United States Patent

Chu

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[54] **WIRING LOOM**

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[52] **U.S. Cl.** ....**29/203 MM**
[51] **Int. Cl.** **H05k 13/04**
[58] **Field of Search**.........29/203 MM, 203 MW, 203 B, 203, 29/208

[56] **References Cited**

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Primary Examiner—Thomas H. Eager
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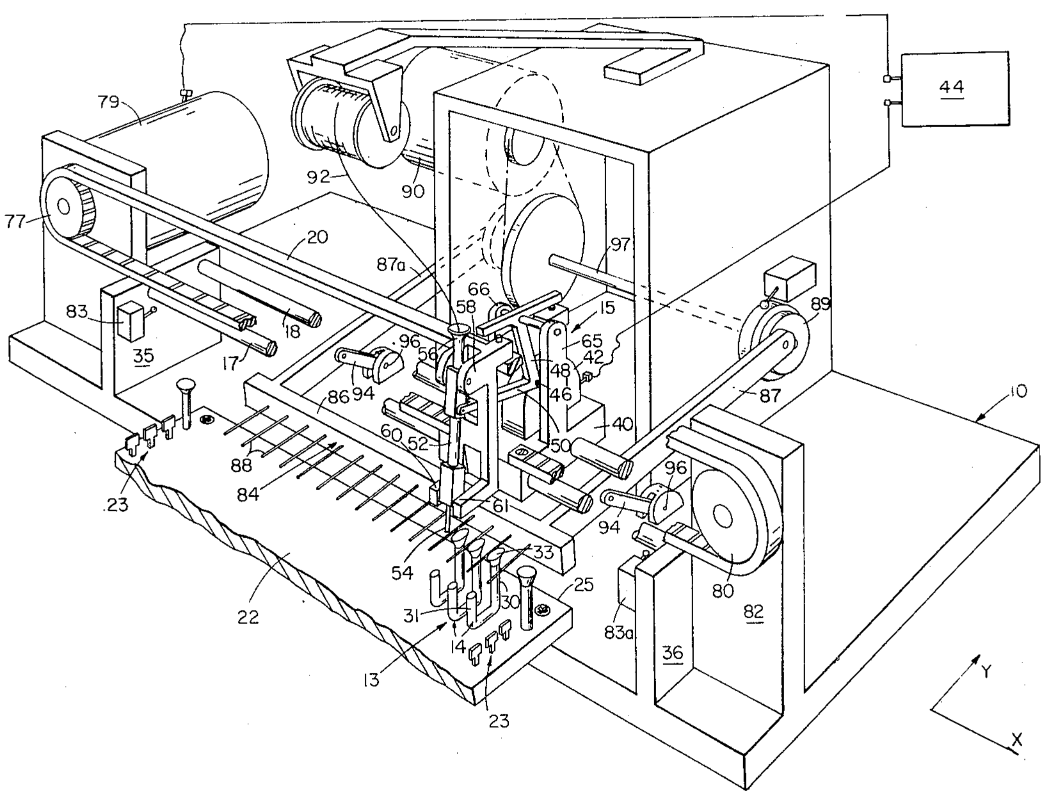
[57] **ABSTRACT**

An automatic wiring loom in which a row of core posts is held on a stationary base in horizontal alignment with a track, a wire laying head is movably mounted on a track and includes a carriage rotatably supporting a threading arm carrying wire to be woven, connected to an electrically operated solenoid for displacement of the arm in a plane normal to the row of core posts between a first position in which the arm is spaced inwardly from the side of the row of core posts adjacent the track, and a second position in which the arm is spaced outwardly from the opposite, outer side of the row of core posts, a motor driven timing belt is operatively associated with the wire laying head for effecting reciprocal movement along the track and control means are connected to the solenoid to reciprocally move the arm between the first position and the second position to weave wire around portions of said posts in a predetermined pattern to form a computer matrix.

6 Claims, 4 Drawing Figures



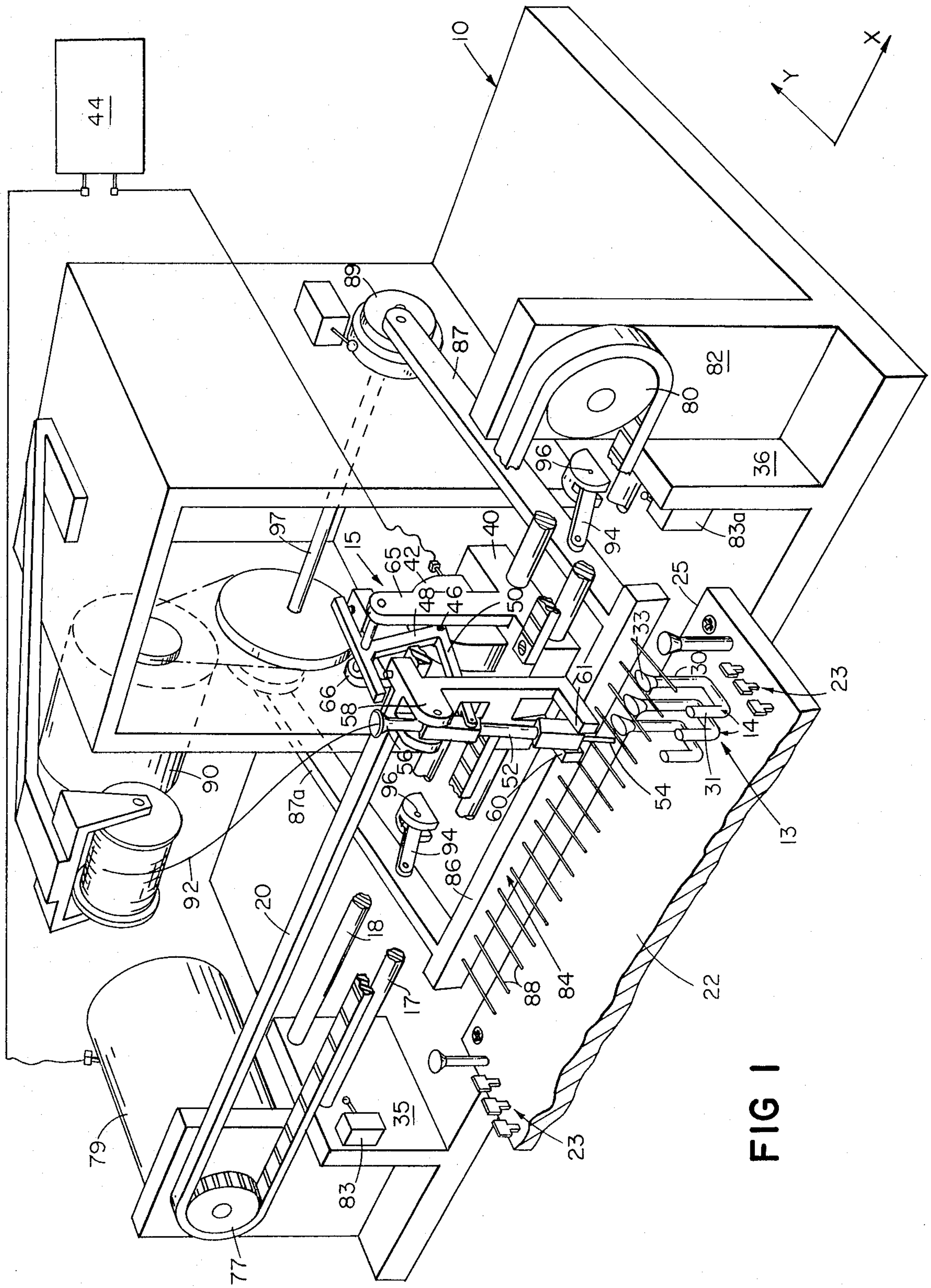

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FIG I

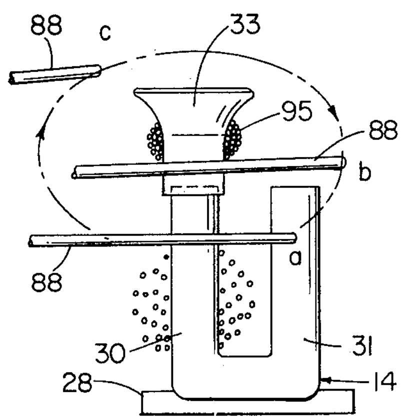

FIG 5

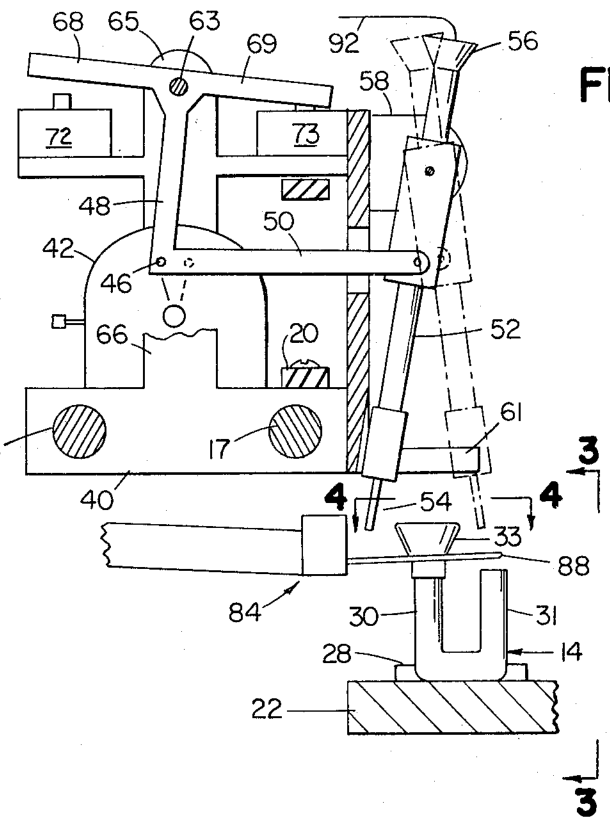

FIG 2

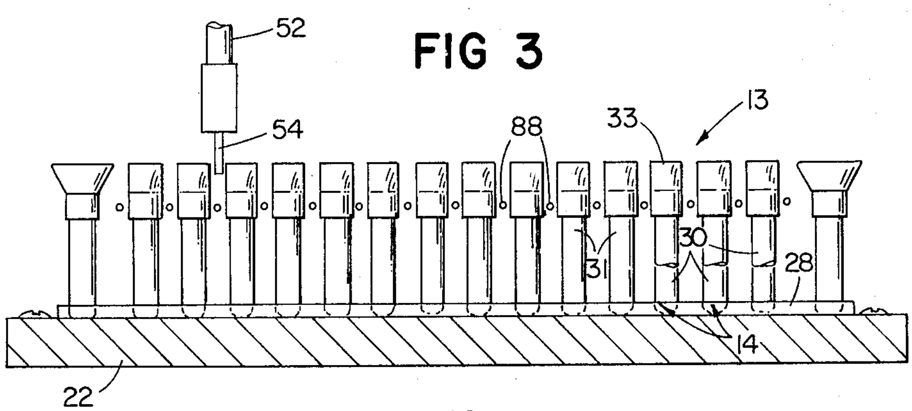

FIG 3

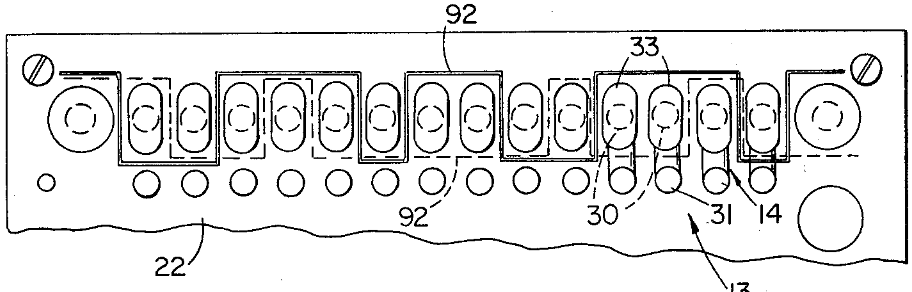

FIG 4

WIRING LOOM

This invention relates to controlled winding of wires around a series of core posts in predetermined patterns.

In recent years, woven wire matrixes have been used as memory elements in electronic computers. These memory elements are generally formed manually by weaving continuous insulatably coated conductors around a series of closely spaced core posts in given patterns to form a complex woven wire matrix. The wire, being thin, is difficult to manipulate, and where the number of closely spaced posts is large (i.e., 40), manual weaving is time consuming and produces occasional weaving errors due to the intricacy of the required weaving pattern. Such weaving errors are troublesome as they are difficult to detect and expensive to correct. Further, if undetected, these weaving errors introduce undesirable errors in the computer output. Consequently, there exists a need for a mechanical weaving device capable of rapidly weaving wire matrixes in an accurate manner.

Moreover, as computers use a variety of memory elements, each comprising a different wire matrix, the weaving device must not only be accurate but flexible (i.e., capable of weaving a variety of wiring patterns). It has been especially difficult to meet the dual requirements of uniformity of product and flexibility of product pattern in high-speed production systems.

Accordingly, it is a primary object of the invention to automatically control the weaving of wires around magnetic core memory posts by mechanical means in uniform predetermined patterns in an accurate, rapid manner. Other objects are to detect wiring errors as they occur during weaving, and to avoid tangling of wires during weaving.

These and other objects of the invention are uniquely accomplished in the preferred embodiment by providing an automatically controlled wiring loom having a stationary base for supporting a plurality of upwardly projecting core forms fastened to a memory element having a plurality of electrodes, the core forms being sequentially arranged horizontally in a row, tubular tracks positioned parallel to the row of core forms, being spaced rearwardly therefrom for slideably supporting wire laying means connected to traverse means and electronic control means for winding wire around the core posts in predetermined patterns. Preferably the wire laying means includes a carriage member pivotally supporting a threading arm having a feed tube carrying wire to be wound around the core forms, an electrically operated rotary solenoid linked to said arm and connected to a remotely located automatic control means for operating the threading arm and a rocker attached to the top of the threading arm for making and breaking switches connected with the control means for detecting weaving errors.

Also, the traverse means preferably includes a timing belt driven by a stepping motor, also connected to the automatic control means, attached to the carriage member of wire laying means for effecting reciprocal movement along said track in a transverse horizontal direction parallel to said row of core forms.

In another respect, the invention features a comb pivotally mounted adjacent and parallel with said row of core forms, having pins extending perpendicularly and horizontally between mandrels provided on the top of each core form and connected by linkage to drive means, all for controlling the stacking of wires wound on the core forms.

Wire weaving is accomplished by threading the free end of a continuous wire through the feed tube of the wire laying means, the other end of the wire being fastened to an electrode on the memory element and actuating the automatic control means to cause the traverse means to displace the carriage laterally along the track in a given direction (i.e., the X-axis) and to cause the solenoid to periodically move the weaving arm accurately and transversely toward or away from the row of core posts (i.e., in the Y-axis) between a given pair of core posts, to weave the wire around the series of core posts in a pattern determined by input (i.e., punched cards or magnetic tape) supplied to the automatic control means. Once the carriage has traversed the entire row of core posts, the wire is cut and attached to a second electrode. The free end of the remaining wire extending from the feed take is attached to a third electrode and the movement of the carriage is reversed to continue weaving in the opposite direction.

Periodically the comb is manually cycled through a generally elliptical path by drive means wherein the pins which normally support the wire matrix being formed on the mandrels above the core posts are withdrawn from beneath the wires permitting them to slide downwardly on the core posts for stacking, whereupon the comb is returned to the original position effective to compress the stacked wires. The winding cycle is repeated until a complete memory matrix is wound on the core forms.

For the purpose of more fully explaining the above and still further objects and features of the invention, reference is now made to the following detailed description of a preferred embodiment of the invention, together with the accompanying drawings, wherein:

FIG. 1 is an isometric view of the wiring loom according to the invention;

FIG. 2 is a fragmentary side elevation of the wire laying head and a core form of the wiring loom of FIG. 1;

FIG. 3 is a front elevation of a portion of FIG. 1 showing the row of core forms;

FIG. 4 is a plan view of the row of core forms of FIG. 3 showing two different weaving patterns; and,

FIG. 5 is an enlarged side elevation of the core form of FIG. 2 showing the elliptical path of the pins.

There is shown in FIG. 1 a wiring loom including a stationary base **10**, a row **13** of core forms **14** fixed to a horizontal panel **22** and a wire laying head shown generally at **15** slideably mounted on rods **17** and **18** and connected to motor driven timing belt **20**.

As seen in FIG. 1, panel **22** provided with a series of electrodes **23** arranged along opposite lateral edges is securely mounted on base **10** by means of screws. Core forms **14** totaling 14 in number, each constructed of molded plastic, are arranged in a row in spaced relationship along the top edge **25** of panel **22** parallel with the X-axis, being secured to said panel.

As shown in FIGS. 1 and 5, each core form **14** is constructed in a U-shape, is hollow for receiving magnetic cores, has a flat mounting member **28**, and is provided with two cylindrical, vertical posts **30** and **31**.

Each core form being aligned parallel with the Y-axis with respective post **30** adjacent edge **25** is provided with a removable plastic mandrel **33** having an oval top and curved inwardly and downwardly sloping walls for receiving wire stacked thereon as hereinafter described.

Mutually parallel rods **17** and **18**, consisting of aluminum, are mounted at opposite ends in spaced transverse vertical walls **35** and **36** provided in base **10**, and extend horizontally in the X-axis direction in parallel alignment with base **10**. Mounted on rods **17** and **18** in sliding engagement therewith is a wire laying head **15** including a movable carriage **40** supporting an electrically operated rotary solenoid **42** connected by leads to a remotely located control system comprising a programmer adapted to receive input such as punched cards or magnetic tape and to emit signals controlling the operation of drive **79** and solenoid **42** of known construction shown generally at **44**. Post **46** (see FIG. 2) connected to the internal armature of solenoid **42** reaches through an opening provided in the solenoid housing for engagement with upwardly extending rocker arm **48** and horizontally arranged drive bar **50**.

Included in wire laying head **15** is a hollow arm **52** provided with a threading tip **54** at the lower end positioned adjacent row **13** and a guide tube **56** at the upper end. Being pivotally mounted in bracket **58** secured to carriage **40**, arm **52** is connected to solenoid **42** by drive bar **50** for reciprocal movement parallel to the Y-axis from the "in" position shown in heavy lines in FIG. 2 to the "out" position shown in dotted lines.

Guide prongs **60** and **61** are provided adjacent threading tip **54** for extending through the spacing provided between adjacent core forms **14** for centering arm **52** relative to respective posts **30** to be wound with wire.

Rocker arm **48**, pivotally mounted on rod **63** extending horizontally between upright posts **65** and **66** on carriage **40**, is provided with oppositely extending lateral members **68** and **69** overlying microswitches **72** and **73** secured in spaced relationship on said carriage and an integral vertical shaft secured at one end to post **46**. Microswitches **72** and **73** are electrically connected to control system **44** for matching the actual position of arm **52** (i.e., "in") relative to a given post **30** with the programmed position (i.e., "in").

Timing belt **20** is supported between drive wheel **77**, mounted on drive **79**, and idler wheel **80** mounted on bracket **82** in parallel alignment with rod **17** and is attached at terminal portions to opposite sides of carriage **40** for horizontally driving wire laying head **15** reciprocably along rods **17** and **18**. Drive **79**, consisting of a stepping motor constructed with a total of 200 steps and designed to hesitate during rotation every 15 steps for positioning wire laying head **15** relative to the row of core forms **13**, is connected to the control system **44** for operating timing belt **20** in either clockwise or counterclockwise directions in synchronization with the operation of solenoid **42**. Limit switches **83** and **83***a* are mounted on walls **35** and **36** for contacting carriage **40** and stopping drive **79** at the traverse limits of said carriage.

Continuous wire **92** fed from a remotely located spool to guide tube **56** extends through the central hollow passage provided in arm **52** and projects outwardly through threading tip **54** for winding around respective posts **30**.

Further included in the wiring loom is a comb **84** comprising a bar **86** extending horizontally adjacent and parallel with the row of core forms **13**, having pins **88** projecting perpendicularly forward between mandrels **33** mounted on posts **30**. At opposite ends of bar **86**, beams **87** and **87***a* project rearwardly in the Y-direction having respective distal ends pivotally secured to posts offset from the axis of discs **89** and **89***a* mounted on shaft **97**. Intermediate bar **86** and discs **89**, beams **87** and **87***a* are movably supported by links **94** in turn mounted in swivels **96** provided on base **10**. Rotation of discs **89** by a conventional electric motor **90** connected to shaft **97** by means of a chain drive displaces bar **86** and pins **88** through an elliptical path adjacent mandrels **33** to control the stacking of wires thereon (see FIG. 5)

In operation, wire **92** is threaded on arm **52**, normally arranged in the "in" position, when wire laying head **15** is positioned by timing belt **20** on the left hand extremity of rods **17** and **18** adjacent wall **35**. Input in the form of magnetic tape defining a given wiring pattern is supplied to control system **44** for regulating the operation of solenoid **42** and electric drive **79**. Drive **79** rotates drive wheel **77** in a counterclockwise direction moving timing belt **20** also in a counterclockwise direction to displace wiring head **15** horizontally toward wall **36** along rods **17** and **18**. The periodic hesitation of drive **79** causes wire laying head **15** to pause opposite each spacing provided in row **13**. During traverse of wire laying head **15**, solenoid **42** alternatively moves arm **52** toward or away from the row of core posts to the "in" or "out" position responsive to control system **44** signals, passing tip **54** through the spaces provided between adjacent core posts **30** effective to wind the wire around mandrels **33** in a pattern regulated by control system **44** as seen in FIG. 4.

As post **46** is moved arcuately by the armature of solenoid **42** to displace arm **52** from the "out" position to the "in" position, rocker arm **48** is pivoted about the axis of rod **63** such that lateral member **69** closes microswitch **73** and opposite lateral member **68** opens microswitch **72** to provide feedback to control system **44**. Reverse movement of arm **46** pivots rocker arm **48** in the reverse direction to close microswitch **72** and open microswitch **73**. In the event solenoid **42** fails to actuate rocker arm **48** responsive to a given weaving pattern programmed in the control system and the appropriate microswitch is not consequently closed by said rocker arm, control system **44** stops drive **79** permitting immediate error detection.

Once wire laying head **15** has traversed the entire row **13** of core posts **14**, a segment of wire **92** is soldered to the proper electrode mounted on the right hand side of panel **22**; thereafter, the wire is cut to provide a free end to be attached to a second electrode. With wire **92** thus secured to a second electrode, timing belt **20** is driven in a clockwise direction by drive **79** responsive to control system **44** to cause wire laying head **15** to traverse toward wall **35** and wind a second wire pattern around row **13**. Winding is repeated by cycling wire laying head **15** reciprocally until the wiring matrix is completed.

As seen in FIG. 5, successive wires are supported by the curved walls of mandrels **33** above pins **88** normally occupying position *b*, the mandrels being of greater diameter than post **30**. The smooth surfaces of the mandrels act to guide the wires as they are wound and prevent tangling. Periodically, comb **84** is reciprocally cycled causing the tip of pins **88** to move through an elliptical path permitting the accumulated wires **95** to drop down to surround post **30**, being compressively stacked thereon as the pins move from position *c* to *a*.

Other embodiments will occur to those skilled in the art and are within the following claims.

What is claimed is:

1. An automatic wiring loom for weaving wire onto a workpiece having a row of magnetic core memory posts comprising

workpiece support means aligning and supporting in a predetermined position said workpiece with track means positioned parallel to said support means carrying said row of core posts and spaced therefrom

wire laying carriage means movably mounted on said track including wire weaving arm means movable in a direction normal to said support means carrying said row of core posts and to said track means, said arm means being movable between a first position in which said arm means s spaced from one side of said row of core posts adjacent said track to a second position in which said arm is spaced from the opposite side of said row of core posts, and

control means for controlling said carriage and arm means to weave said wire about portions of said posts in a predetermined pattern.

2. An automatic wiring loom as claimed in claim **1** wherein a comb is provided for alternatively stacking wire segments on the core posts and compacting said wires on the base of said posts.

3. An automatic wiring loom as claimed in claim **1** wherein said pattern may be readily altered by changing input consisting of memory elements to said control means.

4. An automatic wiring loom as claimed in claim **1** wherein said arm means is connected to a rotary solenoid mounted on said carriage means for movement in a direction normal to said row of core posts and to said track means.

5. An automatic wiring loom for weaving wire onto a workpiece having a row of magnetic core memory posts comprising

workpiece support means aligning and supporting in a predetermined position said workpiece with track means positioned parallel to said support means carrying said row of core posts and spaced therefrom

wire laying carriage means movably mounted on said track means including wire weaving arm means movable in a direction normal to said support means carrying said row of core posts and to said track means, said arm means being movable between a first position in which said arm means is spaced from one side of said row of core posts adjacent said track to a second position in which said arm is spaced from the opposite side of said row of core posts,

traverse means connected to said carriage means for effecting reciprocal movement of said carriage means along said track means

control means for controlling said carriage and arm means to reciprocally weave said wire about portions of said posts in a predetermined pattern in both the right hand and left hand direction

detecting means connected to said arm means and said control means for monitoring weaving of said pattern to detect weaving errors and arrest said carriage and arm means facilitating removal of said errors.

6. An automatic wiring loom as claimed in claim **5** wherein said traverse means includes a timing belt connected to said carriage means, said belt being driven by an electric stepping motor.

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