# United States Patent [19]

**Eller et al.**

[11] **3,902,938**

[45] **Sept. 2, 1975**


[54] **PROCESS FOR CONTINUOUSLY COVERING A LINEAR ELEMENT**


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[73] Assignee: **Ford Motor Company**, Dearborn, Mich.



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[21] Appl. No.: **436,009**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 231,299, March 2, 1972, abandoned.

[52] **U.S. Cl.** ..... **156/54;** 156/201; 174/117 FF

[51] **Int. Cl.**[2] ..... **H01B 13/06**

[58] **Field of Search** ..... 156/54, 202, 216, 201, 156/229; 174/117 F, 117 FF



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,101,845 | 8/1963 | Heasley | 206/59 |
| 3,206,541 | 9/1965 | Jachimowicz | 156/54 X |
| 3,530,018 | 9/1970 | Ash | 156/54 |
| 3,549,926 | 12/1970 | Pentland | 174/117 X |
| 3,576,941 | 5/1971 | Colglazier | 174/117 |



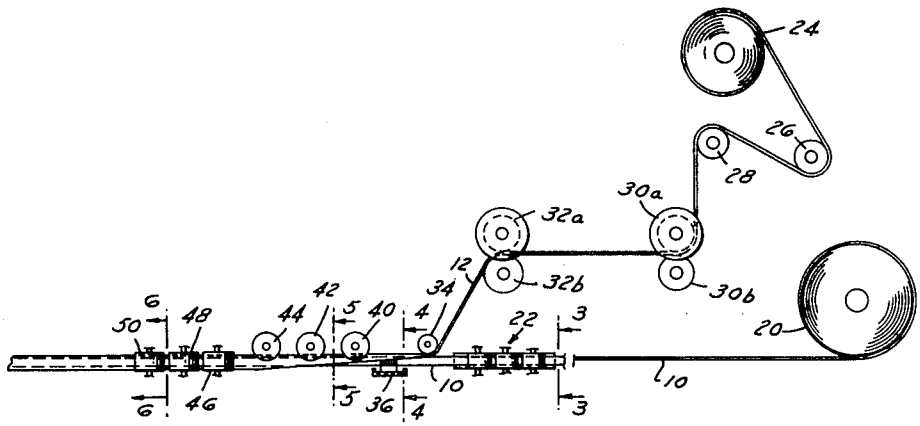
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[57] **ABSTRACT**

Crimped paper insulation is applied linearly and continuously to a moving linear electrical conductor without bonding the paper insulation directly to the conductor. The paper insulation is formed with a width exceeding the cross sectional perimeter of the conductor and an adhesive is applied only to longitudinal tab portions formed by the extra width. Progressive rollers fold the paper insulation over the conductor so that the extra width contacts another portion of the insulation but does not contact the conductor itself.


**4 Claims, 6 Drawing Figures**



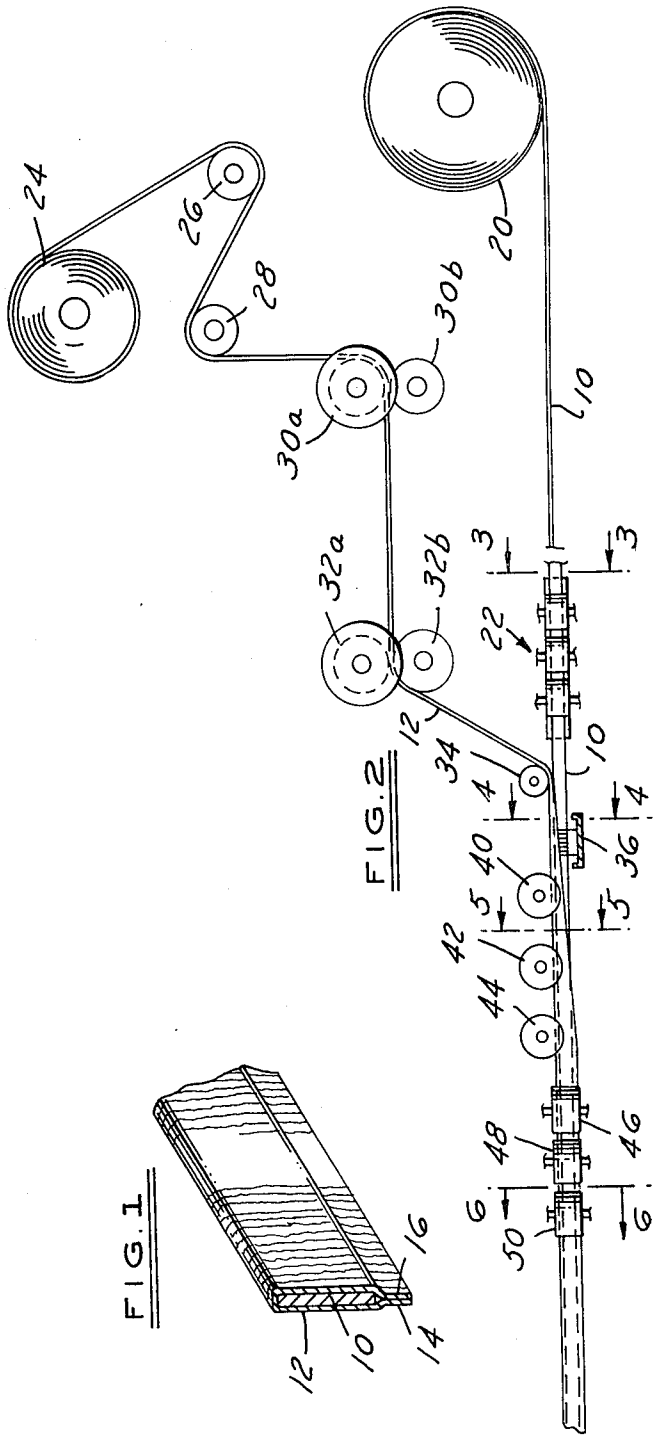



FIG. 2




FIG. 1

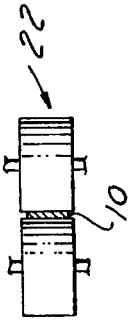



FIG. 3

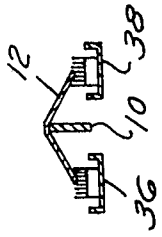



FIG. 4

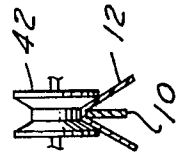



FIG. 5

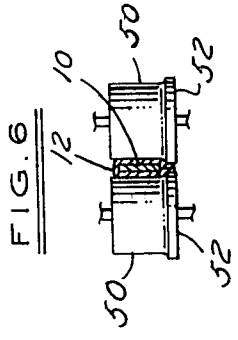



FIG. 6

# PROCESS FOR CONTINUOUSLY COVERING A LINEAR ELEMENT

This is a continuation of application Ser. No. 231,299, filed Mar. 2, 1972, now abandoned.

## SUMMARY OF THE INVENTION

Electric starting motors for automotive type reciprocating engines require relatively large amounts of electrical current during starter motor actuation. Field coils for the starter typically are made from an electrical conductor having a large, substantially rectangular cross section capable of carrying the large current without taking up excessive space. Traditionally, strips of paper have been inserted between layers of the conductor as the conductor is wound into the shape of the field coil. More recently, a technique for applying paper insulation to portions of the electrical conductor prior to winding the conductor into the shape of the field coil was disclosed in U.S. Pat. No. 3,549,926, which is assigned to the assignee of this invention. As the disclosure of that patent points out, it is extremely difficult to strip the paper insulation from the connecting ends of the coil and for that reason the insulation is not applied to such ends. Moreover, the paper insulation itself would not tolerate the sharp bends necessary at the ends of the field coil.

This invention provides a process for continuously applying a flexible linear insulation or covering to a moving linear element by a technique that permits subsequently cutting the linear element to the appropriate length, winding it into the shape of the field coil and stripping the insulation from the ends of the coil without undue difficulty. The process comprises forming the flexible covering with a width exceeding the cross sectional perimeter of the linear element so that after the covering is folded around the linear element, a portion of one side of the covering that is adjacent one longitudinal edge contacts another portion of the covering but does not contact the linear element. An adhesive is applied to one or both of the overlapping portions but not to any part of the covering that will contact the linear element. The covering is brought into contact with the linear element while the longitudinal dimension of the covering is aligned substantially with the longitudinal dimension of the linear element. Progressive folding techniques fold the width of the covering around the linear element to bring the adhesive portions thereof into contact with each other so that the adhesive bonds the portions of the covering to each other without bonding the covering directly to the linear element.

The process of the invention can be used to apply any linear covering to a moving linear element although it is useful particularly in applying crimped paper insulation to moving electrical conductors. Such paper insulation preferably is crimped so that at least a component of the crimping extends across its longitudinal dimension and that component is sufficient to permit subsequent stretching of the insulation by at least an amount capable of absorbing the bending necessary to form the coil. One difficulty encountered in applying such crimped insulation at high speeds results from the nonuniform stress induced in the edges of the insulation during crimping. The rippled edges resulting from such nonuniformity are corrected conveniently by passing the insulation through a prestretching mechanism before bringing the insulation into contact with the linear element. Generally, prestretching the insulation about ten percent moves the ripple and insures smooth, continuous mating of the insulation to the linear element and smooth, continuous application of adhesive to the longitudinal edges of the insulation.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectioned perspective of an insulated electrical conductor resulting from the process of the invention.

FIG. 2 is a side view of the mechanism used to carry out the process, and

FIGS. 3–6 are sectional views taken along respective section lines in FIG. 2 to illustrate certain details of the mechanism and process.

## DETAILED DESCRIPTION

Referring to FIG. 1, an elongated electrical conductor **10** having a relatively flat rectangular cross section is covered by paper insulation **12.** The width of the paper insulation exceeds the perimeter of conductor **10** by an amount sufficient to provide the two tab portions **14** and **16** that are brought together below one of the narrow sides of the conductor. Adhesive applied to the tab portions bonds the tab portions to each other. The amount of crimping remaining in insulation **12** is sufficient to permit bending the conductor into any desired coil shape. None of the insulation is bonded directly to the conductor; thus the insulation can be stripped readily from the conductor to permit subsequent electrical connections.

Turning to FIG. 2, the electrical conductor **10** typically is acquired in the form of a large coil **20** (coil **20** is shown 90° out of position in FIG. 2). One end of the coil is fed through a series of rolls **22** that straighten, stabilize and propel the conductor through the remaining mechanism (See also FIG. 3). The coil typically moves at a speed ranging from about 300 feet per minute to speeds in excess of 1,000 feet per minute.

Crimped paper insulation **12** also is acquired in the form of a large roll **24.** Crimping extends laterally across insulation **12.** The amount of crimping is sufficient to permit removing the ripple at the edges while leaving enough stretchability to absorb subsequent forming steps and flexibility requirements of the application. Feed rolls **26** and **28** direct the insulation into a prestretching mechanism represented in FIG. 2 by a first set of rolls **30***a* and **30***b* and a second set of rolls **32***a* and **32***b*. Rolls **32***a* and **32***b* are driven at a higher speed than rolls **30***a* and **30***b* so that a predetermined amount of prestretching is induced in the paper between the rolls. The prestretching mechanism preferably is aligned in the plane of the larger, lateral dimension of conductor **10,** which in FIG. 2 is the vertical plane. A speed differential between rolls **32** and rolls **30** preferably is sufficient to remove about ten percent of the crimping from insulation **12.**

Paper insulation **12** leaving rolls **32** is brought downward under a freewheeling roll **34** to contact the upper edge of conductor **10.** Freewheeling roll **34** can be perfectly cylindrical but preferably has a slightly concave shape that produces initial folding of the insulation as shown in FIG. **4.** Just downstream from roll **34,** the outer edges of insulation **12** pass over adhesive applicators **36** and **38** spaced on each side of conductor **10.** Applicators **36** and **38** apply a small amount of a heated hot melt type adhesive to the edge portions of the insulation.

A series of progressive rolls **40, 42** and **44** that have increasing concavity continue folding insulation **12** around conductor **10** as indicated in both FIG. **2** and FIG. **5.** Downstream of roll **44,** a series of horizontal rolls **46, 48** and **50** progressively bend the sides of insulation **12** into contact with the sides of conductor **10.** Narrow ridges **52** at the bottom edges of rolls **50** finally move the tab portions of insulation **12** into contact with each other as illustrated in FIG. **6** and the adhesive bonds the tab portions to each other.

The insulated conductor continues to a cutting mechanism (not shown) that cuts it to the desired length and the resulting lengths are wound into the desired coil form. Small portions of the insulation at the ends of each length are removed easily to expose the conductor end portions.

Other adhesives can be substituted for the hot melt adhesive if desired. The process can be used to apply a covering to linear elements having a variety of cross sections; for example, the linear element can be round and the covering can be folded around the linear element so that one edge portion contacts the exterior surface of the other edge portion. Adhesive can be applied to the outer edge portion to bond it to the exterior of the previously applied covering.

Thus this invention provides a process for rapidly applying linear covering to a moving linear element. The process can be carried out at extremely high speeds and readily permits subsequent removal of the covering.

We claim:

**1.** In a process for continuously applying a flexible covering to a moving linear element wherein the flexible covering is paper insulation crimped so that at least a component of the crimping extends across its longitudinal dimension and the linear element has a cross-sectional perimeter smaller than the width dimension of the covering and the linear element is extracted from a source with the covering being simultaneously extracted from a separate source, the element and the covering being brought together as the covering is being arranged for folding about the element so that a first portion of the covering contacts the element about its periphery and a second portion of the covering contacts only a further portion of the covering, the improvement comprising:

longitudinally prestretching the paper insulation to remove a predetermined amount of the crimping prior to contacting the paper insulation with the linear element; and

applying an adhesive to at least one of said second and further portions of the paper insulation while avoiding the application of adhesive to any part of the first portion of the paper insulation prior to the step of folding the paper insulation about the linear element whereby the paper insulation may be bonded to itself in surrounding relation to the linear element without being bonded to the linear element.

**2.** The process of claim **1** in which the linear element has a substantially rectangular cross section and the covering first contacts one of the smaller sides of the linear element.

**3.** The process of claim **1** wherein the step of applying an adhesive occurs subsequent to the step of bringing the paper insulation into contact with the linear element.

**4.** The process of claim **1** wherein the step of applying an adhesive comprises

positioning at least one adhesive applicator means in proximity to, and to one side of, the linear element; and

arranging said adhesive applicator to intercept, and apply adhesive to, one of said second and further portions of the paper insulation as the paper insulation is being arranged for folding about the linear element.

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