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Krag et al.

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[54] **METHOD FOR LAYING WIRES ON TAPE**

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[52] **U.S. Cl.** .... **156/178,** 29/203 MM, 29/203 MW, 29/604, 29/605, 156/168, 156/562

[51] **Int. Cl.** **B32b 5/00**

[58] **Field of Search** ..... 29/604, 203 MM, 203 MW, 29/241, 233, 605; 156/176, 178, 166, 168, 297, 299, 302, 559, 562

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Primary Examiner—Charles W. Lanham
Assistant Examiner—Carl E. Hall
Attorney, Agent, or Firm—Lindenberg, Freilich & Wasserman

[57] **ABSTRACT**

An apparatus and method for laying elongated members such as needle-wire assemblies on the adhesive side of a strip of tape so that the front ends of the needles are accurately spaced from one another across the width of the tape. A strip of tape is laid on the periphery of a wheel with the adhesive side up, and with a front end of the tape extending through an aperture to the inside of the wheel. A needle guide having numerous slots is located immediately in front of the aperture through which the tape extends. The rear end of a needle is laid in one of the slots, with the wire which extends behind the needle being held under moderate tension by a stationary wire guide spaced a small distance from the tape. The wheel is rotated by one turn so all of the wire is laid onto the tape. After the other needle-wire assemblies are similarly laid on the tape, the tape is pulled backwards so the front end is pulled out of the aperture while the needles are pulled back through the needle guide into contact with the tape.

7 Claims, 11 Drawing Figures

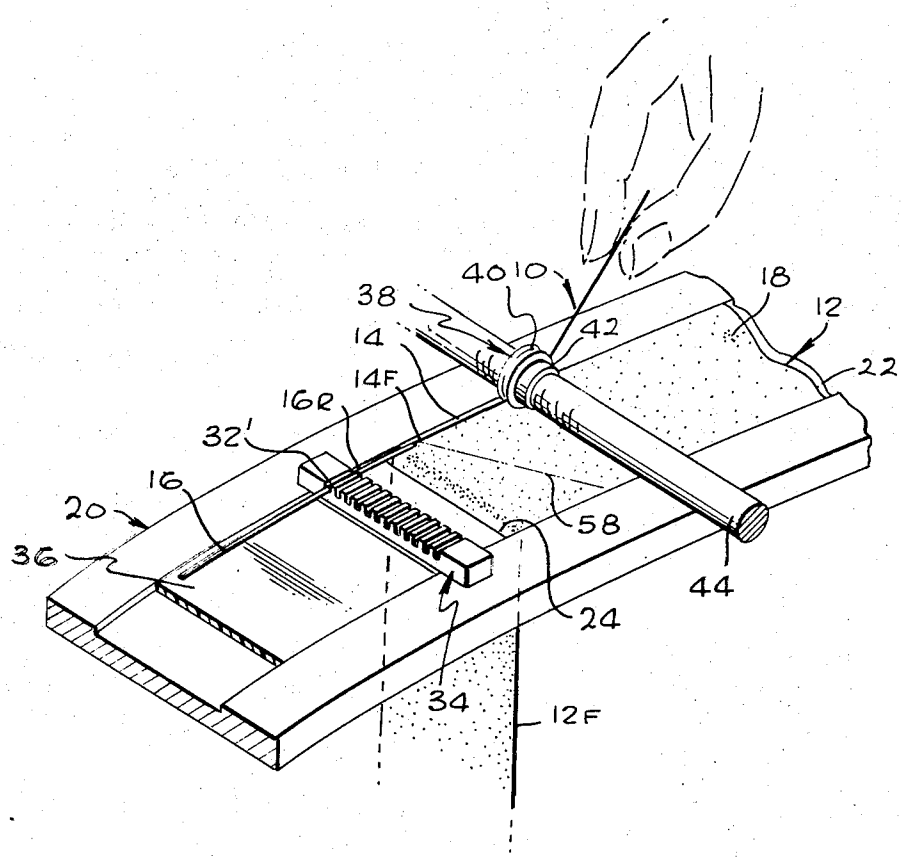


Fig. 1

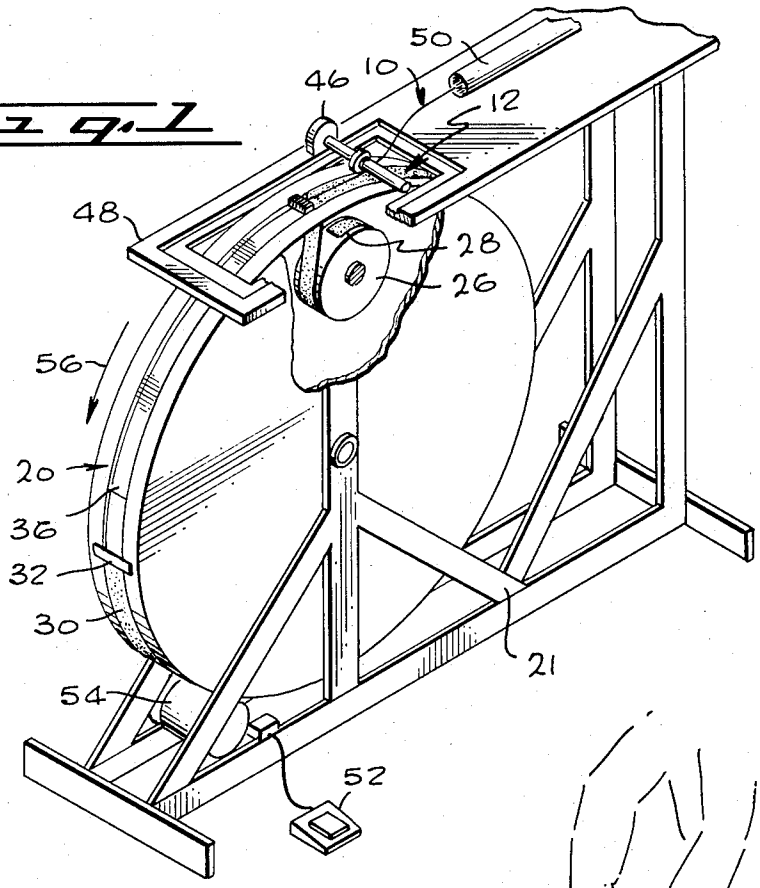

50
46
10
12
48
28
26
56
20
36
32
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21
54
52

Fig. 2

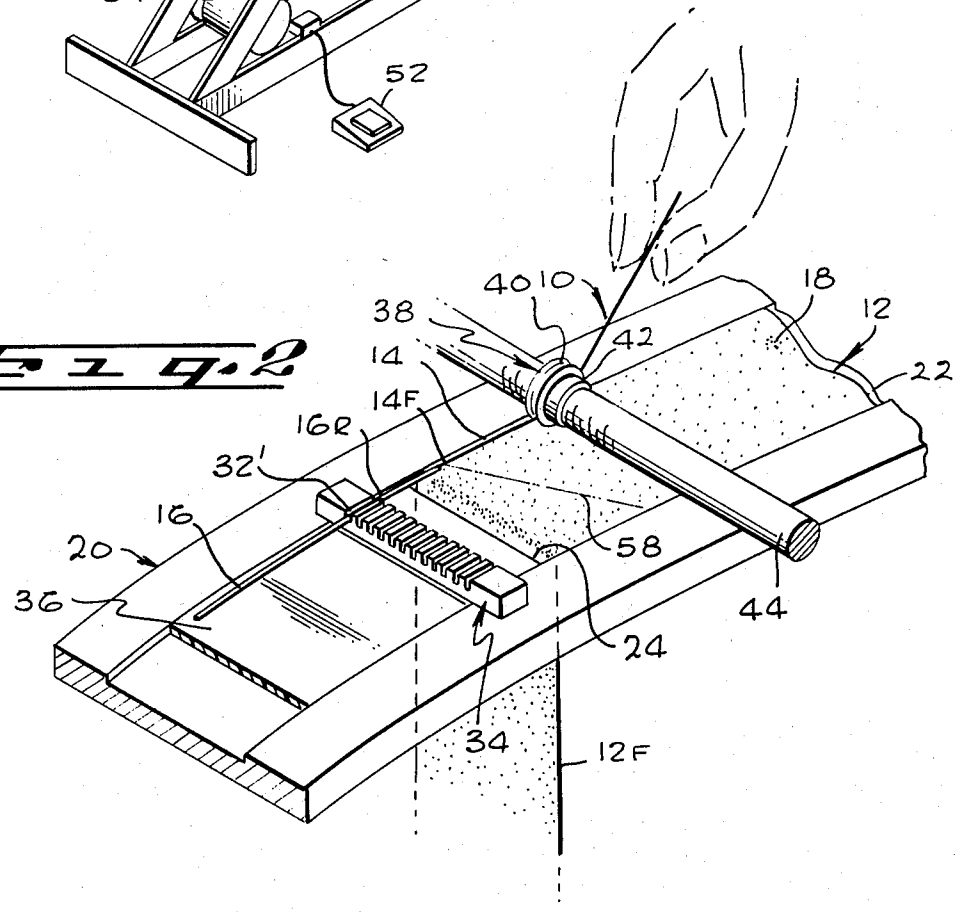
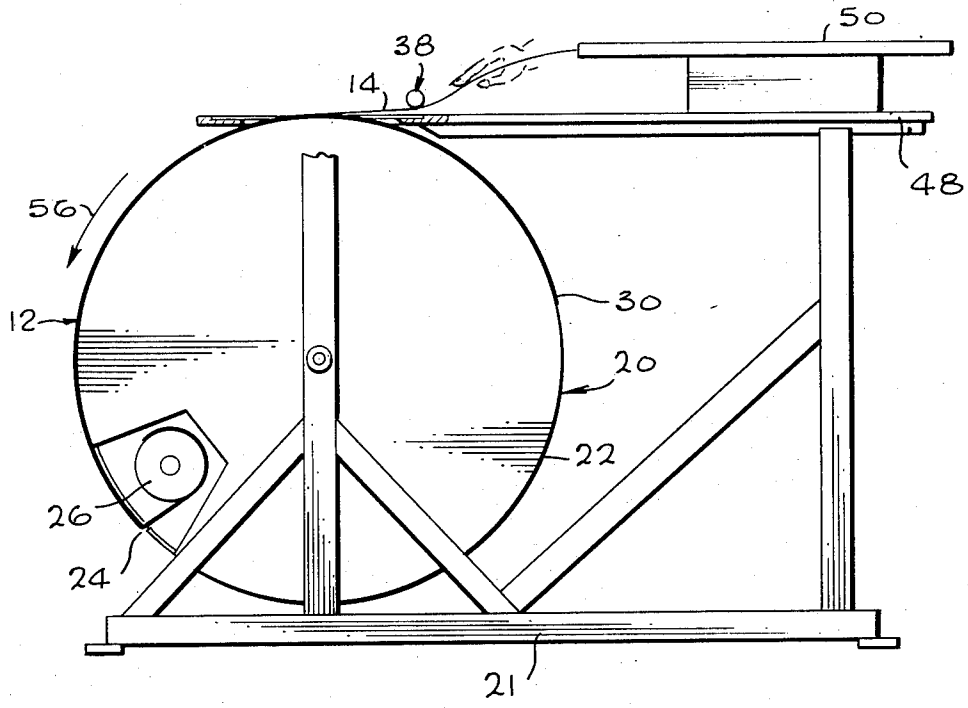

40
10
18
12
38
42
14
22
14F
16R
32'
16
58
20
36
44
24
34
12F

Fig. 3



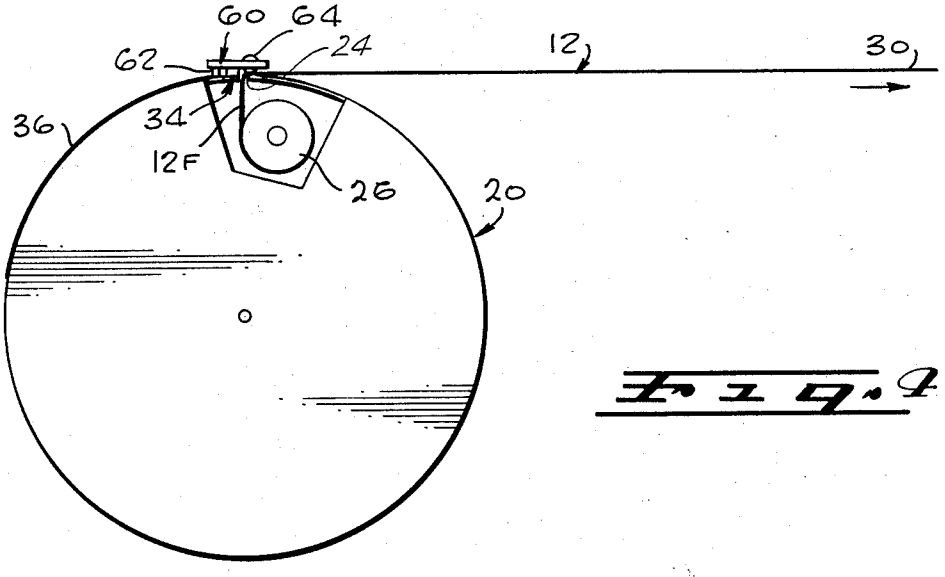


Fig. 4

Fig. 5

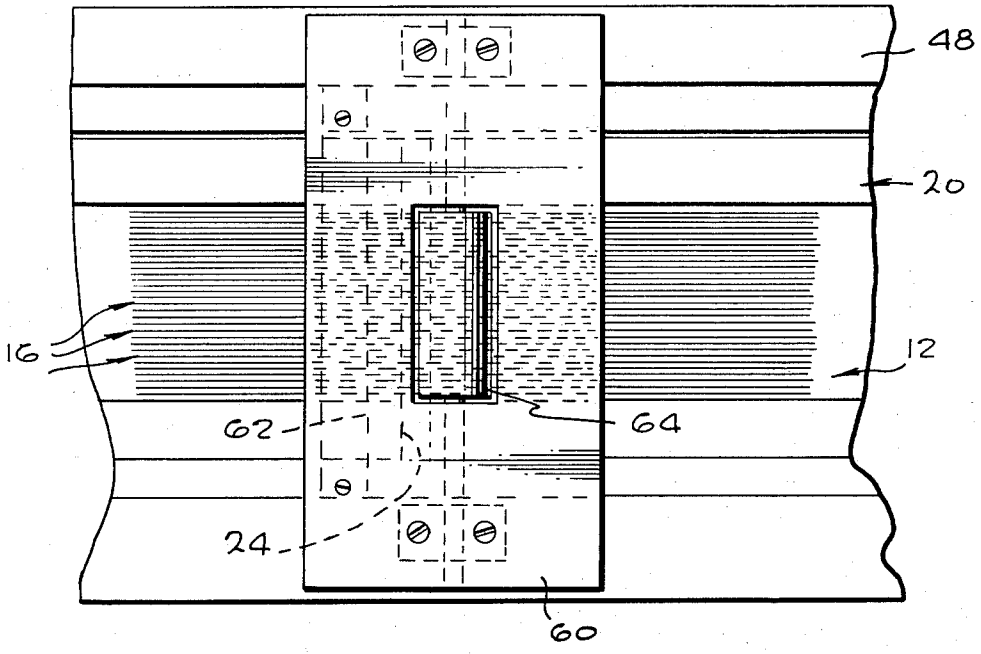


Fig. 6

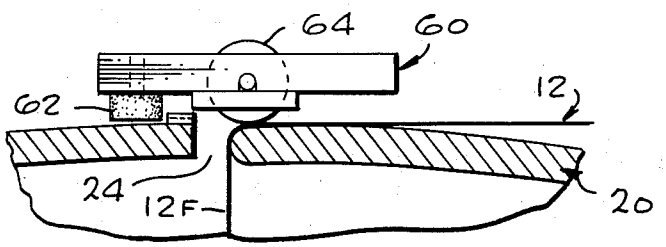
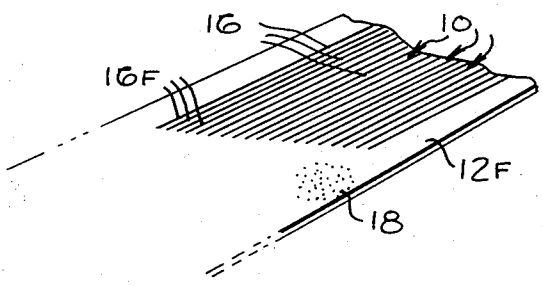


Fig. 7



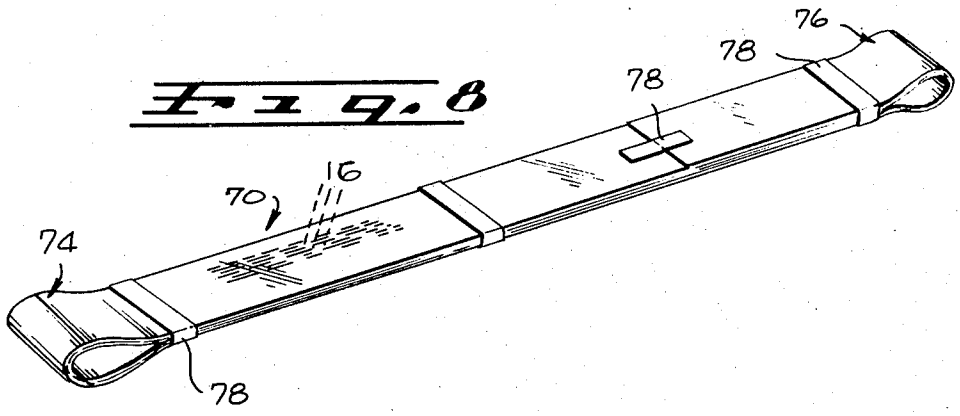


Fig. 8

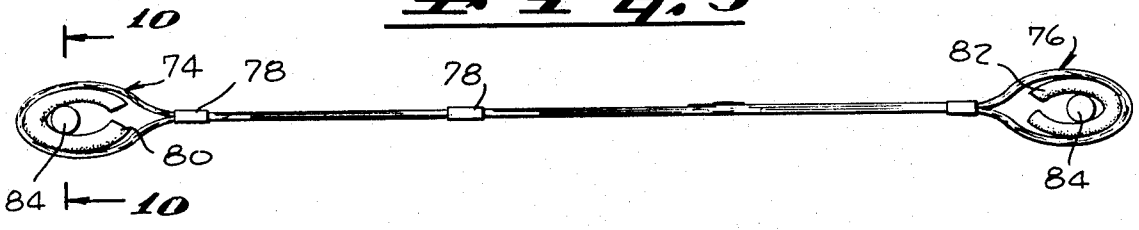


Fig. 9

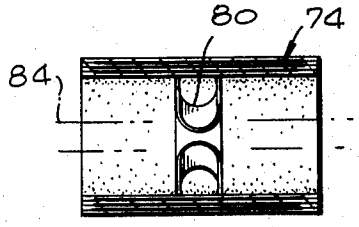


Fig. 10

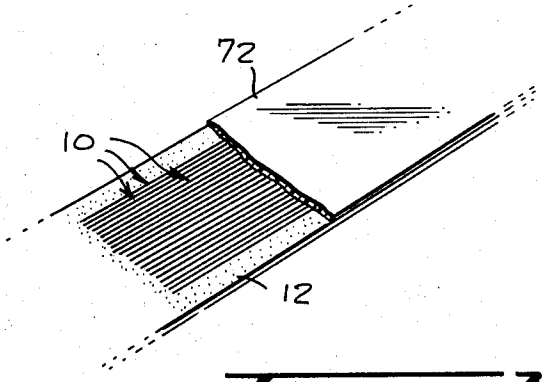


Fig. 11

METHOD FOR LAYING WIRES ON TAPE

BACKGROUND OF THE INVENTION

This invention relates to apparatus and methods for positioning needle-wire assemblies on tape.

Magnetic core memories used in computers and other applications are constructed by projecting numerous fine wires through a matrix of small toroidal magnetic cores. One method which has been developed for automating such stringing of the cores involve attaching needles to the front ends of the wires, laying the needle-wire assemblies on the adhesive surface of a tape so the assemblies are accurately spaced from one another across the width of the tape, and mounting the tape in front of a matrix of cores. The tape is slowly pulled around a sharp edge so it separates from the needles while causing the needles to advance forwardly into rows of magnetic cores. The needles are pulled after emerging from the matrix so that the wires trailing behind them are pulled through the cores. A large number of needle-wire assemblies, such as 64 of them may thus be simultaneously projected through a matrix of cores. A description of this method is given in U. S. Patent application Ser. No. 245,542, filed Apr. 19, 1972.

In order to perform the above core stringing process, it is necessary to first lay the needle-wire assemblies on the tape at accurately spaced intervals laterally, or in other words in a direction across the width of the tape. It is necessary to maintain especially accurate spacing at the front ends of the needles which must enter the holes in the cores. The wires trailing behind the needles do not have to be accurately spaced from one another, but they should not indiscriminately overlap one another, inasmuch as this can lead to tangling of the wires. The laying of the needle-wire assemblies on the sticky surface of a tape is difficult to perform rapidly and accurately.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide an economical method and apparatus for the laying of elongated members on the adhesive side of a tape.

Another object of the invention is to provide a method and apparatus for the laying of needle-wire assemblies on tape so that the front ends of the needles are accurately spaced from one another across the width of the tape.

Still another object of the invention is to provide a package containing tape with needle-wire assemblies thereon, which can be easily stored without damage to the needle-wire assemblies that would impair their use in the stringing of magnetic core.

In accordance with one embodiment of the present invention, a method and apparatus is provided for laying multiple needle-wire assemblies onto a tape with the front ends of the needles accurately spaced from one another in a lateral direction. The apparatus includes a large rotatable wheel with an aperture in the periphery, and a needle guide with numerous slots therein positioned immediately in front of the aperture. A length of tape is laid on the periphery of the wheel, adhesive side up, with a front portion of the tape extending through the aperture in the wheel. A needle-wire assembly is positioned by laying the rear portion of the needle in a slot of the needle guide, and extending the wire which trails from the needle through a wire guide that does not rotate with the wheel. The wheel is rotated one turn while the wire is maintained in tension, so that the wire is progressively laid onto the tape. Additional needle-wire assemblies are similarly mounted with the rear portion of the needles in the guide and the wires laid onto the tape. After all the needle-wire assemblies are thus laid, the tape is pulled backwards, so that the front portion of the tape is pulled out through the aperture in the wheel while the needles are pulled backwards through the needle guide. This causes the front portion of the tape and front portions of the needles to be moved into contact with one another. The needle guide accurately positions the needles on the tape since it engages the needles close to the locations where they contact the tape.

The needle-wire-tape assembly can be packaged by laying a strip of adhesive-resistant material such as wax paper on the sticky side of the tape over the needle-wire assemblies thereon to form a sandwich with the tape and protective strip of the outside and the needle-wire assemblies on the inside. This sandwich is then formed into multiple elongated overlapping loops. The sides of the loops are held together to form a thin package except at the ends of the loops where the wires bend. The loops are longer than the needles, and the needles extend only along one side of a loop so that the needles are not bent. A pair of curved retainer members are inserted into each end of the loop to resist creasing of the ends of the loops, which would produce a crease in the wires, and to enable the ends of the loops to be hung onto posts for easy storage and shipment.

The novel features of the invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a laying apparatus constructed in accordance with the invention;

FIG. **2** is a partial perspective view of the laying apparatus of FIG. **1**;

FIG. **3** is a front elevation view of the apparatus of FIG. **1**, shown at a later stage of the laying process;

FIG. **4** is a front elevation view of the apparatus of FIG. **3** at a still later stage of the laying process;

FIG. **5** is a plan view of a portion of the apparatus of FIG. **4**;

FIG. **6** is a side elevation view of the apparatus of FIG. **5**;

FIG. **7** is a partial perspective view of the needle-wire-tape assembly at the end of the laying process;

FIG. **8** is a perspective view of a package constructed in accordance with the invention;

FIG. **9** is a side elevation view of the package of FIG. **8**;

FIG. **10** is a view taken on the line **10—10** of FIG. **9**; and

FIG. **11** is a partial perspective view of the package of FIG. **8**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1** and **2** illustrate apparatus for laying elongated members **10** onto a length of tape **12**, so that the

front ends of the members are accurately spaced from one another across the width of the tape. The elongated members **10** are needle-wire assemblies, each including a thin electrical wire **14** of easily bendable material such as copper, and a needle **16** of a stiffer material such as partially hardened steel. The rear end portion **16R** of the needle is butt welded to the front end **14F** of the wire. The tape **12** has an adhesive **18** on a face thereof, and the needle-wire assemblies **10** are laid against the adhesive face so they are securely held thereon. A large number of the assemblies **10** is laid on the tape, so that after the laying process, a front portion **12F** of the tape has the appearance indicated in FIG. **7** wherein the needles **16** are accurately spaced from one another laterally, or in other words, in a direction across the width of the tape, particularly at the front end **16F** of the needles.

The apparatus for laying the elongated members **10** on the tape includes a larger wheel **20** which is rotatably mounted on a stand **21.** The wheel has a curved peripheral surface **22** for holding the tape **12.** The tape is mounted on the wheel by first projecting a forward portion **12F** of the tape through an aperture **24** in the wheel at the forward end of the tape-holding surface **22,** so that the forward tape portion lies within the wheel. The forward tape portion **12F** is wound onto a small drum **26** that is rotatably mounted on the large wheel **20,** but which is normally locked against rotation. The extreme front end **28** of the tape can be held to the drum **26** by a small piece of tape laid over it with the adhesive side down. Most of the tape extends around the periphery of the large wheel **20,** with the extreme rear end **30** of the tape fastened in place as with a strip of additional tape **32** laid with its adhesive side down.

The needle-wire assemblies **10** are individually mounted on the tape, by first laying a rear portion **16R** of the needle in a slot **32'** of a needle guide **34.** The needle guide **34** is located immediately in front of the aperture **24** through which the tape extends, and the needle is placed in the guide so that a portion of the needle rests on the tape **12.** In order to hold the needle to the wheel so it does not fall out of the needle guide, a strip of magnetic material **36** is mounted on the wheel in front of the needle guide. The strip **36** is constructed of a rubber matrix with magnetic particles therein which have been magnetized, so that the strip can readily conform to the surface of the wheel. The wire **14** is maintained in tension along a path which extends through a wire guide **38** that is spaced from the tape **12.** The wire guide **38** includes a groove **40** through which the wire extends, and a nut **42** which is threadably mounted on a threaded shank **44.** The shank **44** has one end held on a support **46** that is fastened to a stationary table **48.** Tension in the wire **10** can be achieved by the operator running the wire through his fingers, as indicated, so that the wire guide **38** serves in conjunction with the operator's hand as means for holding the wire in tension and at a controlled lateral position. The needle-wire assemblies may be originally supplied in a tube **50** that may be laid on the support **48** so that the rear portions of the wire initially remain in the tube.

The laying of the rear wire portions on the tape is accomplished by rotating the wheel **20** by a turn. An operator can accomplish this by depressing a pedal **52** that causes a wheel-rotating motor **54** to be energized. An indexing mechanism (not shown) stops wheel rotation after one turn. As the wheel rotates in the direction of arrow **56,** the wire **14** is laid on progressively more rearward portions of the tape **12,** as shown in FIG. **3.** The fact that the tape is held in a curve and the wire **14** is maintained in tension as it extends tangent to the curve, means that the wire is progressively laid onto the tape, which assures that all wire portions are firmly pressed onto the tape. Of course, the length of the tape extends circumferentially about the axis of curvature of the tape-holding surface **22.** The wire is pressed onto the tape by the force vector of wire tension that points towards the center of the wheel. While it is important for the front ends of the needles to be accurately spaced from one another in a lateral direction, it is not important that the wires **12** be accurately spaced from one another, so long as they are firmly pressed against the tape and do not interweave so that they could become entangled.

After a first needle-wire assembly is laid onto the tape, the next assembly is mounted in a similar manner, by first locating the rear portion of the needle in the next slot of the needle guide **34,** and rotating the wheel by a turn while holding the wire in tension. The needles are preferably laid with their extreme rear ends, where they are butt welded to the wires, lying over a diagonal guide line **58** marked on the wheel behind the aperture **24** (this line can be seen when transparent tape is used) to facilitate the subsequent core stringing process. Inasmuch as the wires should be laterally spaced from one another, the wire guide **38** is laterally shifted after each needle-wire assembly is laid onto the tape, by turning the nut **42** to shift it by a distance approximately equal to the spacing of the slots in the needle guide **34.** It may be noted that the length of the exposed tape on the periphery of the wheel is long enough so that the rear ends of the wires do not extend past the rear end of the tape.

After all of the needle-wire assemblies have been laid in the manner described above, the forward portions of the needles must be accurately laid on the tape. This is accomplished in the manner indicated in FIG. **4,** by removing the rear end **30** of the tape from the wheel, unlocking the drum **26** which holds the forward portion **12F** of the tape, and pulling rearwardly on the tape. This causes the forward portion of the tape to be drawn back through the slot **24** and onto the periphery of the wheel. At the same time, this causes the needles to be drawn backwards through the needle guide **34** and into contact with the tape. The result is that the needles and tape are drawn into contact with one another at progressively more forward positions of the needles and tape. During such rearward movement of the needles, the portions being laid on the tape are maintained at accurate lateral spacings by the needle guide. The needle guide is close to the location where the needles are being pressed onto the tape, so high accuracy of needle location is assured. Accordingly, the front ends of the needles will be accurately spaced from one another across the width of the tape.

Prior to the rearward movement of the tape and needles as indicated in FIG. **4,** a hold down apparatus **60** is mounted on the wheel **20.** This apparatus includes a strip of felt **62** or other material that presses down the needles against the magnet **36** to prevent the needles from moving out of the slots of the needle guide **34.** As illustrated in FIGS. **5** and **6,** the apparatus also includes a roller **64** of an adhesive-resistant material such as

Teflon, which presses the needles against the tape as the tape emerges from the aperture in the wheel, to assure firm mounting of the needles in the tape adhesive. After the front ends of the needles have been fastened to the tape, the needle-wire-tape assembly is ready for use or storage. Another similar assembly can be constructed by laying another length of tape on the wheel, with the front end of the tape extending through the slot in the wheel and disposed on the drum **26,** and by again laying a group of needle-wire assemblies in place.

The needle-wire-tape assembly must be carefully stored to prevent damage to it. Convenient storage is accomplished by forming a package **70** of the type shown in FIGS. **8–11,** wherein the tape (with the needles and wires thereon) is wound into multiple overlapping loops. Prior to winding the tape into the loops, a protective strip of adhesive-resistant material **72** (FIG. **11**) such as waxed or equivalently treated paper, is laid against the adhesive face of the tape over the needle-wire assemblies thereon, and the assembly including the protective strip is wound into loops. The multiple loops are held together along their length, except at the opposite ends **74, 76** by several binders **78** such as lengths of masking tape. The loops **74, 76** at the opposite ends are provided so that the wires do not undergo sharp bends that would hamper their use in stringing magnetic cores. The length of the package **70** is greater than the length of the needles **16,** and the needles extend only along one straight side of a loop. This is to prevent bending of the steel needles, which are too stiff to bend in a short radius curve without damage. After the package is thus formed, a pair of curved members **80, 82** is inserted within each looped end **74, 76.** The curved members **80, 82** are stiff enough to resist compression to a flat state, so they help prevent creasing of the ends of the loop during handling. Each of the curved members **80** also serves to provide a mounting for mounting the package on posts **84.** The mounting of the packages on the posts **84** helps to avoid damage, which would be more likely to result if the packages were merely piled on top of one another during storage. The members **80, 82** also help to prevent damage to the package during projection of the posts through the looped ends of the package.

Thus, the invention provides an apparatus and method for laying elongated members, and particularly needle-wire assemblies, on tape in a closely controlled manner, with the front ends of the needles accurately spaced in a lateral direction across the tape. This is accomplished by laying a portion of each member spaced from the front end thereof, in a guide with apertures that are accurately spaced in a lateral direction, and by mounting the tape so a front portion thereof which is at a location immediately behind the guide, extends out of line with the guide. The elongated members are pressed against the tape and held in tension while being laid on the tape. During such laying, the tape is held in a curve, so that the force pressing the elongated members on the tape is supplied by reason of tension of the members. This also assures progressive laying of the members on the tape so that all portions of the members are securely held thereon. The curved tape-holding surface does not have to be part of a wheel, but can even be part of a belt with a portion extending in a curve. Furthermore, it is not necessary that the tape move relative to the wire guide, but instead the wire guide can move relative to the tape while the tape is held stationary in a curve. After laying of the elongated members on the tape, the tape is pulled rearwardly so that the front ends of the members are drawn into contact with the front portion of the tape, the guides holding the members at accurately spaced locations near the points where the members contact the tape, thereby assuring that the front ends of the members are accurately spaced from one another. The assembly which includes the tape and elongated members, can be packaged for convenient storage by wrapping the assembly into multiple overlapping loops. The opposite sides of the loops are pressed against one another except at the ends which are left rounded to prevent sharp bends in the elongated members.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and consequently it is intended that the claims be interpreted to cover such modifications and equivalents.

What is claimed is:

1. A method for laying a plurality of elongated members onto tape which has an adhesive-like surface, at closely controlled lateral spacings thereon at the front portions of the members comprising:

placing predetermined first portions of said elongated members which are spaced from the front ends thereof on a predetermined first tape region which is spaced from a forward tape portion communicating with a front end of the tape, and at positions on said first tape region which are accurately spaced from one another laterally across the width of the tape;

securing second portions of said elongated members which are behind said first portions thereof, onto regions of said tape behind said first tape region; and

pulling said tape with the rear portions of said elongated members thereon, rearwardly, while guiding the forward tape portion and forward portions of each of the elongated members into contact with each other and maintaining closely controlled lateral spacing of the members.

2. The method described in claim **1** wherein:

said step of securing second portions of said elongated members onto said tape, includes maintaining said second portions of a member in tension while holding said tape in a curve and creating relative movement of the tape to the elongated member so the member progressively wraps onto progressively more rearward locations of the tape.

3. The method described in claim **1** wherein:

said elongated members comprise electrical wires and needles which are stiffer than the wires and which are fastened to the front ends of the wires; and

said step of securing predetermined first portions of said elongated members on said first tape region includes laying rear portions of said needles in a guide having laterally spaced passageways; and

said step of guiding the forward tape portion and the forward portions of the elongated member includes passing said forward tape portion rearwardly about a curve into a path substantially in line with said needles, and sliding said needles rearwardly through said passages of the guide.

4. A method for applying needle-wire assemblies that include needles fastened to the front ends of electrical wires, onto an elongated length of tape that has an adhesive side, at intervals spaced laterally across the width of the tape, comprising:

mounting a portion of said tape on a convexly curved support with the length of the tape extending circumferentially at least 90° about the axis of curvature of the support and with the adhesive side of the tape exposed, so that said tape portion is convexly curved along its length;

positioning at least portions of the needles against said adhesive side of said tape portion at accurately controlled positions that are laterally spaced across the tape; and

holding said wires in tension and extending substantially tangential to the curved tape and at laterally controlled positions while laying them progressively onto said convexly curved tape portion along the lengthwise dimension of the tape so that the wires contact the tape along an arc of at least 90°.

5. The method described in claim 4 wherein:

said step of mounting a tape portion includes mounting it on a rotatable wheel;

said step of positioning said needle portions includes locating said needle portions in the apertures of a needle guide that has laterally spaced apertures, and that is mounted on said wheel; and

said step of holding said wires in tension includes passing the wires through a wire guide that is accurately located on a support which can remain stationary when the wheel rotates, and rotating said wheel so the needle guide thereon initially moves away from the drag inducing means.

6. The method described in claim 5 wherein:

said tape is mounted so that it is sharply curved at a location immediately behind the needle guide, with a tape portion behind the sharp curve extending substantially in line with the needle guide and with a forward tape portion in front of the sharp curve extending into the wheel; and including

pulling said tape with wires thereon away from the guide so that progressively more forward portions of the needles move into contact with the forward portion of the tape.

7. A method for laying a plurality of elongated members onto tape at closely controlled lateral spacings thereon at the front portions of the members comprising:

placing predetermined first portions of said elongated members which are spaced from the front ends thereof on a predetermined first tape region which is spaced from a forward tape portion communicating with a front end of the tape, and at positions on said first tape region which are accurately spaced from one another laterally across the width of the tape;

securing second portions of said elongated members which are behind said first portions thereof, onto regions of said tape behind said first tape region;

pulling said tape with the rear portions of said elongated members thereon, rearwardly, while guiding the forward tape portion and forward portions of each of the elongated members into contact with each other and maintaining closely controlled lateral spacing of the members; and

maintaining said elongated members in place on the tape.

* * * * *