

[54] **WIRE INSULATION FORMED FROM PLEATED SHEET MATERIAL AND METHOD OF MANUFACTURE**

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3,654,027 4/1972 Middleton..... 156/461 X

[75] Inventor: **John Thomas Early**, North Plainfield, N.J.

*Primary Examiner*—Charles W. Lanham  
*Assistant Examiner*—Joseph A. Walkowski  
*Attorney*—W. L. Keefauver et al.

[73] Assignee: **Bell Telephone Laboratories, Incorporated**, Murray Hill, N.J.

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[57] **ABSTRACT**

[52] U.S. Cl. .... **29/624, 29/203 C, 156/47, 156/51, 174/110 R, 174/117 F**

[51] Int. Cl. .... **H01b 13/00**

[58] Field of Search ..... 156/51-54, 257, 259, 436, 438, 461, 462, 464; 174/110 R, 110 A, 110 P, 110 AR, 110 N, 110 PN, 110 D, 110 U, 117 F, 117 FF; 156/257, 259, 436, 438, 461, 462, 464; 29/624, 631, 517, 203 C; 270/4, 5, 39, 40, 41

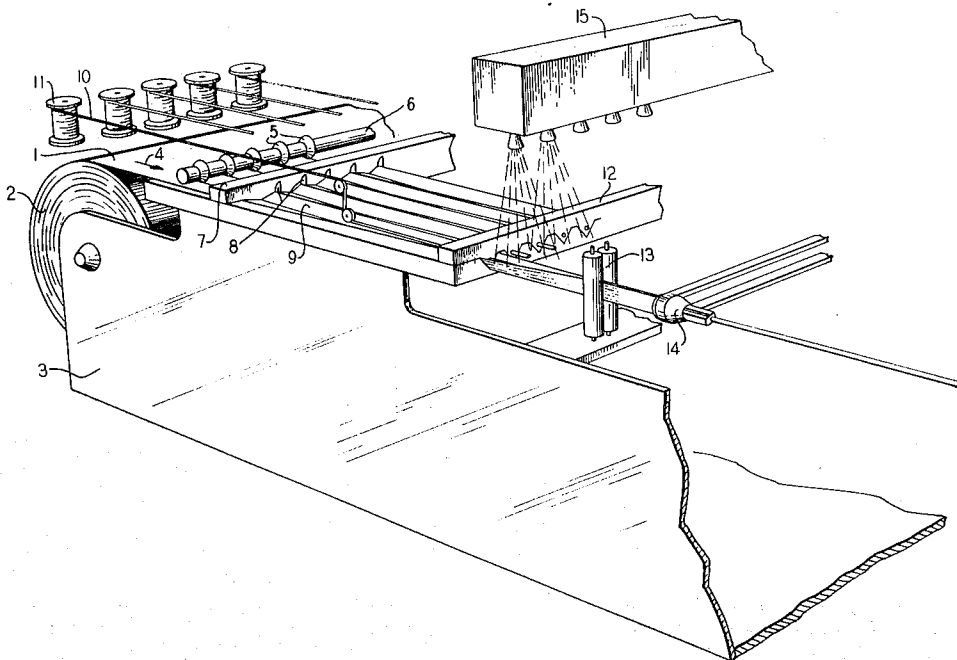
This disclosure describes process and apparatus for continuous insulating of wires in which sheet material drawn from a roll is pleated and the wires are introduced into the pleats. The pleat envelopes are severed and each assembly of wire and pleat is closed and polished. Advantageously, the sheet material is preselected for specific dielectric and structural characteristics. The sheets may also be precoated with adhesive, and also pre-color coded. The process is capable of high speed operation and produces a highly reliable product without creating air or water pollutants.

[56] **References Cited**

**UNITED STATES PATENTS**

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**11 Claims, 10 Drawing Figures**



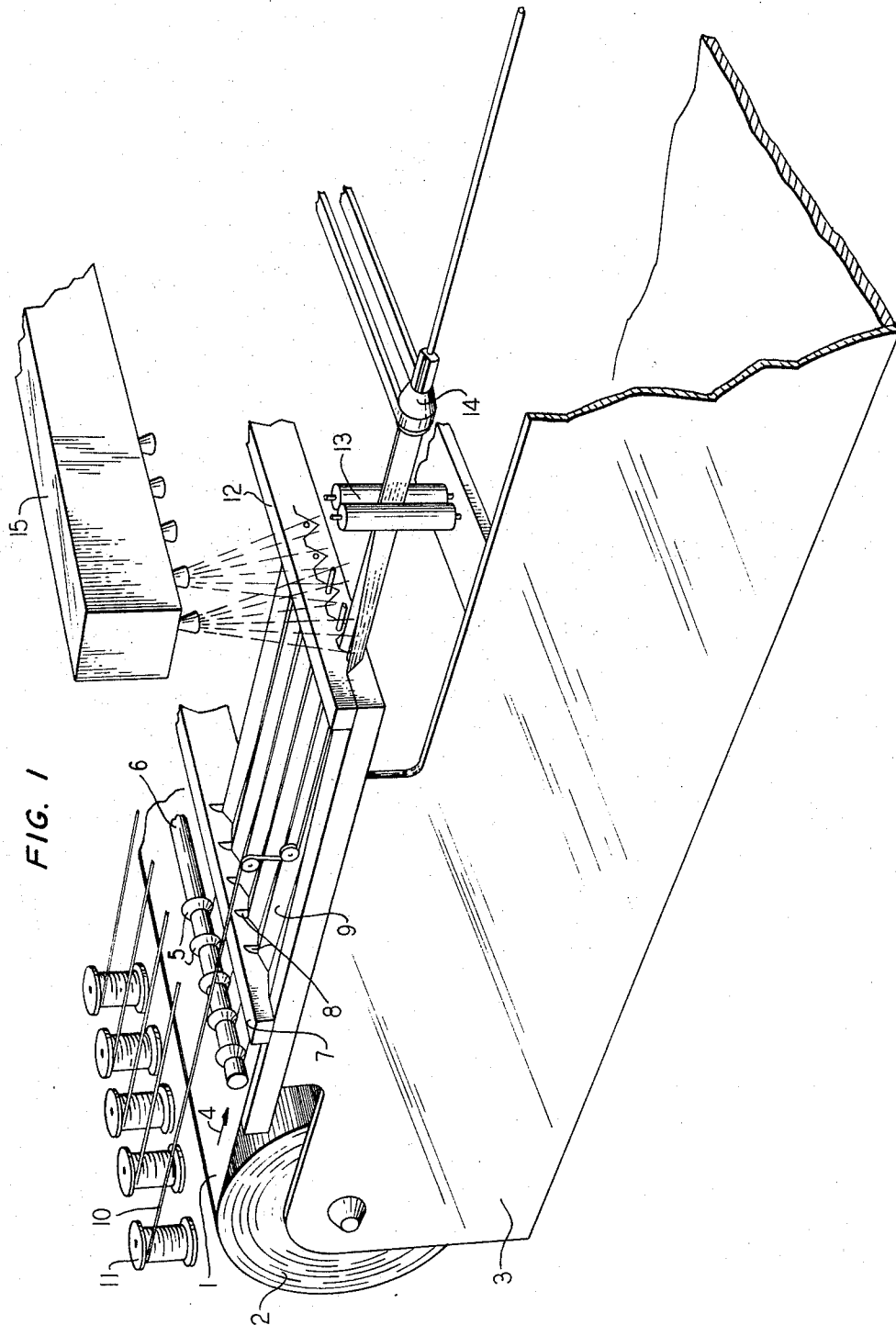


FIG. 2

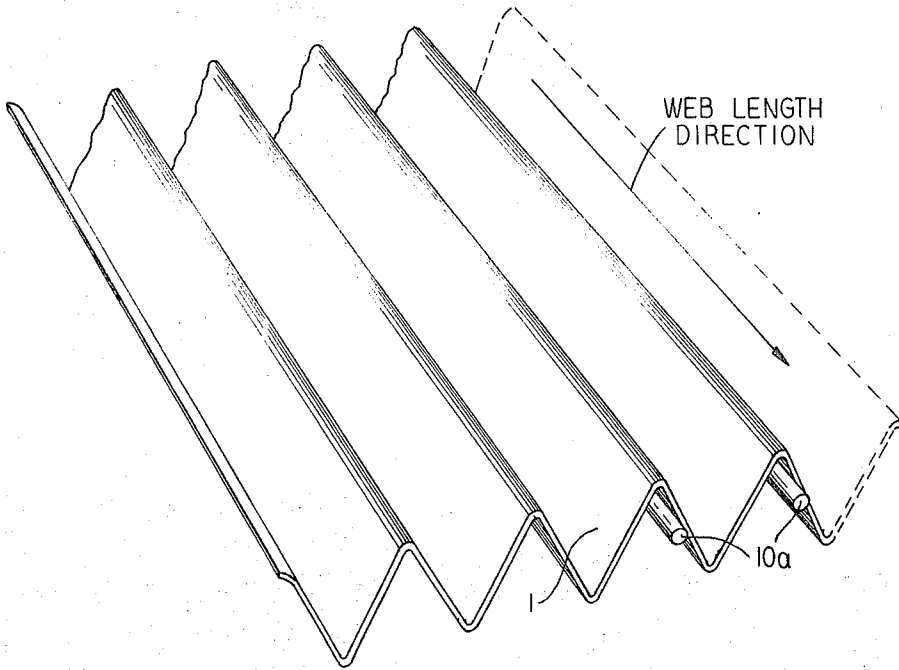


FIG. 3

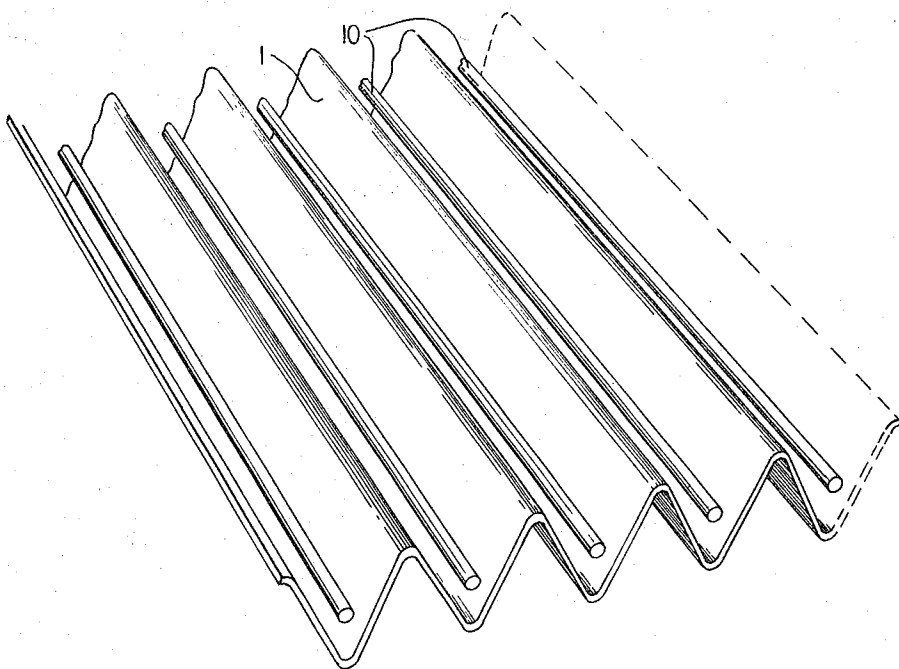


FIG. 4

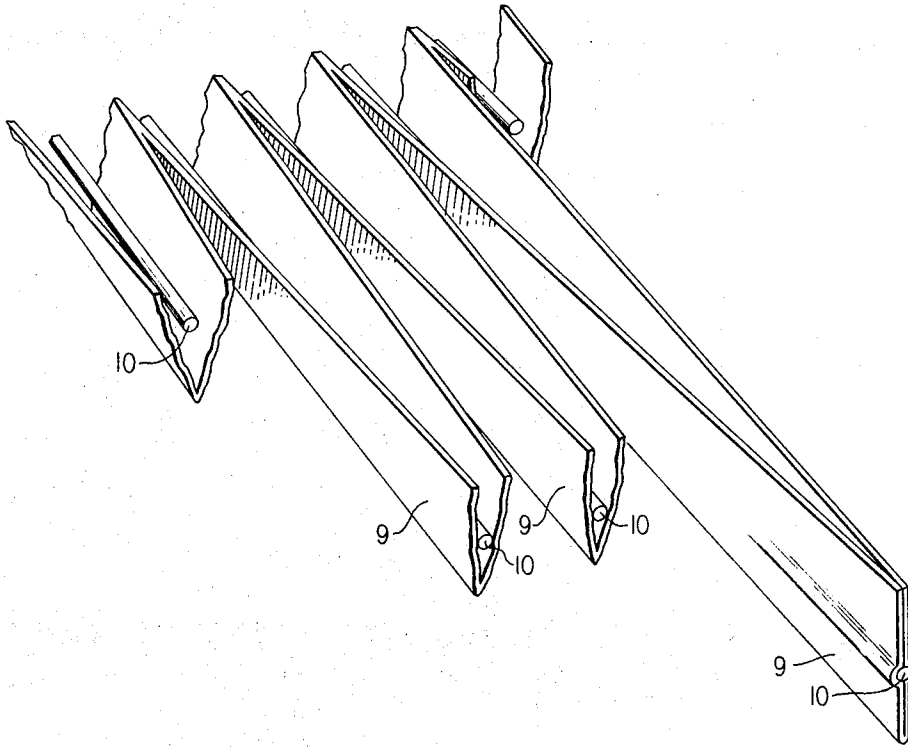


FIG. 5

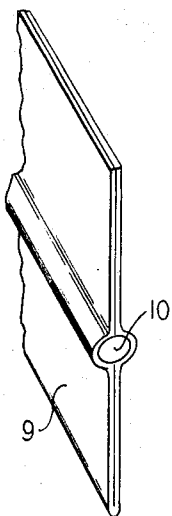


FIG. 6

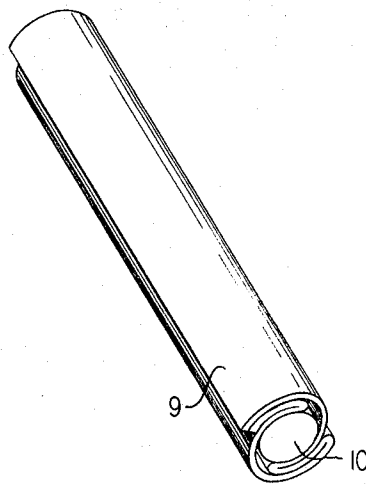
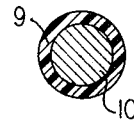
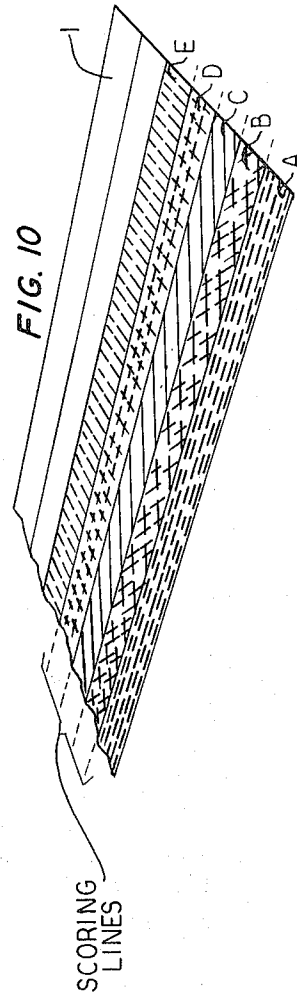
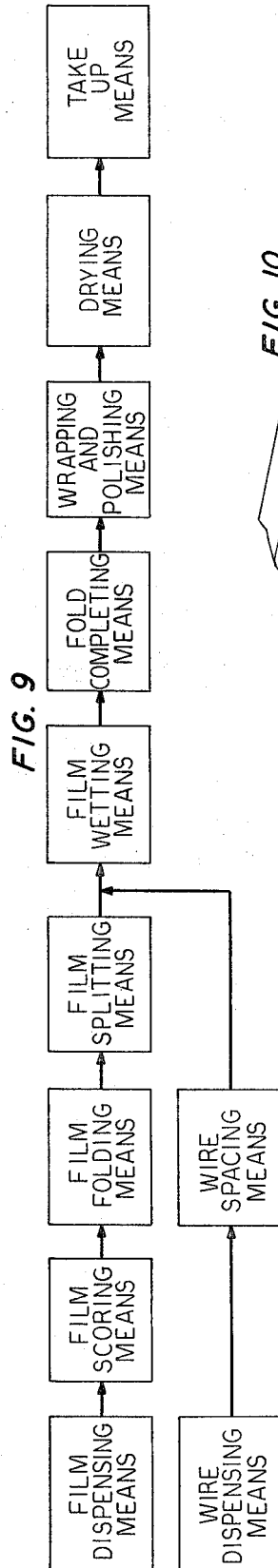
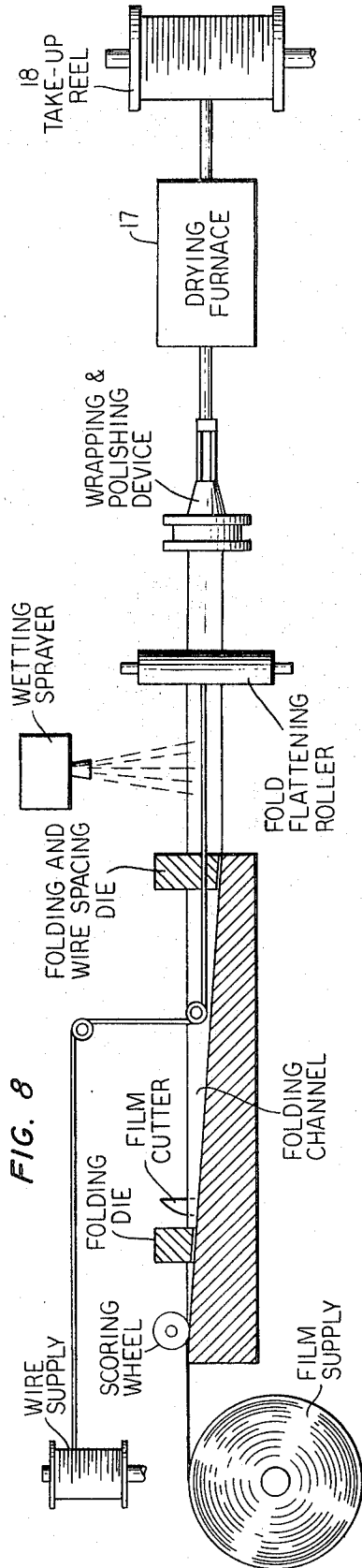


FIG. 7





# WIRE INSULATION FORMED FROM PLEATED SHEET MATERIAL AND METHOD OF MANUFACTURE

## FIELD OF THE INVENTION

This invention relates to the insulating of wires, particularly small gauge wires; and especially concerns the insulating of telephone conductors.

## BACKGROUND OF THE INVENTION

Despite the advent in recent years of thermoplastic extruded insulation, it remains the case today that a majority of exchange-area telephone cable conductor is insulated by the sulfate wood-pulp process.

Several important reasons have accounted for wood pulp's continued use. Wood pulp is hydroscopic and wet-swelling, and therefore in use provides a barrier to longitudinal flow of water that may penetrate the cable sheath. Further, pulp insulation when wet, so drastically alters the transmission characteristics of the pair in the wet region that it is relatively simple to detect the problem promptly, and to locate the water-logged portion—and hence the cable fault—by voltage breakdown tests. In contrast, plastic insulation when wet affects transmission properties only very slowly and does not swell into a water-blocking medium.

The common sulfate wood-pulp insulation process, however, has well recognized inherent process control problems relating to uniformity of insulation and coating weight, and moisture content of dried insulation. Wastage caused by defectively manufactured insulated conductor is significant despite quality control efforts and skilled process operators. Besides, unlike plastic insulation, the dielectric properties of wood pulp cause severe signal attenuation at frequencies of about 1 MHz and beyond. Because of this drawback, the high bit rate needs of video telephony and many other proposed subscriber services tend to preclude use of conventional pulp insulation, however attractive its wet-swelling properties may be.

Additionally, and importantly, powerful financial incentives exist to keep the tremendous capital investment in current pulp-insulation equipment fully utilized.

Thus, the study of wood pulp and plastic has continued in search of the best from both worlds, its objectives being substantially as stated in the following objects of my invention:

To provide an insulated telephone conductor having the favorable high frequency properties of plastic insulation and the water-fighting properties of pulp insulation;

To improve the quality of fiber conductor insulation;

To continue using present wood-pulp insulation equipment wherever possible;

To reduce the operator skill required on such equipment;

To reduce the wastage experienced in use of wood-pulp insulation equipment;

To increase the production rate per machine of such equipment; and

To overcome the limitations as to materials that are inherent in the wet-tape wood-pulp technology involving vats.

## SUMMARY OF THE INVENTION

All of the foregoing objects, and more, are achieved

in accordance with the principles of this invention, by supplying to advancing wires raw insulation in the form of sheet material folded into accordionlike pleats. Wires are inserted into the pleats continuously, the pleats are severed, and the resulting sheet material envelope that surrounds each wire is molded or polished to roundness.

Thus, the invention contemplates a payout device for feeding a web of material in tandem with the advancing wires. The wires are continuously enveloped in this material by folding the material into parallel pleats running the long direction of the web, continuously gathering the pleats, and continuously inserting conductors into the pleat interstices. The pleats are cut apart, smoothed and, if necessary, wetted. Thereafter, the pleats are passed through polishing heads to wrap the tabs around the conductor as is done in conventional sulfate wood-pulp insulation polishing.

One feature of the invention is the use of any insulative sheet material as a starting point in a wire insulating line which need not be changed equipment-wise when the sheet material is changed.

A further feature of the invention is use of precolor coded sheet material to supply conductor color coding.

A further feature of the inventive process is the step of pleating an advancing sheet to create slots or envelopes to receive advancing wires, and then severing the sheets to provide one envelope per wire.

The invention and its further objects, features, and advantages will be readily apprehended from a reading of the detailed description to follow of illustrative embodiments.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side schematic perspective diagram showing the inventive process;

FIGS. 2-7 are schematic diagrams illustrating in stages the structures used to produce the inventive result;

FIGS. 8 and 9 are a schematic flow diagram and a schematic block process diagram respectively further illustrating the invention; and

FIG. 10 is a color code version.

## DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

FIG. 1 shows apparatus for practicing the invention. A flat sheet of insulating material 1 from a source such as roll 2 mounted on chassis 3 is advanced in the direction of arrow 4 by means not shown. First, sheet 1 is scored at spaced intervals by the scoring wheels 5 mounted on shaft 6. Next, the advancing sheet 4 enters a folding die 7, which places a wide-angled pleat pattern across the entire sheet face, by cooperation of the die 7 with mating surfaces therebeneath, not shown.

After the pleats are begun, sheet-cutting knives 8 slice the advancing sheet at the top of each pleat fold to produce a series of advancing bottom-pleated strips 9. Wires such as the substantially round wire 10 depicted in FIG. 7 from reels 11 are led into the envelope of each pleated strip 9. The wires 10 are advanced in the direction of arrow 4 and at the same rate as the pleated strips 9. The pleated strips 9 and wires 10 are fed through the folding and wire spacing die 12, where each wire 10 is positioned, for example, about midway within the pleat envelope, that is, into a central region

of the envelope. Each pleat envelope on exiting from die 12 is formed as a well-defined V-shape.

Thereafter, each pleated strip 9 and its respective wire 10 are fed through a fold flattening roller 13 and thence to a conventional wrapping and polishing head 14. A wetting spray from sprayer 15 may be applied to the strip 9 before it enters the roller 13. Wetting at this point with a solution such as soap and water serves the purpose of softening the paper and making it self-adherent on drying.

From the polishing head, each insulative wire—which now has the shape depicted in FIGS. 6 and 7—is dried in furnace 17 and stored on a takeup reel 18 shown in FIG. 8.

In a further embodiment, the wires 10 are precoated with an adhesive such as polyvinyl alcohol-acetate or an acrylic latex to cause the pleat envelope to adhere to the wire and thus stabilize the configuration. In a further variation, the adhesive can be activated by the liquid applied by the wetting sprayer 15. Alternatively, the adhesive can be solvent activated, pressure activated, or heat activated; or can be applied to the paper raw material if desired.

It can be appreciated that the invention in its broadest aspect contemplates the forming of a pleated sheet structure such as shown in FIG. 2, introduction of wire into the pleat envelopes either before or after cutting, then cutting of the sheet into advancing pleated strips as in FIG. 4, closing of each pleat as shown in FIG. 5, and polishing or otherwise dressing the closed pleat to produce the structure shown in FIGS. 6 and 7. The entire process is illustrated further in the schematic apparatus diagram of FIG. 8 and a flow chart of FIG. 9.

It will be seen that of the standard wood-pulp insulation equipment, the conductor payout stands, polishing units, drying ovens and insulated conductor takeup capstans are retained in the inventive process as illustrated above.

Advantageously, use in the inventive process of any preformed insulation web assures a uniform insulation covering on each wire, thus substantially reducing the wastage in manufacture.

Of primary significance is that, as a result of the inventive process, materials other than paper may be used. These include nonwoven fabrics, synthetic paper, preformed webs, fabrics of various types, film, or foil. Many material candidates from this wide assortment have been known to possess intriguing conductor insulation properties, but for want of a viable application process have not found much use.

In a particular embodiment of the invention 0.002-inch-thick paper approximately 15 pounds per 3,000 square foot basis weight, is used to produce 60 parallel separate conductors insulated with approximately a 0.006-inch-thick paper insulation creating a 0.020-inch diameter conductor.

The advantages of sheet material preselection are illustrated by reference to the following examples in the below table.

Sheet Material	Trade Name	Desirable Insulation Properties
Fire retardant nylon fiber web	Nomex (E.I. du Pont)	Will not burn— inert
Polyester fiber web	Remay (E.I. du Pont)	Very low density— low dielectric constant
Polypropylene fiber material	Polypropylene nonwoven fiber	Extremely low dielectric constant

Polyester film

Kapton (3M)

Very strong— high dielectric strength

The insulation as applied in the inventive process can be arbitrarily strong, tough and abrasion resistant since the insulation is preselected on the basis of whatever properties are desired and during the process the material does not undergo any changes.

Although only one form of pleat—namely the accordion pleat—has been shown, there are other useful forms of pleats such as a star or a cross-shaped pleat.

It is not necessary that the wires 10 be stationed in the troth of the pleats as shown in FIG. 3. Rather, it may be desirable to station them within the roof of pleats as is illustrated by the wired 10a in FIG. 2.

The above-described process enjoys advantages over helical-wrapped insulating and also over the single conductor axial wrapping processes. These two other processes require slitting the sheet material into narrow tapes and individual rolls prepared, before the tape can be applied to the wire. In contrast, the pleat insulation process of the present invention does not require the narrow width paper to begin with.

FIG. 10 shows an example of a preprinted sheet 1 with regions A-E defined between scoring lines made by the scoring wheel. Each of the regions is preprinted with color pursuant to some preselected color code scheme. Obviously one color, or a variety of colors may be preprinted on sheet 1.

There is no significant limitation on the forward speed possible in the inventive process. Indeed, calculations indicate the present process to be quite faster in speed of advance than the sulfate wood-pulp process, for example.

The impact of industrial processes on environment is of increasing importance to all. In this connection, the present invention enjoys a complete absence of the air and water pollution problems associated with some prior art processes, especially sulfate wood-pulp processes.

It is to be understood that the embodiments described herein are merely illustrative of the principles of the invention. Various modifications may be made thereto by persons skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

- Method of making insulated conductors comprising the steps of:
  - forming continuous plural lengthwise pleats in an advancing compliant sheet of insulative material, severing the sheet along every other lengthwise pleat, thereby creating plural open-sided envelopes, feeding an advancing substantially round wire into each said envelope, closing said envelope by bringing together the two sides of said envelope, and rounding said envelope around said wire.
- Method of making insulated conductors comprising the steps of:
  - forming plural continuous lengthwise accordionlike pleats in an advancing compliant relatively flat sheet of insulative material, severing the sheet along every other lengthwise pleat, thereby creating plural open-sided envelopes, feeding an advancing substantially round wire into the internal region within each said envelope,

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closing said envelope around said wire by bringing the two sides of each said envelope together, and polishing said envelope into roundness on said wire.

3. Method pursuant to claim 2, comprising the further step of scoring said advancing sheet, along the lines later to be severed, while said sheet is still flat.

4. Method pursuant to claim 2, wherein said advancing envelopes are dry up to said feeding step, and comprising the further step of applying a wetting solution to said envelopes prior to said closing step.

5. Method pursuant to claim 4 wherein said sheet is preimpregnated with wire adhesive, and wherein said wetting step activates said adhesive means.

6. Method pursuant to claim 2, wherein said sheet is preimpregnated with wire adhesive.

7. Process for insulating a wire, comprising: folding a compliant sheet of insulative material into consecutive lengthwise pleats;

advancing said pleated material continuously, while feeding an advancing substantially round wire into the envelope of all pleats on one side only of said sheet;

separating said sheet at every other fold, forming thereby an insulative envelope around each advancing wire, and

rounding said envelope around said wire.

8. In a continuous process for placing insulation around wires, the steps comprising:

advancing a compliant sheet of insulating material having formed therein a plurality of lengthwise, open, accordionlike pleats;

advancing a wire into a central region between every other pleat at substantially the same speed as said advancing sheet;

severing said sheet along each of said every other pleat, thereby creating plural open-sided envelopes within each of which a said wire is disposed;

closing each said envelope; and rounding each said envelope around its respective said wire.

9. Method pursuant to claim 2, wherein said internal region is a central region substantially midway between the pleat and the edges of said open side.

10. Method pursuant to claim 2, wherein said wires prior to said advancing step are precoated with an adhesive to cause the pleated material to adhere to said wire.

11. Method pursuant to claim 2, wherein said sheet is precolored so as to control the color of the insulative envelope thereby to effect a desired color coding of the insulated conductor produced by said process.

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