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(54) **Notchless electrical ribbon cable.**

(57) A multi-conductor insulated electrical ribbon cable (20) having webs (23) of insulation for spacing apart and joining the cable conductors (21) in a continuous, generally flat array. The webs are adapted with lengthwise grooves (24) positioned in close proximity to the conductors (21), thereby facilitating severance of the webs in a manner which will allow the cable to be easily and reliably terminated to an insulation displacement connector without removal of the webs.

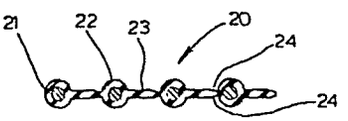

FIG. 2

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NOTCHLESS ELECTRICAL RIBBON CABLE

This invention relates to flat electrical ribbon cable construction and, more particularly, to insulated ribbon cable having the capability of being terminated to an electrical connector assembly by displacement of the insulation surrounding the cable conductors.

Electrical ribbon cable has gained wide acceptance in a variety of applications involving the interconnection wiring of electrical and electronic assemblies. It is particularly suitable for low voltage applications such as in the interconnection of telecommunications or computer subassemblies where a plurality of discrete electrical signals are required to be transmitted from one subassembly to another. Typically in these applications, the interconnection ribbon cable is terminated at each end with electrical connectors having the capability of being mounted on printed circuit boards by connection to a plurality of spaced wire pins which have been wave-soldered to the board circuitry, for example.

In order to ensure that ribbon cables of various origins are compatible with generally accepted printed circuit board design configurations, industry conventions have developed such that ribbon

cable is manufactured with standard center spacing of the cable conductors. Generally, the conductor center spacings which have been adopted are those spacings which have been found preferable for standardized pin separation in the design of printed circuit board circuitry layout. These spacings are typically on the order of several conductor-diameters in magnitude. Accordingly, it is common practice to manufacture ribbon cable by an extrusion process which coats the conductors with a relatively uniform layer of insulation and joints adjacent pairs of conductors in spaced-apart relationship with a web of extruded insulation. The webs need only have a thickness sufficient to maintain the individual conductors in uniform separation and assure the integrity of the cable as a unitary structure during handling and use.

For economoy of manufacture, it has been found desirable to extrude ribbon cable with a predetermined large number of conductors, and then separate the conductors by tearing to obtain a cable having a lesser width where fewer interconnection circuits are needed. By such a method, manufacturing efficiency is enhanced, in as much as only one extrusion die and related machinery are necessary to manufacture ribbon cable of various widths. To facilitate the

uniform tearing of the master cable into cables having lesser width, it is common practice to extrude the master cable with lengthwise grooves formed in the webs equi-distantly between adjacent pairs of conductors.

One method of terminating interconnection wiring that has gained wide acceptance in the above-mentioned applications because of its efficiency in assembly is mass termination by insulation displacement. In the insulation displacement process, the conductors are not stripped of their covering insulation prior to termination, whether they are discrete insulated wires or in ribbon cable form. Instead, the insulation is severed and displaced by the respective terminal to which the conductor is electrically connected. Connectors having the capability of insulation displacement termination are disclosed, for example, in US-A-4,217,022 and typically comprise a row of stamped, slotted metal terminals with V-shaped ends for receiving and making electrical contact with the respective conductors of the interconnection wiring or cable.

Where ribbon cable is used instead of discrete insulated wire, it is common practice to prepare the cable by removing the insulation webs for a distance from the cable end or along an intermediate portion

of the cable at the locations where connectors are to be installed. Preparing the ribbon cable by removing insulation web portions is desirable for the reason that it permits the cable to be terminated as if it were composed of a plurality of discrete wires. More specifically, by removal of the webs in the region of the connector termination, less force is required to press the cable conductors into their respective terminals and a more reliable connection between the cable conductors and terminals can be assured. Additionally, if the cables are not prepared, there is a tendency for overpacking of the terminal interface area with excess insulation causing withdrawal forces to be imposed on the conductors as a result of the latent resiliency of the insulation. This condition can, with time, result in inadequate electrical conductivity at the terminal-to-conductor interface of an operative connector. The step of preparing the ribbon cable, however, involves the use of specialized equipment and added investment of time. Additionally, where the cable user is unequipped to prepare the cable but requires multiple connector terminations within a single cable span, the cable must be specially prepared by the cable manufacturer, resulting in increased cost to the cable user.

In order to resolve these problems, the present

invention provides a generally flat electrical ribbon cable including a plurality of parallel, spaced-apart electrical conductors, each of said conductors being embedded in a continuous generally planar layer of insulation having a plurality of webs integrally formed between said conductors, said webs each having groove means running lengthwise of said conductors characterized by said groove means including at least one groove being formed proximate and adjacent to one of said conductors.

Some ways of carrying out the invention will now be described in detail by way of example and not by way of limitation with reference to drawings in which:

FIG. 1 is a perspective view of a typical prior art cable prepared for multiple connector terminations within a single cable span;

FIG. 2 is an end sectional view of a multi-conductor flat cable embodying the present invention;

FIG. 3 is a perspective view, partially in section, of the ribbon cable of Fig. 2 terminated to a typical insulation displacement type connector;

FIG. 4 is an end sectional view of a further multi-conductor flat cable embodying the present invention; and

FIG. 5 is a perspective view, partially in

section, showing the ribbon cable of Fig. 4 terminated to a typical insulation displacement type connector.

Referring to the drawings and first to Fig. 1, a prior art, round-conductor ribbon cable, designated generally by the reference numeral 10, is shown. The ribbon cable 10 consists of a plurality of electrical conductors 11 enveloped in a coating of insulation 12. The conductors 11 are arranged in parallel side-by-side relationship, uniformly separated from each other by a standard dimension which is maintained by connecting webs of insulation 13. Formed in the webs of insulation 13 are grooves 14 running lengthwise of the conductors 11 and positioned equi-distantly between adjacent pairs of conductors 11. To facilitate termination of the cable 10 to an insulation displacement type connector, the cable 10 has been prepared by removing portions 15 of its webs of insulation 13 at the locations where connectors are intended to be installed.

Referring now to Fig. 2, there is shown a round-conductor ribbon cable 20 manufactured in accordance with the present invention and comprising electrical conductors 21 enveloped in a coating of insulation 22. Ribbon cable 20 may be made by an

extrusion process whereby continuous lengths of conductors 21 are conveyed through a die which forms the insulation layer 22 in any desired cross-sectional configuration. Preferably, the conductors 21 are arranged in parallel side-by-side relationship, uniformly separated by webs of insulation 23 which have a thickness no more than that required to maintain the cable 20 as a unitary structure in handling and in use. Formed in the webs of insulation 23 are grooves 24 positioned in close proximity to one of the pair of conductors 21 between which each web 23 is formed. The grooves 24 permit manual or machine separation of the cable 20 into preselected conductor groupings, and additionally, they facilitate termination of the cable 20 without preparation, in a manner which will, hereinafter, be described in greater detail.

Referring now to Fig. 3, a portion of the cable 20 shown in Fig. 2 is disclosed in association with an insulation displacement type connector, designated generally by the reference numeral 30. The connector 30 includes a rigid dielectric housing 31 into which are fitted a plurality of metal insulation displacement type terminals 32. Each terminal 32 is formed with a slotted V-shaped edge portion 33 adapted to receive an individual conductor 21. Molded

integrally with the housing 31 and extending to a position immediately above the terminals 32 are a plurality of strain reliefs 35 configured with angled surfaces 36 which serve to guide the individual conductors 21 into position over their respective mating terminals 32. The strain reliefs 35 also serve to retain the conductors 21, within the slotted terminals 32 after termination. Because of their somewhat pointed configuration, the strain reliefs 35 initiate the severing of the ribbon cable webs 23 upon moving the cable towards the connector 30 in order to effect termination.

Turning now to Fig. 4, there is shown an alternative embodiment of the present invention in which a ribbon cable, designated generally by the reference numeral 40, is provided with web grooves 44 immediately adjacent to both sides of the individual conductors 41. As a result of the dual groove construction and, as best shown in Fig. 5, upon termination of the cable 40 to an insulation displacement connector 30, the webs 43 sever completely away from the conductors 41 in a flap-like manner for a suitable distance from the cable end or along an intermediate portion (not shown) of the cable 40. By this arrangement, the cable conductors 41 become, in effect, the equivalent of

discrete insulated wires, and they can be terminated with relatively uniform severing of their insulation covering by the edge portions 33 of the terminals 32.

Upon termination of the ribbon cable 20 of Fig. 2, as best shown in Fig. 3, the cable 20 severs at each of the grooves 24 formed between adjacent pairs of conductors 21 as a result of piercing action imposed on the webs 23 by the pointed strain reliefs 35 of the connector housing 31. As the cable conductors 21 are further forced into the terminals 32 of the connector 30, they rotate about their longitudinal axes due to the pivotal interaction of the webs 23 with the surfaces 33 of the terminals 32 and of the surfaces 36 of the strain reliefs 35. By the rotation of the conductors 21, the webs 23 are caused to trail the conductors 21 into the terminals 32 as final termination is achieved. Accordingly, the webs 23 do not interfere with the displacement of the insulation layer 22 adjacent the conductors 21 by the terminal edge surfaces 33. Additionally, there is no overpacking of the opposed terminal edges 33 with web insulation, thus avoiding the tendency for excess web insulation 23 to withdraw the conductors 21 from seated relationship with the terminals 32 as a result of the latent resiliency

of the insulation 22. Upon termination of the alternative cable 40 of Fig. 4, as best shown in Fig. 5, the cable 40 severs at each of the grooves 44 formed at the juncture of the webs 43 with the conductors 41 as a result of piercing action imposed by the strain reliefs 35. After severance, the webs 43 completely dissociate from between the conductors 41 and will not enter the region of the opposed edges 33 of the connector terminals 32.

The grooves 24 and 44 are so configured and located as to permit severing of the webs 23 and 43 respectively, without exposing the conductors 21 and 41 to the environment or reducing the dielectric properties of the cable 20, 40. Also, the grooves are configured and positioned such that the conductors 21 and 41 have a substantially uniform thickness of insulation 22 and 42, respectively, after severance of the webs. In this manner, the cable 20 and 40 may be separated along its entire length to provide a cable of lesser width without reducing the dielectric properties of the cable as a result of excessive thinness of the insulative covering 22, 42 along the edges of the resultant cable. Additionally, the cables 20 and 40 do not require preparation, in order to effect termination at any position along a cable span. Accordingly,

the cable user is not limited to placement of connectors only at cable sections which have been prepared by the cable manufacturer.

CLAIMS:

1. A generally flat electrical ribbon cable including a plurality of parallel, spaced-apart electrical conductors (21 or 41), each of said conductors being embedded in a continuous generally planar layer of insulation having a plurality of webs (23 or 43) integrally formed between said conductors, said webs each having groove means running lengthwise of said conductors characterized by said groove means including at least one groove (24 or 44) being formed proximate and adjacent to one of said conductors (21 or 41).

2. The ribbon cable of claim 1 wherein said groove (24 or 44) is configured as to permit severance of said web from said conductor (21 or 41) in a manner such that said conductor retains a substantially uniform coating (22 or 42) of insulation around its circumference.

3. The ribbon cable of claim 1 wherein said groove means has a second groove (44) running lengthwise of said conductors (41) and said second groove is formed proximate and adjacent to the other of said conductors (41) between which said webs (43) are formed.

4. The ribbon cable of claim 3 wherein said grooves (44) are configured as to permit severance

of said web (43) from said conductors (41) in a manner such that said conductors (41) retain a substantially uniform coating (42) of insulation around their circumference.

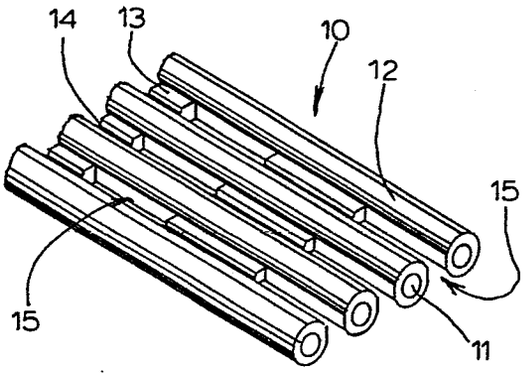

FIG.1
PRIOR ART

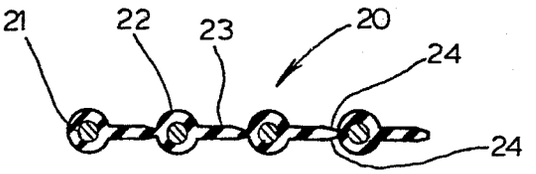

FIG. 2

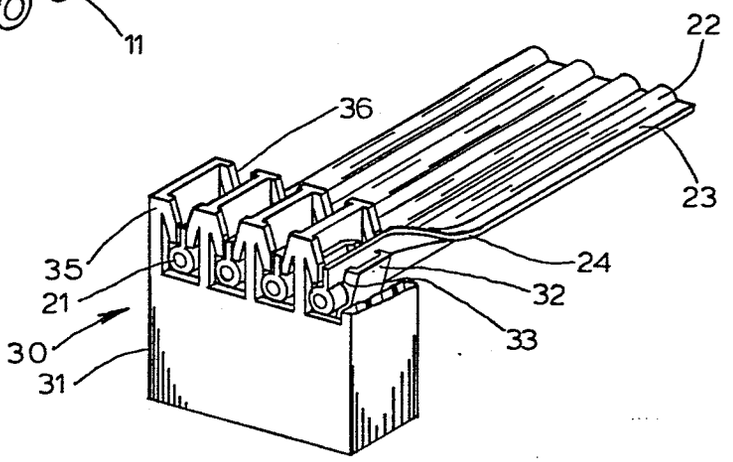

FIG.3

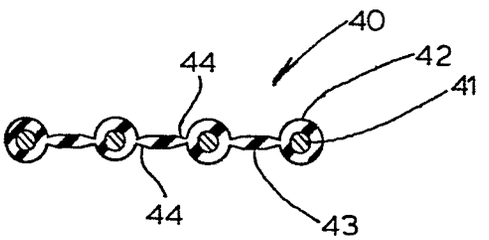

FIG.4

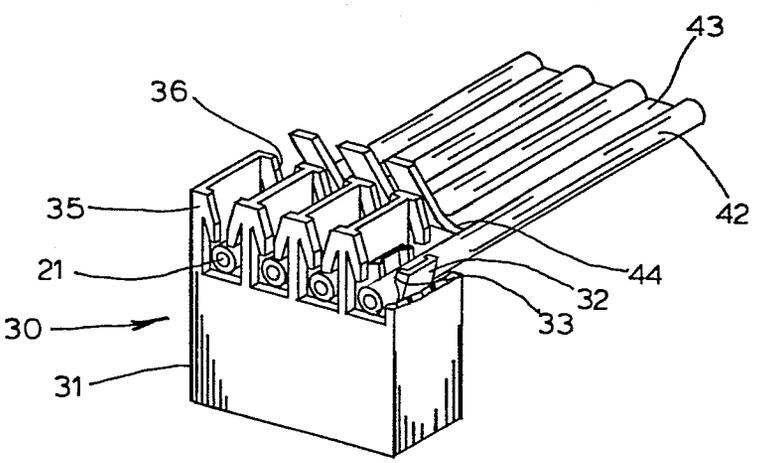

FIG.5