NASA CASE NO. LAR 15072-1

PRINT FIG. 1

P-19

NOTICE

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Serial No.: 08/260,162
06/10/94 LaRC

(NASA-Case-LAR-15072-1) ADJUSTABLE REED FOR WEAVING NET-SHAPED TAILORED FABRICS Patent Application (NASA. Langley Research Center) 19 p

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NASA Case No. LAR 15072-1

ADJUSTABLE REED FOR WEAVING NET-SHAPED TAILORED FABRICS

AWARDS ABSTRACT

The ability to weave fabrics with variable widths and fill yarn angles is a critical capability for forming net-shaped tailored fabrics. Traditionally, it has been possible to modify fabric widths by halting production and exchanging fixed reeds. In addition, fill yarn angle was typically modified by canted reeds. Neither of these approaches permitted fabric width and fill yarn angle to be modified dynamically and simultaneously. The present invention overcomes these limitations through the use of an adjustable reed.

The invention comprises an adjustable reed in which groups of reed wires are attached to sliders mounted on reed rails. The distance between groups of reed wires can be varied during weaving. Also, the distances between the reed wires within a group can be varied. This ability permits the fabric width to be changed dynamically, without the need to halt production to exchange fixed reeds. In addition, the reed wires within each group can be skewed during weaving to dynamically and simultaneously modify the fill yarn angle.

Novel aspects of the present invention include a fully adjustable reed comprised of reed groups in which the distance between reeds and the angular positions of the reed wires within a group can be varied to modify fabric width and fill yarn angle simultaneously during weaving.

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ADJUSTABLE REED FOR WEAVING NET-SHAPED TAILORED FABRICS

Origin of the Invention

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to weaving and more particularly to an adjustable reed capable of tailoring the fill yarn angle and width of woven fabrics.

2. Description of the Related Art

The traditional role of the reed in the weaving of net-shaped fabrics is to tailor the fill yarn angle, control the width of the fabric and beat the fill yarn into the fell of the fabric. Increased flexibility in the design and fabrication of fabrics could be obtained if the ability to control the location of each reed wire were achieved. Conventional reeds, including fixed reeds and width adjustable reeds offer some flexibility in fabrication, but are still severely limited.

Fixed reeds such as fan reeds, in which the shape of the reed is unalterable, typically have been used to tailor fabric width. However, the fixed reed constrains the tailoring of fabric width based upon the fixed reed's original shape since the location of the warp yarn is set by the design of the reed. This makes use of such reeds impracticable or impossible in applications where the design requires a high level of tailorability. Even where it is possible to produce the desired fixed reed geometry, the reed may only be applicable to that specific application. Producing new reeds for each application is expensive and time consuming especially when prototyping a new structure where a design may still be in a state of flux. Adjustable width reeds are known, but offer only limited variations in reed spacing. U.S. Patent No. 5,067,215 to Behl et al. discloses an expanding reed comprised of a number of hinged points which can be moved in a guide to uniformly pull apart the individual reed teeth to a greater or lesser extent to change the width of a yarn sheet. U.S. Patent No. 5,158,116 to Kazuo et al. discloses several means for moving dents toward and away from each other, including: 1) a guide plate with a pattern of elongated slits to guide the dents, 2) an expander in which individual dents are mounted to crossing portions, and 3) an elastic member to which individual dents are attached at equal intervals.

The ultimate in tailorability of fill yarn angle and fabric width would require the ability to dynamically change the location of each individual reed wire during the weaving process. However, for most structural applications it would be more practical to control the position of groups of reed wires. In the present invention, reed wires are grouped and each group can be moved parallel and perpendicular to the warp yarns. The profile of the reed wires within the groups can be skewed to tailor fill yarn fiber angle and the reed wires within each group can be simultaneously spread or contracted to locally control fabric width. In addition, the spacing between reed groups can be individually varied. This dual capability to vary fill yarn angle and fabric width does not exist in typical fixed reeds or adjustable width reeds. Presently, if variations of width or fill yarn angle are desired in a finished article it is generally necessary to exchange reeds or halt the production to adjust the reed.

The tailorability possible with the present invention may offer benefits in the fabrication of a variety of materials. Laminated composite materials have typically been difficult to fabricate because they exhibit many unique failure modes. Delamination induced failures initiated at the free edge of the composite laminate are frequently produced. This failure is created from the high interlaminar stresses that only occur adjacent to the free edge. The creation and magnitude of these interlaminar stresses near the free edge can be partially attributed to the mismatch in Poisson's ratio between adjacent layers of material having different fiber orientation. The ability to tailor the fiber angle in each layer near the free edge could result in a significant reduction in the magnitude of these interlaminar and intralaminar stresses. Utilizing the adjustable reed of the present invention, it will be possible to readily tailor the fiber orientation of each layer at the free edge.

An adjustable reed with the ability to control the fiber angle and fabric width dynamically during the weaving process greatly increases the level of tailoring that is achievable by facilitating the simultaneous local tailoring of fill yarn angle and fabric width along the length of the fabric. This adjustability results in higher levels of structural efficiency and reduced structural cost through more optimal use of materials and the elimination of the need for secondary steps such as cutting. An adjustable reed will also significantly reduce material prototyping cost because new reeds will not have to be produced for each design and through reducing setup time required to redraw the warp yarns through the loom.

Summary of the Invention

It is accordingly an object of the present invention to form fabrics using an adjustable reed wherein the fill yarn angle can be modified.

It is another object of the present invention to form fabrics using an adjustable reed wherein the fill yarn angle can be modified during fabrication without the need to halt production to adjust the reed.

It is another object of the present invention to form fabrics using an adjustable reed to modify the fabric width.

It is another object of the present invention to form fabrics using an adjustable reed to modify the fabric width during fabrication without the need to halt production to adjust the reed.

It is another object of the present invention to form fabrics using an adjustable reed by simultaneously controlling the local fill yarn fiber angle and the fabric width.

It is another object of the present invention to form fabrics using an adjustable reed wherein the fill yarn fiber angle and the fabric width can be modified simultaneously and continuously during fabrication, without the need to halt production to adjust the reed.

The above and numerous other objects are achieved by an adjustable reed which generally includes a reed frame which supports a number of reed groups. Each reed group has a number of slotted reed wires which are supported on reed wire sliders. The reed wire sliders are supported by reed wire rails and are capable of movement along the reed wire rails. Fill yarns are positioned within the slots of the reed wires. The position of the fill yarns can be modified by motion of the sliders which can be translated as a group or skewed to create a local change in fill yarn angle. The width of the fabric can be changed by spreading the reed rails which support the reed wire sliders.

The flexibility in adjusting the fill yarn angle by translation or skewing of the reed wire sliders, combined with the ability to modify fabric width by spreading of the reed wire rails, permits the formation of a variety of net shape fabrics with desired mechanical properties related to fill yarn angle. This adjustable reed offers the additional advantage of being able to modify fabric width and fill yarn angle without the need to halt production, i.e., it is not necessary to stop production to exchange reeds of various designs in order to get various configurations in the finished fabric.

Brief Description of the Drawings

Other objects, features and advantages of the present invention will become more fully apparent from the following detailed description of the preferred embodiment, the appended claims and the accompanying drawings, in which:

FIG. 1 is a perspective view of a reed frame with three reed groups in accordance with this invention.

FIG. 2 is a side view of a reed group mounted in a reed frame.

FIG. 3(a) is an end view of a reed wire group.

FIG. 3(b) is a side view of a reed wire group.

FIG. 4(a) is a top view of reed wire sliders mounted on reed rails.

FIG. 4(b) is a top view of reed wire sliders mounted on reed rails and skewed with respect to each other.

FIG. 5(a) is a top view of an expanded end bracket.

FIG. 5(b) is a top view of a retracted end bracket.

FIG. 6(a) is a top view of an expanded end bracket with reed rails.

FIG. 6(b) is a top view of a retracted end bracket with reed rails.

FIG. 7(a) is a top view of an expanded end bracket with rail expanders.

FIG. 7(b) is a top view of a retracted end bracket with rail expanders.

Description of the Preferred Embodiments

Referring to FIG. 1, an adjustable reed includes a reed frame **8** which supports a plurality of reed group frames **95**. Each reed group frame **95** is comprised of two elongated, vertical end pieces. Each of the end pieces is connected at the top to a linear actuator **40** which is any conventional device that converts power, such as electric, pneumatic or hydraulic, into linear motion. Interposed between each bottom portion of each end piece and the top surface of the reed frame **8** is a bearing **115**, such that the reed group frame **95** can move along parallel to the edge of the reed frame **8** upon which it is supported. A plurality of reed rails **30** are expandably connected to the inner face of each of the reed group frames **95**. Details of the expanding means **79** are provided below in reference to FIGS. 5-7. A rail slider **20** is slidably disposed on each reed rail **30**. The tops of each rail slider **20** within each reed group frame **95** are rotatably interconnected by a telescoping rod **70**. A reed wire **10** is attached to the bottom of each rail slider **20** and hangs beneath it. A fiber angle motor **50** is connected at one end to the linear actuator **40** and is rotatably connected at the other end to the telescoping rod **70** whereby movement of the linear actuator **40** pulls the fiber angle motor **50** parallel to the length of the reed rails **30**, along with the reed wires **10** and rail sliders **20** which are attached to the telescoping rod **70**.

For illustration purposes only, three reed group frames **95** are shown, with each reed group frame **95** holding a group of five reed rails

30 which support a corresponding number of rail sliders **20** with attached reed wires **10**. The number of reed group frames **95** may vary to accomodate fabrication of a specific fabric. In addition, the number of rail sliders **20** with attached reed wires **10** in each group may vary. Although the preferred embodiment illustrates a group with five reed wires **10** spaced at about four wires per inch, any number of reed wires **10** may be used at any convenient spacing sufficient to produce a fabric of a desired width with the desired fill yarn angle.

Referring now to FIG. 2, rail expanding means **79** are interconnected between each reed rail **30** and the reed group frame **95**. Details of the expanding means are discussed below in reference to FIGS. 5-7. Each expanding means **79** is connected to a rail spreader motor **105** by means of a shaft **100**, such that rotation of the shaft causes the expanding means **79** to expand or contract to vary the distance between the reed rails **30** within each reed group. A reed group motor **110** is attached to one end of each reed group frame **95**. The lower end of the reed group motor **110** is attached to a bearing **116** which interacts with a worm gear (not shown) attached to the outer edge of one side of the reed frame **8** along which the reed group frame **95** travels, such that activation of the reed group motor **110** causes the reed group frame **95** to travel along the edge of the reed frame **8**.

As illustrated in FIGS. 3(a) and 3(b), each rail slider **20** within a reed group is rotatably connected to a telescoping rod **70**. The rail sliders **20** are slotted to accomodate the reed rails **30** and slider bearings **113** are interposed between the rail sliders **20** and the reed rails **30** to facilitate movement of the rail sliders **20** along the reed rails **30**. The reed wires **10** are suspended beneath the rail sliders **20** and are slotted to accomodate the warp yarns **14**. In alternate embodiments of the present invention, the reed wires **10** may be substantially solid with the warp yarns **14** positioned between and guided by the reed wires **10** or there may be a combination or slotted and solid wires with warp yarns positioned both in the slots and between the wires.

As shown in FIGS. 4(a) and 4(b), each reed slider **20** is connected to a segment of a telescoping rod **70**. The telescoping rod **70** is further connected at the center segment of the rod to the fiber angle motor **50**, as shown in FIGS. 3(a) and 3(b). Activation of the fiber angle motor **50** causes rotation of the center segment and expansion of the telescoping rod **70** which results in skewing of the rail sliders **20** on the reed rails **30** to produce variations in fiber yarn angle. Regardless of whether the telescoping rod **70** is expanded or contracted, the reed sliders **20** attached to the telescoping rod **70** are moved along the reed rails **30** as a group as the fiber angle motor **50** is pulled along the linear actuator **40**.

The expanding means **79** is shown in FIGS. 5-7 and is comprised of a telescoping end bracket **80** and rail expanders **90**. A telescoping end bracket **80** is interposed between the reed group frame **95** and is attached at each end of each reed rail **30** within each reed rail group. The telescoping end bracket **80** has a segment attached to each reed rail **30** to keep the reed rails **30** in a vertical position and to facilitate the spacing of the reed rails **30**. A hinged, segmented rail expander **90** is rotatably attached to each segment of the telescoping end bracket **80**. The rail spreader motor **105**, see FIG. 2, is attached to the center segment of the rail expander **90**, such that as the motor **105** turns, the center segment of the rail expanders **90** rotate causing the end bracket **80** to expand or contract laterally.

The operation of all the motors disclosed in the above illustration of the preferred embodiment can be controlled by any convenient, conventional means, ranging from manual to computer control.

While the present invention has been disclosed in connection with the preferred embodiment thereof, it should be understood that there may be other embodiments which fall within the spirit and scope of the invention. All such modifications are intended to be encompassed within the following claims.

What is claimed is:

ADJUSTABLE REED FOR WEAVING NET-SHAPED TAILORED FABRICS

Abstract

The invention is an apparatus and method for forming woven fabrics through the use of an adjustable reed. The adjustable reed has multiple groups of reed wires that guide the warp yarns. The groups of reed wires move on reed rails parallel to the warp direction. In addition, rail expanders permit the space between the reed wires to be modified and telescoping rods attached to the rail sliders can be turned to permit the reed wires to be skewed to alter the fill yarn angle. These adjustments to the reed permit simultaneous variation of fill yarn angles and fabric widths and allow these variations to be made during fabrication, without the need to halt production.

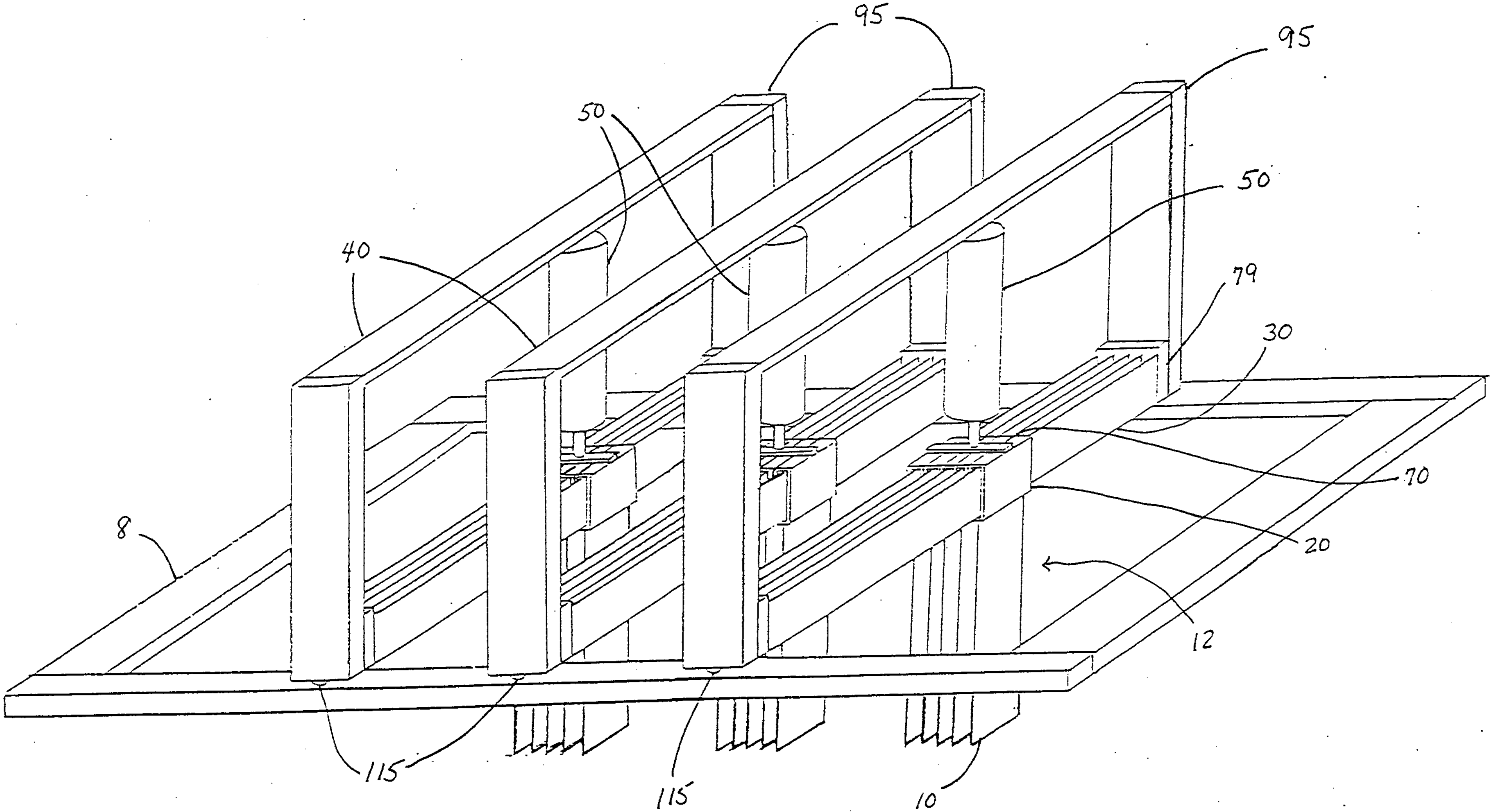

FIG. 1

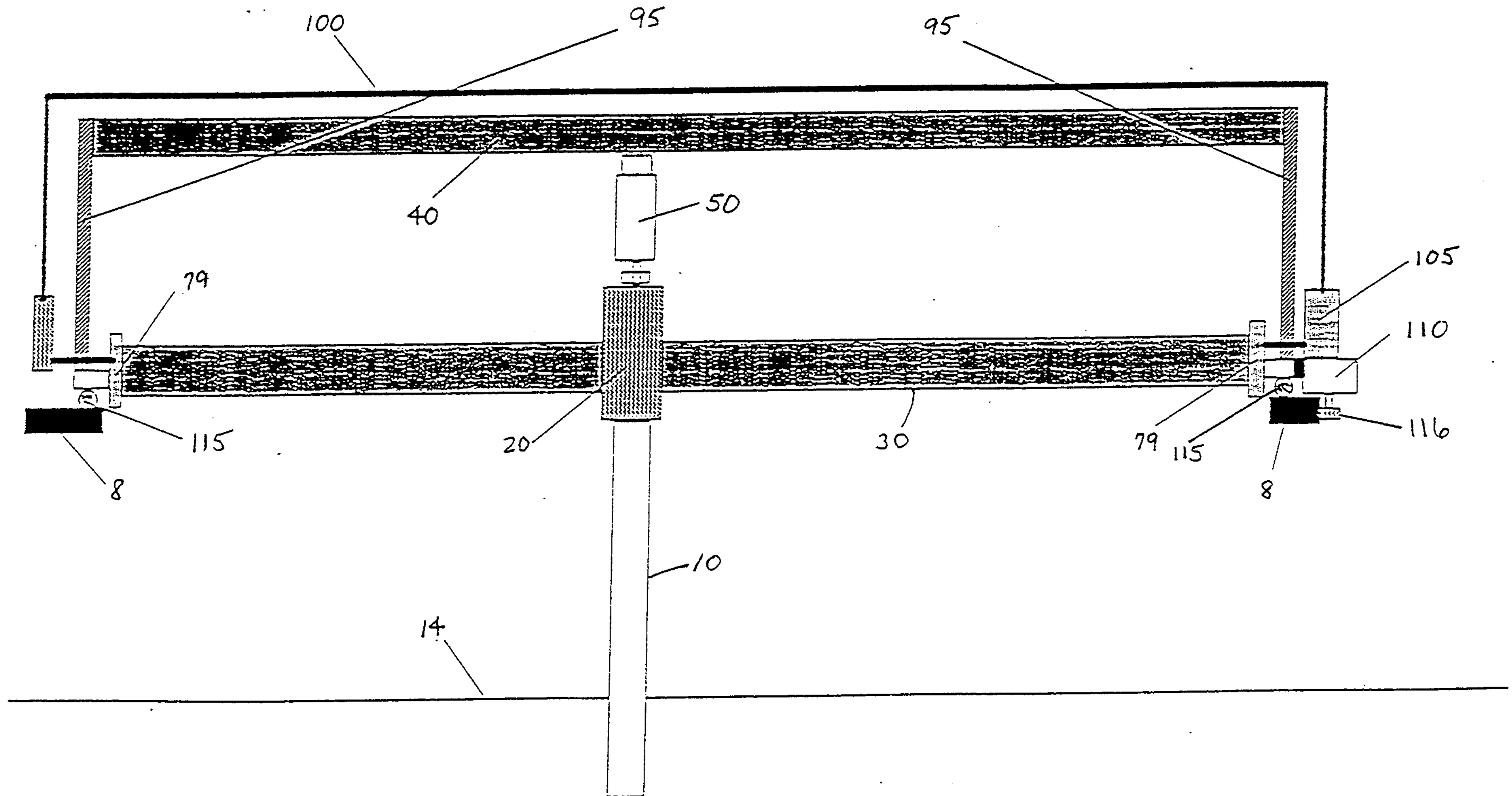

FIG. 2

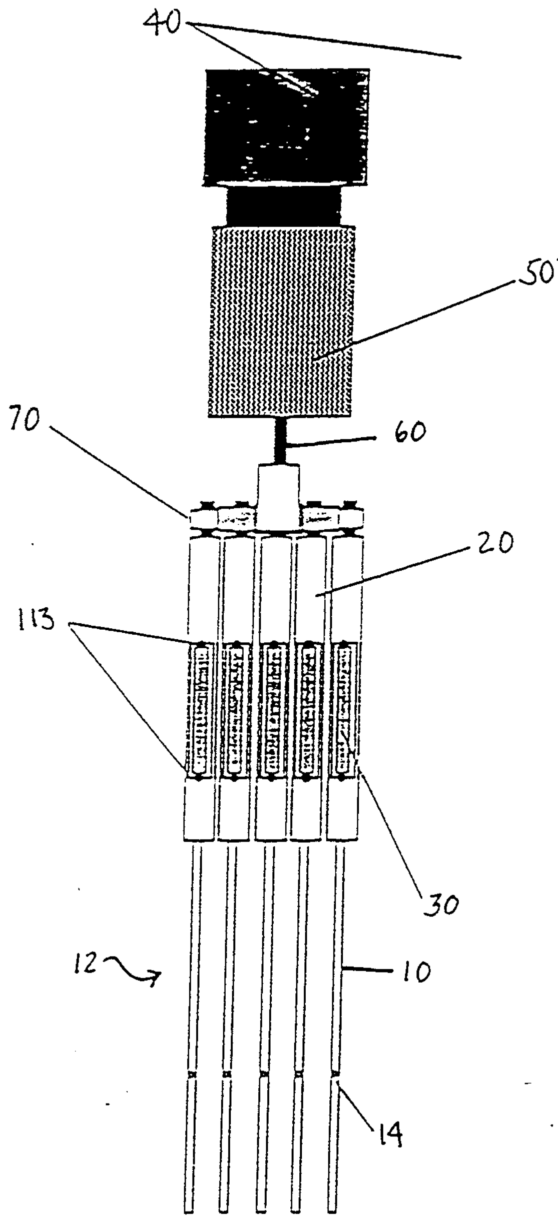

FIG. 3(a)

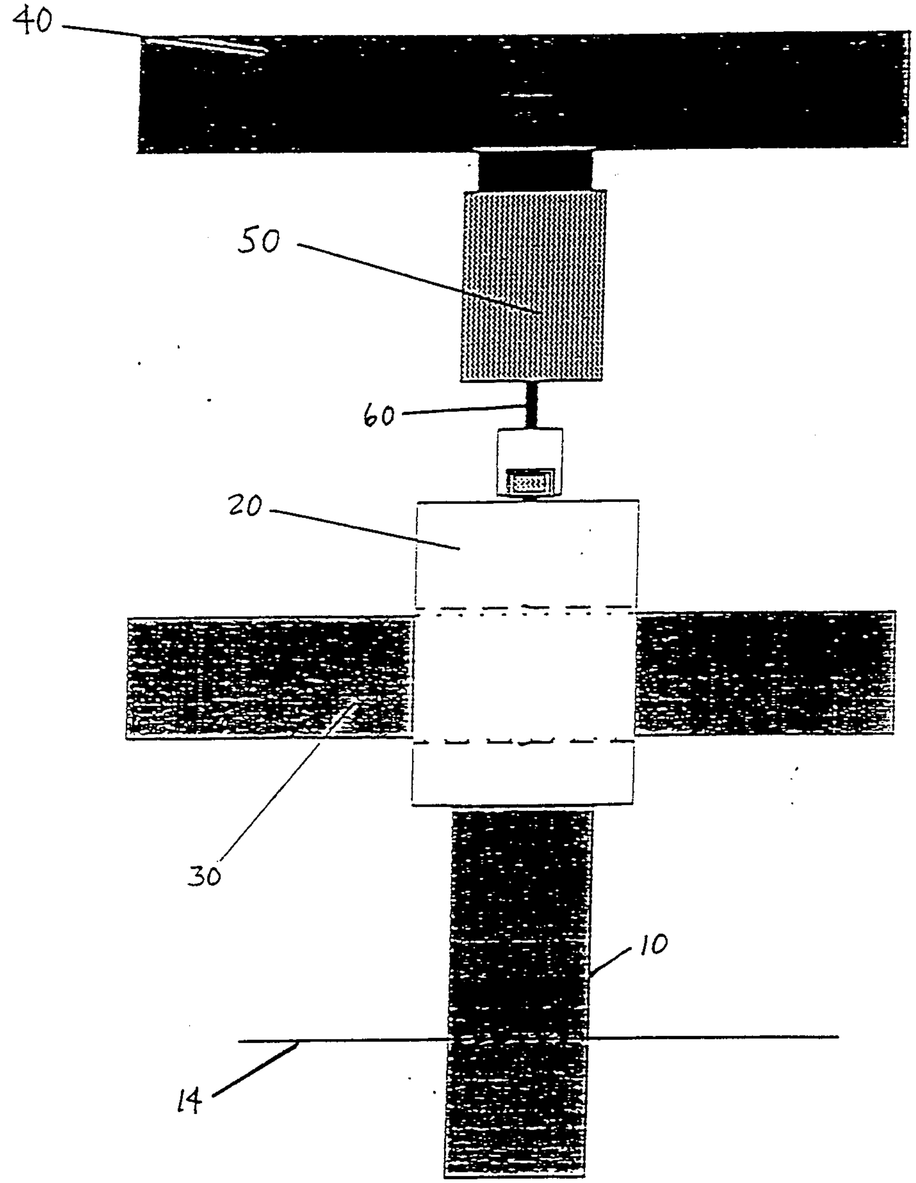

FIG. 3(b)

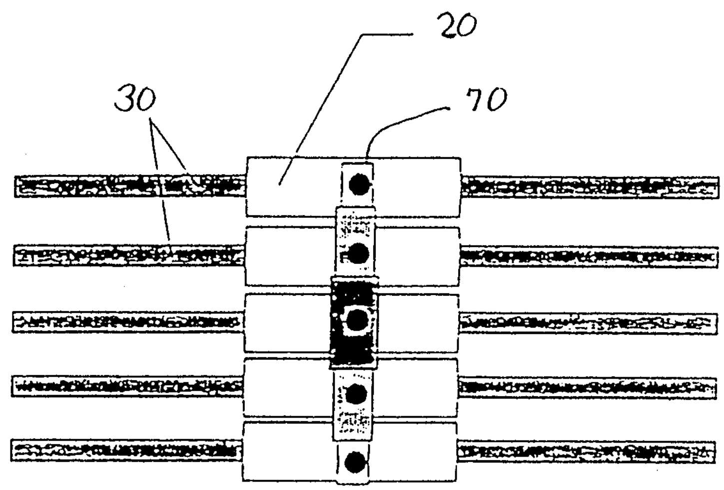

FIG. 4(a)

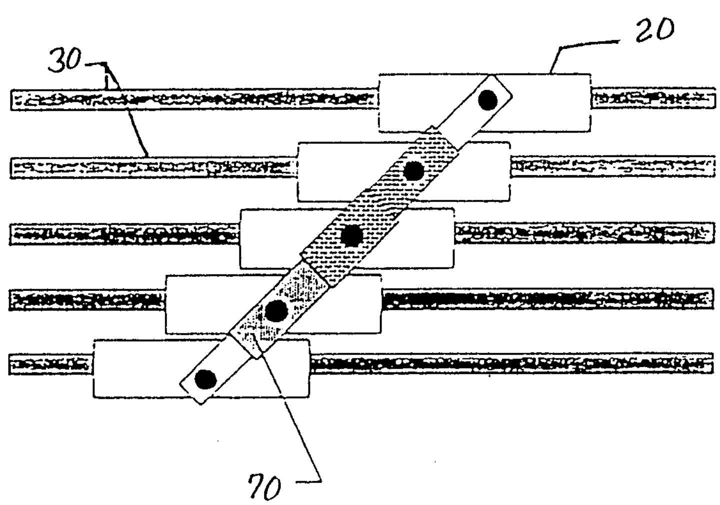

FIG. 4(b)

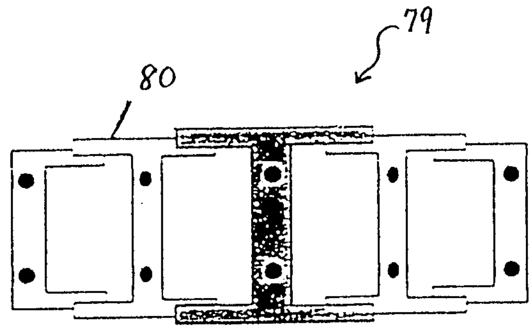

FIG. 5(a)

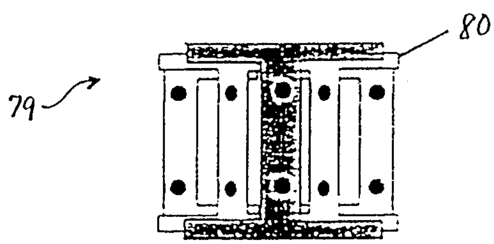

FIG. 5(b)

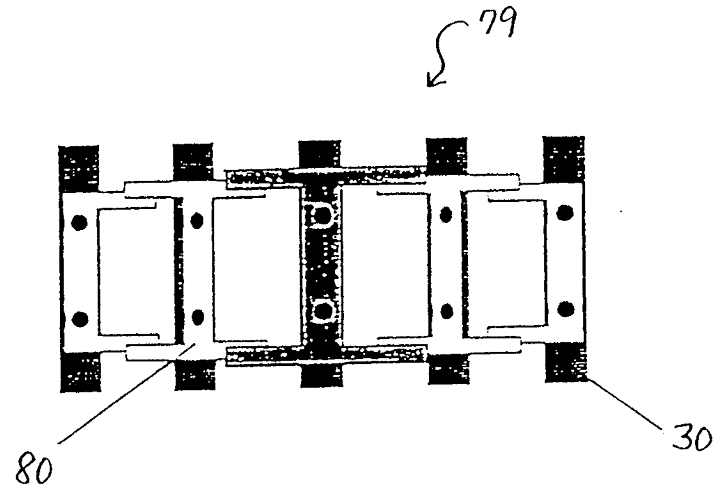

FIG. 6(a)

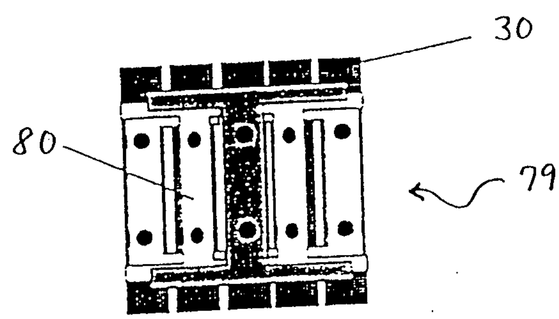

FIG. 6(b)

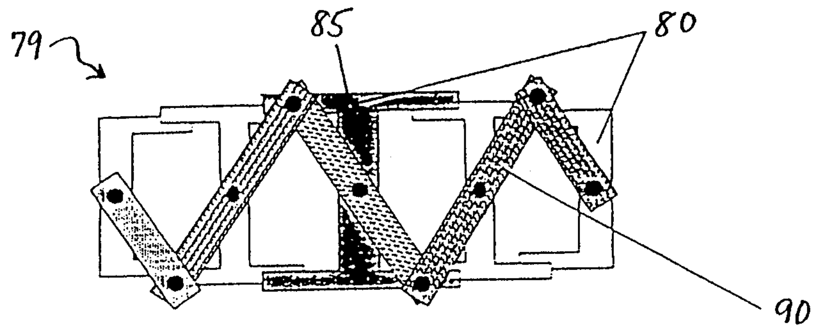

FIG. 7(a)

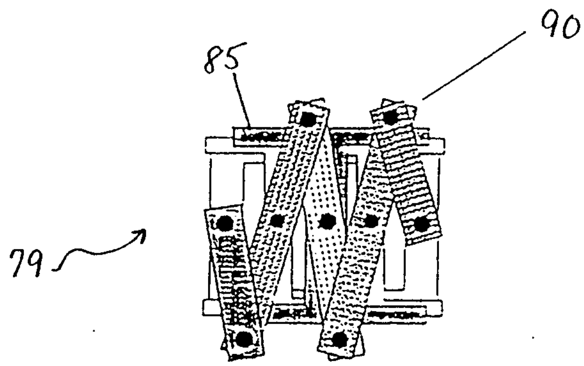

FIG. 7(b)