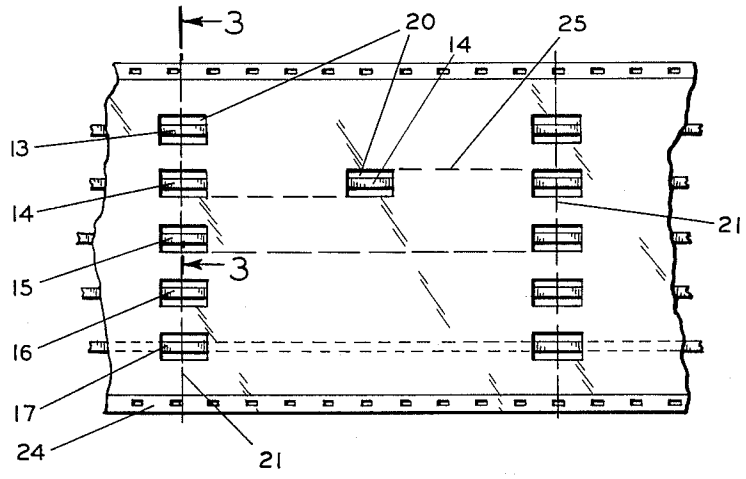
March 15, 1966 E. L. LOVE 3,239,916

RIBBON CABLE

Filed Oct. 17, 1962 2 Sheets-Sheet 1

FIG. 1



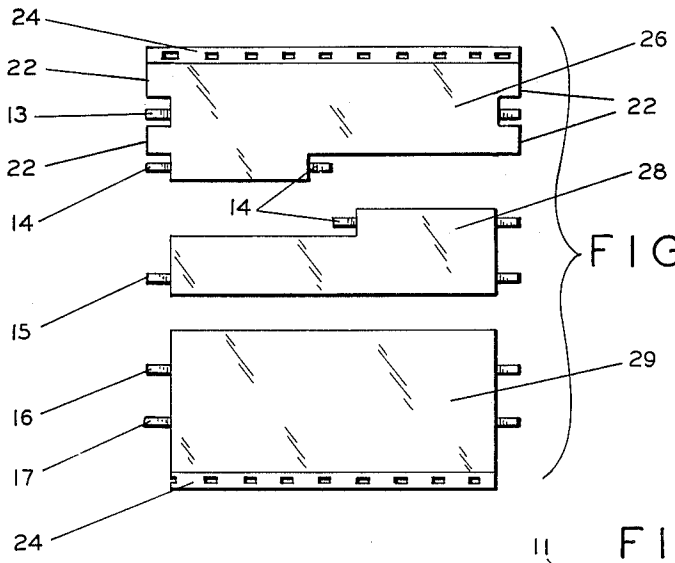


FIG. 2

FIG. 3

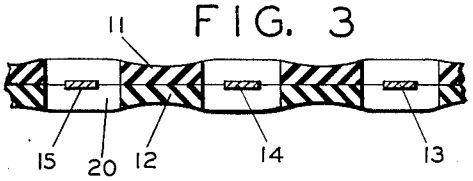


FIG. 4

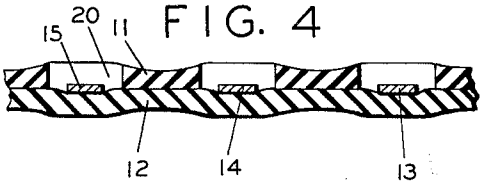


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FIG. 5

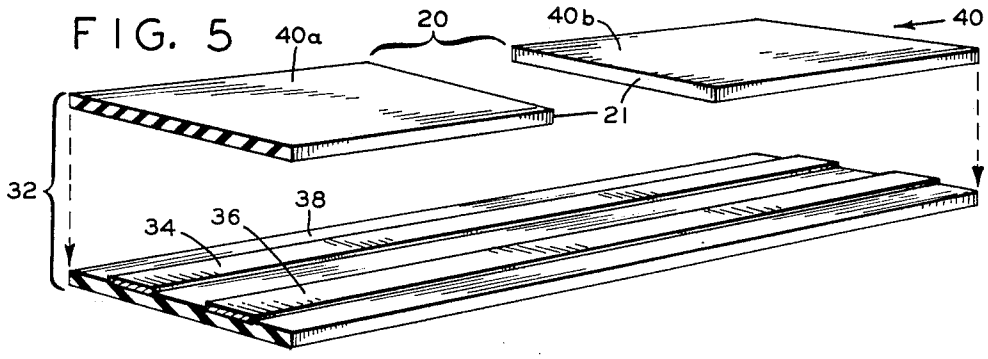


FIG. 6

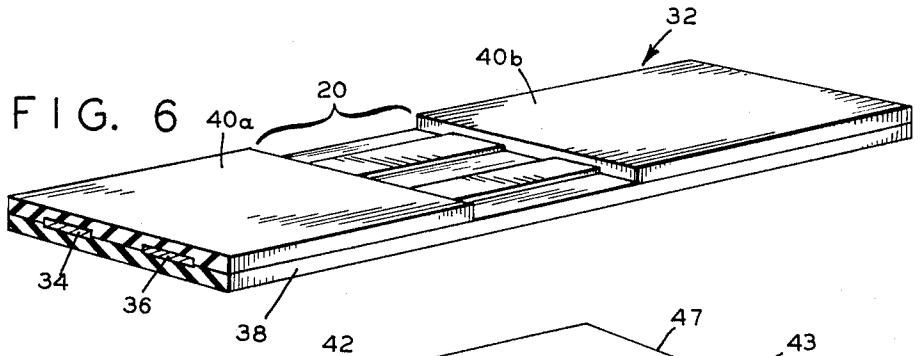


FIG. 7

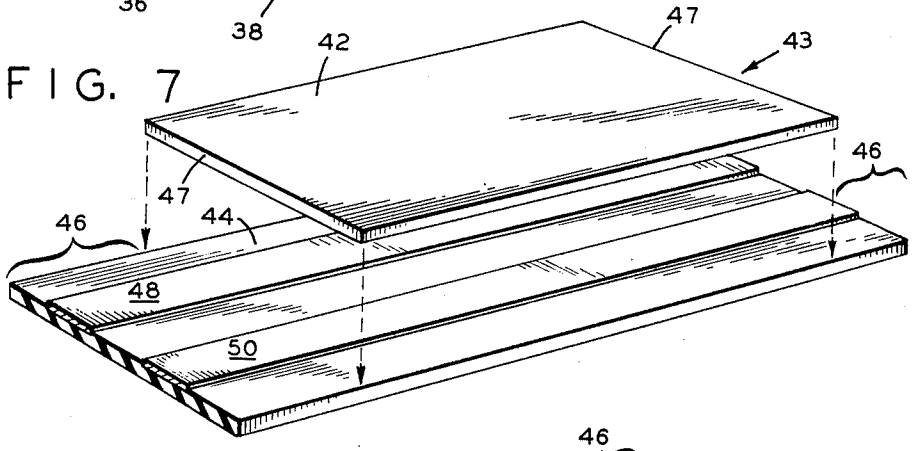
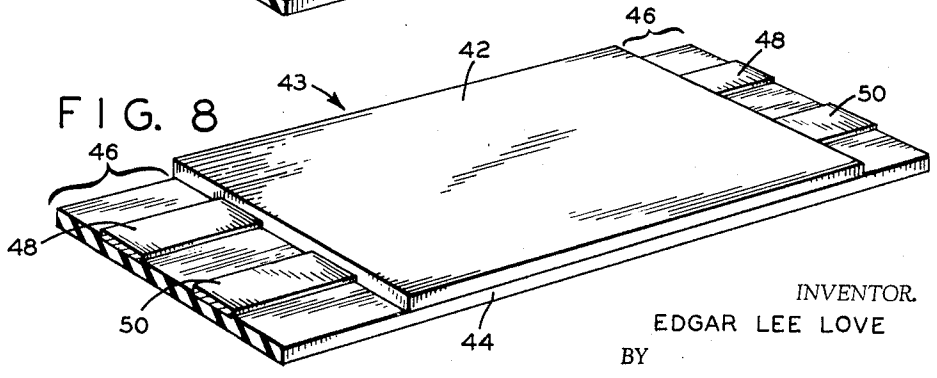


FIG. 8



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3,239,916

RIBBON CABLE

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5 Claims. (Cl. 29—155.5)

This application is a continuation-in-part of my copending application Serial No. 88,861, filed February 13, 1961, now abandoned.

This invention relates to flat or ribbon cable and more particularly, to a unique construction for ribbon cable which may be cut at predetermined lengths to produce cable segments with conductor portions automatically stripped of insulation.

Flat, or "ribbon" cable as it is more commonly called, has recently become extremely popular. It is relatively easy to install and has good load capacity, good heat dissipation and is easily shielded electrically from other units.

Ribbon cable originally came into existence as an outgrowth of printed circuitry. The original manufacturing technique involved the printing of parallel lines of copper upon thin rigid plastic sheets or strips. This technique eventually advanced to the sandwiching of flat conductor material, such as copper, silver, aluminum or the like, between continuous lengths of flexible tape. The tape generally consisted of an insulating plastic such as a polyester, a polyamide, a polyhaloalkane or alkene.

In making connections with such ribbon cables, short lengths were cut from the supply roll as needed and the insulation was stripped from the ends. Unfortunately, it was difficult to strip the insulation from the ends or intermediate regions of the thin flat conductors, particularly from only one side of the ribbon cable as required for junctions with many types of connector units. Complicated cutting and stripping techniques were required. In addition, damage to the conductor frequently occurred.

The introduction of insulation piercing connectors overcame some of these problems, but these connectors were expensive and frequently unsuitable for use in many important applications. Until the discovery of the invention disclosed herein, the demand for ribbon cable constructed to facilitate easy connection has not been satisfactorily met.

Accordingly, an object of this invention is to provide ribbon cable which is easy to install.

A further object of this invention is to provide ribbon cable of the above character which, when cut in predetermined lengths or configurations, produces modular cable units of any desired shape or configuration having conductor portions stripped of insulation on one or both sides.

A still further object of this invention is to provide ribbon cable of the above character which can be easily connected to electrical components or to other ribbon cable, even at points intermediate its ends.

Another object of this invention is to provide a unique method of making ribbon cable having the aforementioned features.

Another object is to provide ribbon cable of the above character having indexing means thereon which facilitates the automatic operation of appropriately designed cable shearing apparatus.

A further object of the invention is to provide long continuous ribbon cable adapted for convenient shearing into predetermined modular lengths and configurations of ribbon cable units, each having conductive portions stripped of insulation and ready for connection when the shearing operation is completed.

Another object of the invention is to provide ribbon cable of the above character having continuous and uninterrupted conductor-supporting portions of the insulating layers adjacent to the exposed portions of the conductors to provide continuous longitudinal support for the conductors.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the article possessing the features, properties, and the relation of elements, which are exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a fragmentary top view of a preferred embodiment of the ribbon cable of this invention;

FIGURE 2 is a top view of three cut lengths as indicated by the dotted lines superimposed on the ribbon cable shown in FIGURE 1;

FIGURE 3 is a greatly enlarged transverse sectional view of one embodiment of the ribbon cable, taken along line 3—3 of FIGURE 1;

FIGURE 4 is a similar sectional view of a modified embodiment of the invention similar to the embodiment shown in FIGURES 1–3;

FIGURES 5 and 6 are fragmentary perspective views of a length of ribbon cable incorporating a modified embodiment of the invention, with FIGURE 5 being an exploded view showing this embodiment during the fabrication process, and FIGURE 6 showing the same embodiment in its assembled condition following fabrication; and,

FIGURES 7 and 8 are similar fragmentary perspective views showing another embodiment of the invention, with FIGURE 7 being an exploded view showing this embodiment during the fabrication process, and FIGURE 8 showing this embodiment in its assembled condition following fabrication.

Similar reference characters refer to similar parts throughout the several views of the drawings.

The ribbon assembly illustrated comprises a bonded sandwich construction having a top layer and a bottom layer of insulating tape, and an intermediate layer of one or more flat conductors sandwiched between the bonded top and bottom insulating layers. At least one layer of the insulating tape has been perforated or apertured at predetermind points across its width and length. The flat conductors span the perforations or apertures longitudinally. In assembled form, the novel ribbon cable of FIGURE 1 has a multiperforated ribbon appearance with a portion of a conductor exposed at each perforation. The arrangement of the perforations in the modular pattern shown or in other patterns also constitutes an important feature of this invention, as will presently be described in detail.

By cutting the ribbon cable transversely across its aperture perforations, lengths of single or multiconductor cable with ends stripped of insulation can be formed. And with proper longitudinal cutting in accord with a predetermined modular pattern of perforations in the ribbon cable, either stepped or uniform lengths of multiconductor cable can be produced which are useful for certain specific applications.

In the event that only one layer of insulation has been perforated, as shown in FIGURES 4–8, the cut lengths will have ends with only one side of the flat conductor exposed, and such one-sided exposure is desirable for certain applications.

Since the cut lengths have stripped ends, they are immediately ready for use in making connections. Tedious

stripping operations, incomplete stripping and risk of damage to the conductor are all avoided.

Furthermore, with incorporation of an indexing strip or control tape **24** (FIGURES 1 and 2) into the body of or adjacent to one or both edges of the ribbon cable, automatic shearing or cutting can be effected by mechanically or electronically controlled shearing apparatus. The incorporated control tape governs the operation of the shearing mechanism.

Referring particularly to FIGURE 3, the ribbon cable of this invention includes an upper layer **11** and a lower layer **12** of insulating tape. The tape used should have a width appropriate to the number of flat conductors actually used. Its insulating characteristics should satisfy the needs to which the cable will be put. Generally a highly insulating plastic of a polyester, a polyamide, a polyalkane or similar polymeric material will be satisfactory. However, other insulating material such as rubber, fabric, asbestos, flexible mica and the like might also be used. The tape layers with the conductors therebetween are generally bonded together by heat sealing or by an adhesive.

If desired, shielding layers, armor layers, heat resistant layers or other functioning layers may be superimposed upon the insulating tape, either before or after forming the ribbon cable.

Sandwiched between the insulating tape are flat conductors **13, 14, 15, 16,** and **17** (five being shown in the embodiment illustrated in FIGURE 1). The type, the number of strips, the width, the thickness or the flatness of conductive material is dependent upon the requirements of the user. Generally copper, silver or aluminum will be used as the conductive material.

Prior to lamination or sandwiching of the tape and the conductors into a ribbon cables, either the bottom or the top layer of tape or both, and any additional outer layers that may be superimposed thereon, are apertured or perforated at predetermined points or locations across the width and length of the tape. If both layers are perforated, the perforations may coincide if desired.

In the embodiment shown in FIGURES 1 and 3, the top and bottom insulating tapes incorporate coinciding aperture perforations **20,** in alternate transverse columns of 5 and 1. This modular pattern permits cutting or shearing, as indicated by the dotted lines **21** and **25** into cut lengths of ribbon cable having the stepped configurations shown in FIGURE 2. It should be particularly noted that the cut ribbon cable has insulation-bare ends. Thus, stripping is not necessary.

When only one layer of tape has been perforated, the ends are bare on one side only. As indicated above, such one-sided stripping is frequently desirable in certain specific applications. In particular, where thin foil or vapor deposited metal layers form the conductor strips sandwiched in the ribbon cable, these thin metallic strips require continuous support throughout their length. Underlying support for the thin conductor strips is provided in the embodiments of FIGURES 4 through 8 by a continuous longitudinal underlying layer of insulating material which is not interrupted by apertures. With thicker conductive strips, such as the conductors illustrated in FIGURE 1, intermediate webs of insulating material spaced between the aperture perforations **20** provide the necessary continuous conductor support adjacent the conductors and between the aperture perforations, as shown in FIGURE 3.

Thus in all embodiments of the present invention, continuous longitudinal conductor support is provided either by underlying portions of the insulating layer directly supporting the conductive strip, as shown in FIGURES 4–8, or by adjacent intervening webs spaced between individual aperture perforations in one or both of the insulating layers.

The perforations are preferably rectangular in shape with the long axis in the longitudinal direction of the ribbon, permitting transverse severing along the short axes of the rectangles, such as the lines **21** of FIGURE 1, leaving pre-stripped exposed regions of the conductive elements of sufficient size for convenient connection purposes. Other aperture shapes, such as round, oval or square are obviously also possible. The rectangular configuration has the greatest use and provides the most scrap-free, trim looking appearance.

In the embodiment shown in FIGURE 1 of the drawing, simple staggered positioning of the cutters transversely across the ribbon will cut short lengths of cable ready for immediate use. If a straight cutting edge is used, further "trim" cutting of the tab portions **22** (shown by dashed lines in FIGURE 2) may be performed if desired to eliminate these tab portions. And if longitudinally disposed cutters are simultaneously or subsequently used to make cuts, as illustrated by the dotted lines **25,** the cable will be divided into short narrow lengths **26, 28, 29.** The cut lengths, as shown in FIGURE 2, may have a stepped configuration with bare conductor ends **14** extending from the "riser" portions of the steps. Such cut lengths have particular utility in high-speed production assembly of electrical and electronic equipment.

The particular modular arrangement of aperture perforations and the manner of cutting governs the shape of the cut ribbon segments produced. Obviously there are innumerable patterns which can be produced using this technique, and the particular pattern will be governed by the dictates of the user. A unique method has thus been provided for making cut lengths of ribbon cable ready in any desired length or configuration for immediate use in making connections.

An added feature in the ribbon cable of FIGURES 1 and 2 provides timing means for automatic shearing. To accomplish this, an indexing tape is incorporated into the ribbon structure. In the preferred embodiment, the indexing tape consists of two outer perforated edges **24,** similar in appearance to the outer edges of motion picture film. The perforated edges, when passed over a sprocket wheel in a punch or shear press, actuate the press. Upon a predetermined number of turns of the sprocket wheel, the press automatically shears predetermined lengths and even widths of cable from the supply length. If desired, the indexing tape may be designed to operate an electronically actuated punch or shear press.

Segments of ribbon cables in which the apertures extend across a plurality of adjacent flat conductor strips are shown in FIGURES 5, 6, 7 and 8.

In the embodiment of the invention illustrated in FIGURES 5 and 6, a ribbon cable assembly **32** is constructed of two flat conductor strips **34** and **36** sandwiched between two bonded insulating layers **38** and **40.**

In the ribbon cable segment shown in FIGURE 5, the aperture **20** is positioned at an intemediate point along the length of the cable **32.** The adjacent flat conductors **34** and **36** are positioned side by side on the face of the lower insulating layer **38.** The upper insulating layer **40,** comprising segments **40*a*** and **40*b*** separated by a transverse aperture **20,** is shown ready to be lowered into its final position in the sandwiched ribbon cable of FIGURE 6. This completed cable affords convenient access to the plurality of conductors at the intermediate aperture **20,** while the lower insulation layer **38** provides a substantial supporting substrate for the conductors across the width of the aperture **20.**

These portions of the insulating layer flanking the transverse aperture **20** may be individually positioned and bonded in the assembled form shown in FIGURE 6. Alternatively, an unbonded segment of the upper insulating layer **40** defined by the edges **21** may remain joining the segments **40*a*** and **40*b*** in their original condition, with scorelines being formed along the edges **21.** In this case heat or adhesive is omitted over the segment between the edge scorelines **21,** which is thus not bonded

to the lower insulating layer **38** during fabrication. The omission of heat or adhesive bonding permits this segment of the insulating layer **40** to remain in its assembled position until stripping of this insulating layer is desired, at which time it may be peeled back and separated along the scorelines **21** from the segments **40***a* and **40***b* to produce the transverse aperture **20**, as shown in FIGURE 6, permitting electrical connections to the two conductors **34** and **36** at the transverse aperture **20**.

In the embodiment of the invention shown in FIGURES 7 and 8, a ribbon cable assembly **43** is formed from an upper insulating layer **42** bonded to a lower insulating layer **44**, with two conductor strips **48** and **50** sandwiched side-by-side between the insulating layers **42** and **44**.

In this embodiment, the upper insulating layer **42** is shorter than the lower insulating layer **44**, leaving transverse apertures in the form of stripped end regions **46** at both ends of the assembled ribbon cable segment **43** exposing the upper sides of both conductor strips **48** and **50** at both ends of this segment.

In the embodiments of the invention illustrated in FIGURES 4–8, it will be noted that the underlying insulating layer of the ribbon cable provides continuous and uninterrupted support for the conductive strips throughout the full length of the apertures in the upper insulating layers. This continuous support is particularly useful with extremely thin conductive coatings or layers, such as those formed by vacuum vapor deposition, selective etching, or similar techniques.

The ribbon cables of FIGURES 4–8 may be separated transversely across these aperture perforations **20** or **46** to provide modular cable segments of any predetermined shape, length, or configuration, as shown in FIGURE 2. If desired, however, the ribbon cables may be separated at points spaced away from the transverse apertures, as indicated in FIGURES 5 and 6, leaving one or more apertures spaced along the length of the segment for intermediate terminal connection purposes. The apertures passing through only one insulating layer thus provide a novel and economical solution to the major problem of stripping one insulated side of ribbon cable conductors, as required for connection to many types of terminal connectors, for example.

The shearing steps and timing perforations described with reference to FIGURES 1 and 2 are also useful with the ribbon cables shown in FIGURES 5–8, affording the advantages of modular dimensioning and automatic production of predetermined lengths and configurations of flat ribbon cables with any desired number of conductors sandwiched therein.

The particular ribbon cable structure shown in the drawings accomplishes all of the objects enumerated above. The unique structures shown permit the cutting of a supply roll of ribbon cable into cut predetermined lengths and widths, with conductor regions free of insulation and ready for connection to other elements. If an indexing tape means **24** has been incorporated into the supply length of ribbon cable, the cutting can be accomplished automatically. No tedious stripping of the ends need be performed. Faulty connections and conduction losses caused by incomplete stripping no longer present a problem.

Furthermore, with the uninterrupted underlying support for the thin conductor strips or layers which is provided by the underlying insulating layers of the embodiments illustrated in FIGURES 4–8, these prestripped and severed modular cable units may be employed with very thin ribbon cables incorporating extremely thin conductor elements. The techniques of this invention thus provide a unique new way of fabricating ribbon cable segments of any desired length, shape and configuration, automatically prestripped of insulation and ready for connection to other electrical components.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in carrying out the above method and in the construction set forth without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of producing relatively short lengths of insulated strip conductor from a supply strip of ribbon cable having at least two conductive strips laminated side by side in spaced relationship between two outer insulating layers, comprising the steps of

(A) forming apertures in one layer of said insulating material prior to lamination in registration with said conductive strips in a pattern of predetermined locations along the length of said ribbon cable to expose regions of said conductive strips after lamination,

(B) while maintaining the uninterrupted longitudinal continuity of at least a portion of the other insulating layer adjacent each said conductive strip,

(C) laminating said insulating layers together with said conductive strips disposed therebetween,

(D) and subsequently shearing the resulting laminated ribbon cable transversely and across at least one of said apertures to produce self-supporting multiple-conductor segments of predetermined length and configuration having prestripped insulation-free terminal connection regions thereon.

2. The method defined in claim **1** in which said apertures in said one insulating layer are individually formed each in registration with one of said conductive strips, and laterally spaced apart by longitudinally extending web portions of at least one said insulating layer, providing continuous longitudinal support for said conductive strips in the segments produced by said severing step.

3. The method defined in claim **2** in which coinciding apertures and coinciding webs are formed in both of said insulating layers, whereby both sides of said conductive strips are exposed without insulation at said apertures to provide prestripped conductor segments after said severing step.

4. The method of producing relatively short lengths of insulated strip conductor from a supply strip of ribbon cable having at least two conductive strips laminated side by side in spaced relationship between two outer insulating layers, comprising the steps of

(A) forming apertures in one layer of said insulating material prior to lamination, said apertures being located in registration with said conductive strips and arranged in transverse patterns at predetermined locations along the length of said cable to expose regions of said conductive strips after lamination,

(B) while maintaining the uninterrupted longitudinal continuity of at least a portion of the other insulating layer adjacent each said conductive strip,

(C) laminating said insulating layers together with said conductive strips disposed therebtween,

(D) and subsequently shearing the resulting laminated ribbon cable across said patterns of apertures to produce self-supporting multiple-conductor segments of predetermined length and configuration having prestripped insulation-free terminal connection end-regions thereon.

5. The method of producing relatively short lengths of bare-ended insulated strip conductor from a supply

strip or ribbon cable having at least two conductive strips laminated side by side in spaced relationship between two outer insulating layers, the improvement comprising the steps of

(A) forming apertures in one layer of said insulating material prior to lamination in registration with said conductive strips in a pattern of predetermined locations to expose regions of said conductive strips after lamination,

(B) while maintaining the uninterrupted longitudinal continuity of the other insulating layer underlying said conductive strips at said predetermined aperture locations,

(C) laminating said insulating layers together with said conductive strips disposed therebtween,

(D) and subsequently shearing the resulting laminated ribbon cable transversely and across said apertures to produce self-supporting multiple-conductor segments of predetermined length and configuration having prestripped insulation-free terminal connection regions thereon.

References Cited by the Examiner

UNITED STATES PATENTS

782,391	2/1905	Hanson	174—72
2,964,587	12/1960	Minot	174—117

FOREIGN PATENTS

235,072	6/1925	Great Britain.
824,615	12/1959	Great Britain.

OTHER REFERENCES

Smith, "Making The Most Of Flat Cables," Electronic Design, Oct. 14, 1959, page 56.

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