used in a wide range of installation situations.

To secure the connector of the present invention on a section of ribbon cable 61, an exposed end 66 of the cable is inserted into a groove or slot 58 formed between the transverse end 16 of the body portion 12 and the second end 36 of the clamping member 28 by rotating the operating member 30 away from the plane of the connector. When the cable has been positioned in the slot 58, by rotating the operating member 30 back to the plane of the connector the clamping member 28 is caused to move toward the contact support member 10 and the contact points 47 of each of the contact members 40 apply a predetermined force to the conductors of the ribbon cable.

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Thus the points 47 pierce the dielectric and engage the copper conductor sufficiently for it to form around them. Once the flat ribbon cable is clamped in place, to protect it against dust and moisture a rectangular hood 60 including a rear sealing member 62 of a material such as silicone rubber is slid down over the entire assembly. In addition, if desired, an interface seal 64 of the same material as that of the rear seal may be positioned in contact with one of the connectors before assembling thus providing a seal between the two connectors when they are mated.

Since each of the contact elements 40 includes a flexure area, which provides a linear spring force over a predetermined range of deflections of the contact portion 46, when the exposed end 66 of the cable is brought into contact simultaneously with all of the contact portions and the contact points pierce the insulating material and engage the conductor, the cable will be held in place in the slot 58 by the force applied by the clamping member and the spring force of each of the contact portions. This imparts to the clamped portion of the ribbon cable a sufficient force to prevent any cold flow or transverse displacement thereof.

While but one embodiment of this invention has been herein illustrated it will be appreciated by those skilled in the art that variations in the disclosed arrangement both as to details and as to the organization of such details may be made without departing from the spirit and scope thereof. Accordingly, it is intended that the foregoing disclosure and the showings made in the drawings will be considered only as illustrative of the principles of this invention and not construed in a limiting sense.

I claim as my invention:

1. A connector for flat multiconductor ribbon cable having at least one free end comprising:

- a movable clamping member;
- an operating member rotatably attached to said clamping member;
- a contact support member having a pair of grooves for movably positioning said clamping member adjacent to one end of said support member;
- a pair of lever arms each attached to said operating member and said contact support member for rotation of said operating member to provide a slot between one end of said clamping member and said one end of said contact support member for receiving the free end of said ribbon cable; and

a plurality of deflectable contact elements positioned in said contact support member, each of said contact elements including a first end having a plurality of contact points extending from said one end of said contact support member, a second end having a connectable portion and intermediate said ends a flexible portion,

whereby rotation of the operating member engages simultaneously a portion of each conductor of the multiconductor cable with the contact points of a differing one of the contact members under a controllable force.

2. A connector for flat multiconductor ribbon cable having at least one free end comprising:

- a movable clamping member;
- a pivotable operating member rotatably attached to said clamping member;
- a contact support member having a plurality of bores and a pair of grooves for movably positioning said clamping member adjacent to one end of said support member;
- a pair of lever arms each attached to a pair of opposite sides of said operating member and said contact support member for rotation of said operating member to provide a slot between one end of said clamping member and said one end of said contact support

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member for receiving the free end of said ribbon cable; and

a plurality of deflectable contact elements each positioned in a differing one of the bores in said contact support member, each of said contact elements including a first end having a plurality of contact points extending from said one end of said contact support member, a second end having a connectable portion and intermediate said ends a flexible spring portion, whereby rotation of the operating member engages simultaneously a portion of each conductor of the multiconductor cable with the contact points of a

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differing one of the contact members under a controllable force.

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