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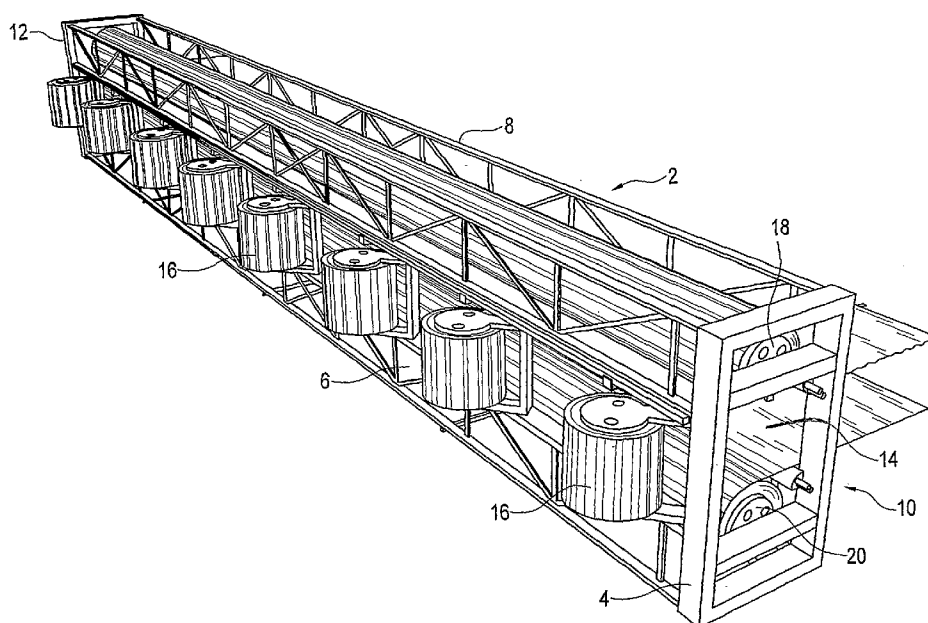
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(54) Title: JOIST FORMING CONSTRUCTION MACHINE AND METHODS



(57) Abstract: A machine and methods of automated building construction are disclosed. A structural member assembly machine has a support frame; a structural member assembly area within the support frame; joist feeder means for feeding a plurality of joists on-edge into the structural member assembly area, upper paneling feeder means connected to the support frame above the joist feeders; lower paneling feeder means connected to the support frame below the joist feeders; structural member assembly means for assembling a plurality of joists, upper paneling and lower paneling into a structural member; structural member receiving means for receiving a structural member, and drive means for moving the structural member through the machine.

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Joist Forming Construction Machine and Methods**Technical Field**

The present invention relates to automated construction. In particular, the invention relates to an apparatus and method for automatic construction of a building using a joist forming device.

Background Art

Conventional frame building construction relies on labour intensive manual work. Upon completion of a foundation, workers must install joists and flooring, erect wall frames, add wall sheathing on exterior and interior surfaces, and add roof trusses and sheathing. In addition, plumbing and electrical wiring require drilling of holes in structural members of the building frame to route wires and pipes to appropriate locations. A large crew of skilled tradespersons are required for building construction.

There is a need, therefore, for a machine and methods of automated construction of a building. In an earlier patent, the inventor of the present invention disclosed an automated construction system which uses prefabricated joists, wherein the joists are parallel to the construction machine and perpendicular to the machine direction. There is a need for an automated construction machine and methods which incorporate joist forming device, and wherein the joists are fed into the structural members perpendicularly to the machine, and parallel to the machine direction.

While the prior art contains some elements useful in automated building construction, none of the prior art incorporate all of the desired characteristics of a machine and methods for automated construction of buildings using a joist forming device according to the invention.

Disclosure of Invention

According to one embodiment of the present invention, there is provided a structural member assembly machine with a support frame having opposed entry and exit sides, opposed first and second ends; a structural member assembly area within the support frame; joist feeder means for feeding a plurality of joists end-on into the structural member assembly area, comprising a plurality of joist feeders releasably connected at spaced intervals on the entry side of the support frame; upper paneling feeder means connected to the support frame above the joist feeders for

feeding upper paneling into the structural member assembly area; lower paneling feeder means connected to the support frame below the joist feeders for feeding lower paneling into the structural member assembly area; structural member assembly means in the structural member assembly area for assembling a plurality of joists, upper paneling and lower paneling into a structural member; structural member receiving means adjacent the exit side of the support frame for receiving a structural member, and drive means for moving the structural member from the assembly area to the structural member receiving means.

The joist feeder may have a housing; at least two rollers, each rotationally connected to the housing; a roll of a joist material wrapped on each roller; a template connected to the housing in spaced relationship to each roll of joist material, wherein the template includes an opening defining a joist circumference, joist material from each roll guidable through the opening so as to position at least one portion of each joist material adjacent to at least one portion of at least one other piece of joist material at a welding position; a welding head disposed in proximity to each welding position; means for connecting each welding head to a welding machine; and sensor means for selectively activating the welding machine to weld adjacent portions of joist material at each welding position to form a joist.

The at least two rollers may be four rollers and the joist circumference may be in the shape of an I-beam or a quadrilateral. Alternatively, the at least two rollers may be three rollers and the joist circumference may be in the shape of a triangle having concave sides.

The joist feeder may have a housing having a roller attached; a roll of a joist material wrapped on the roller; a joist forming unit connected to the housing adjacent to the roll of joist material, wherein the joist forming unit comprises a series of wheels and presses for forming the joist material; at least one welding head disposed at a welding position adjacent the formed joist material; means for connecting each welding head to a welding machine; and sensor means for selectively activating the welding machine to weld the formed joist material at each welding position into a joist.

The structural member assembly machine may have joist fill means for inserting joist fill through the opening of the template into the interior space of each joist. The joist fill means may be at least one tube for passage of joist fill from a fill source into each joist. The joist fill may be a

foam and a bonding agent, concrete, or other structural fill material having an additive or characteristic permitting bonding of the material to the interior of the joist.

Each joist feeder may include corrugation means for corrugating a planar joist material to form a corrugated joist. The corrugation means may be one or more gears rotationally connected to the support frame between the joist feeder and the structural member assembly area, through which the planar joist passes to form a corrugated joist, and corrugated joist bracing means between the joist feeder and the structural member assembly area.

The upper paneling feeder means may include a housing; a roller rotationally connected to the housing; a roll of upper paneling material wrapped on the roller; and guide means for positioning the upper paneling in an installation position adjacent the upper edges of the plurality of joists.

The upper paneling may be corrugated upper paneling. The upper paneling means may further comprise corrugation means for corrugating upper paneling material to form corrugated upper paneling, the corrugation means positioned between the upper paneling feeder and the guide means. The corrugation means may comprise a pair of gears rotationally connected to the support frame between the roll of upper paneling material and the structural member assembly area, through which the upper paneling material passes to form corrugated upper paneling. Alternatively, the corrugation means may comprise at least one hydraulic press, each hydraulic press extending adjacent the frame between the upper paneling feeder and the structural member assembly area, for stamping a plurality of corrugation grooves into the upper paneling material to form corrugated upper paneling.

The upper paneling feeder means may comprise an upper paneling bay; a plurality of individual upper panels stacked in the upper paneling bay; and guide means for positioning the upper paneling in an installation position adjacent the upper edges of the plurality of joists.

The structural member assembly machine may further comprise an actuator connected to the support frame adjacent the rear side of the upper paneling feeder for horizontal dislocation of the lowermost upper panel from the upper paneling bay to an installation position adjacent the upper edges of the plurality of joists.

Each upper panel may have substantially planar upper and lower surfaces, irregular corrugations to control meshing of vertically adjacent upper panels, or synchronous corrugations with separators between upper panels to permit horizontal dislocation of a lowermost upper panel of vertically stacked upper panels.

Each joist may have irregular corrugation along the length of its upper edge corresponding to the irregular corrugation of the upper panels in a manner which prevents meshing of each upper panel with the upper edge of the joist until the joist is in the appropriate position for receiving the lowermost upper panel. Alternatively, each joist may have synchronous corrugation along the length of its upper edge corresponding to the synchronous corrugation of each upper panel in a manner which permits movement of each joist to cause co-linear movement of an upper panel intermittently lowered into an installation position adjacent the joist.

The lower paneling means may comprise a housing; a roller rotationally connected to the housing; a roll of lower paneling material wrapped on the roller; guide means for positioning the lower paneling in an installation position adjacent the lower edges of the plurality of joists. The lower paneling may be corrugated lower paneling. The lower paneling means may further comprise corrugation means for corrugating lower paneling material to form corrugated lower paneling, the corrugation means positioned between the lower paneling feeder and the guide means. The corrugation means may comprise a pair of gears rotationally connected to the support frame between the roll of lower paneling material and the structural member assembly area, through which the lower paneling material passes to form corrugated lower paneling. Alternatively, the corrugation means may comprise at least one hydraulic press, each hydraulic press extending adjacent the frame between the lower paneling feeder and the structural member assembly area, for stamping a plurality of corrugation grooves into the lower paneling material to form corrugated lower paneling.

The lower paneling feeder means may comprise a lower paneling bay; a plurality of individual lower panels stacked in the lower paneling bay; and guide means for positioning the lower paneling in an installation position adjacent the lower edges of the plurality of joists. An actuator may be connected to the support frame adjacent the rear side of the lower paneling feeder for horizontal dislocation of the uppermost lower panel from the lower paneling bay to an installation position adjacent the lower edges of the plurality of joists.

Each lower panel may have substantially planar upper and lower surfaces, irregular corrugations to prevent meshing of vertically adjacent lower panels, or synchronous corrugations with separators between adjacent lower panels to permit horizontal dislocation of an uppermost lower panel of vertically stacked lower panels.

Each joist may have irregular corrugation along the length of its lower edge corresponding to the irregular corrugation of the lower panels in a manner which prevents meshing of each lower panel with the lower edge of the joist until the joist is in the appropriate position for receiving the uppermost lower panel. Alternatively, each joist may have synchronous corrugation along the length of its lower edge corresponding to the synchronous corrugation of each lower panel in a manner which permits movement of each joist to cause co-linear movement of a lower panel intermittently raised into an installation position adjacent the joist.

The structural member assembly means may further comprise fastening means for fastening the upper paneling to the joist material and the joist material to the lower paneling. The fastening means may include mechanical fasteners such as screws, rivets, nails and staples and associated automated fastening devices such as screw guns or nail guns. The fastening means may include at least one welding device, which may be adapted to weld together the joist and the upper paneling, as well as the joist and the lower paneling.

The structural member receiving means may be a constructed platform, a horizontal construction surface of a building under construction, or a vehicle bed.

The structural member assembly machine may include utility line insertion means for inserting utility lines during assembly of the assembled structural member. The structural member assembly machine may include insulation insertion means for inserting insulation material during assembly of the assembled structural member. The insulation insertion means may include at least one insulation feeder tube having a dispensing end positioned adjacent the structural member assembly area for dispensing the insulation material into the interior of the structural member. The insulation material may be sprayable polyurethane foam insulation, loose-fill fibre insulation, or other sprayable or blow-in form of insulation.

The structural member assembly machine may include finishing material application means for applying a finishing material to the assembled structural member. It may also include vapour barrier application means for applying a vapour barrier to the assembled structural member.

The structural member assembly machine may include a plurality of parallel trusses extending perpendicularly to the joists between opposed ends of the frame and releasably fastened to each joist to provide structural support during assembly of the structural member. Each parallel truss may be fastened to the upper edges of the joists or to the lower edges of the joists. The plurality of parallel trusses may extend beyond the ends of the frame and further comprises rollable support means fixed to the ends of each truss for supporting the truss and the structural member.

According to another embodiment of the present invention, there is provided a method of constructing an assembled structural member, comprising the steps of extruding initial portions of a plurality of parallel joists from a plurality of joist feeders into a structural member assembly area to form a joist array having opposing upper and lower faces; positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array; fastening each of the upper paneling and lower paneling to the joists of the joist array; extruding subsequent portions of the plurality of parallel joists into the structural member assembly area; repeating the steps of positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array; fastening each of the upper paneling and lower paneling to the joists of the joist array; and extruding subsequent portions of the plurality of parallel joists into the structural member assembly area until a desired joist length has been achieved; and repeating the steps of positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array; and fastening each of the upper paneling and lower paneling to the joists of the joist array a final time to complete the assembled structural member.

The method of constructing an assembled structural member may include any of the additional steps of inserting utility lines during assembly of the assembled structural member, inserting insulation during assembly of the assembled structural member, applying a finishing material to the assembled structural member, or applying a vapour barrier to the assembled structural member.

According to another embodiment of the present invention, there is provided a welding apparatus for manufacturing a longitudinal structural element, comprising a housing; at least two rollers, each rotationally connected to the housing; a roll of structural material wrapped about each roller; means for feeding the end of each roll of structural material through a template connected to the housing in spaced relationship to each roll of structural material, wherein the template includes an opening defining a structural circumference, structural material from each roll guidable through the opening so as to position at least one portion of each piece of structural material adjacent to at least one portion of at least one other piece of structural material at a welding position; a welding head disposed in proximity to each welding position; means for connecting each welding head to a welding machine; and sensor means for selectively activating the welding machine to weld adjacent portions of structural material at each welding position to form a longitudinal structural element. The at least two rollers may be four rollers and the structural circumference may be in the shape of an I-beam or a quadrilateral. The at least two rollers may be three rollers and the structural circumference may be in the shape of a triangle having concave sides.

The longitudinal structural elements may be joists, ducting, concrete forms or other similar structural members. The welding apparatus may also include structural fill means for inserting structural fill through the opening of the template into the interior space of each longitudinal structural element.

According to another embodiment of the present invention, there is provided a method of manufacturing a longitudinal structural element, comprising the steps of feeding at least two flexible structural material feedstocks in spaced orientation through a first side of a template, wherein the template guides at least one portion of each feedstock into a position adjacent to a corresponding portion of at least one other feedstock; welding each of the pairs of adjacent portions together in the vicinity of the template to form a longitudinal structural element; repeating these steps until the longitudinal structural element is of a desired length; and separating the longitudinal structural element from the at least two structural material feedstocks.

The at least two feedstocks may be four feedstocks and the template circumference may be in the shape of an I-beam or a quadrilateral. Alternatively, the at least two feedstocks may be three

feedstocks and the template circumference may be in the shape of a triangle having concave sides. The longitudinal structural elements may be joists, ducting, concrete forms or similar.

Brief Description of Drawings

A detailed description of the preferred embodiments is provided by way of example only and with reference to the following drawings, in which:

FIG. 1 is a perspective view of a structural member assembly machine, according to one embodiment of the invention;

FIG. 2 is a perspective view of a joist feeder, according to one embodiment of the invention;

FIG. 3 is a perspective top view of a joist feeder, according to one embodiment of the invention, showing opposed wheel drive means;

FIG. 4 is a perspective view of a joist feeder, according to one embodiment of the invention;

FIG. 5 is a perspective view of a structural member assembly machine, according to one embodiment of the invention;

FIG. 6 is a perspective view of a joist feeder, according to one embodiment of the invention;

FIG. 7 is a frontal view of a joist feeder showing a template, according to one embodiment of the invention;

FIG. 8 is a perspective view of a joist feeder showing a template, according to one embodiment of the invention;

FIG. 9 is a perspective view of a joist feeder showing a joist section bay, according to one embodiment of the invention;

FIG. 10 is a perspective view of a joist feeder showing a joist section bay, according to one embodiment of the invention;

FIG. 11 is a perspective view of a joist feeder showing a joist section bay, according to one embodiment of the invention;

FIG. 12 is a perspective view of a joist feeder showing a joist section bay, according to one embodiment of the invention;

FIG. 13 is a perspective view of a joist feeder showing a press device, according to one embodiment of the invention;

FIG. 14 is a perspective view of a joist feeder showing bevelled ended joist sections, according to one embodiment of the invention;

FIG. 15 is a perspective view of a joist feeder showing bevelled ended joist sections, according to one embodiment of the invention;

FIG. 16 is a perspective view of a plurality of joist feeders, according to one embodiment of the invention;

FIG. 17 is a perspective view of a joist exiting a joist feeder, according to one embodiment of the invention;

FIG. 18 is a perspective view of a joist feeder showing corrugation gears, according to one embodiment of the invention;

FIG. 19 is a perspective view of a joist feeder using a prior art corrugation means;

FIG. 20 is a perspective view of a structural member assembly machine using a prior art corrugation means, according to one embodiment of the invention;

FIG. 21 is a perspective view of a joist feeder, showing joist bracing means, according to one embodiment of the invention;

FIG. 22 is a side view of a structural member assembly machine, according to one embodiment of the invention;

FIG. 23 is a perspective view of a structural member assembly machine using a prior art joist corrugation means, according to one embodiment of the invention;

FIG. 24 is a perspective view of a structural member assembly machine using a prior art joist corrugation means, according to one embodiment of the invention;

FIG. 25 is a perspective view of a structural member assembly machine using a prior art joist corrugation means, according to one embodiment of the invention;

FIG. 26 is a perspective view of a structural member assembly machine showing upper and lower paneling bays, according to one embodiment of the invention;

FIG. 27 is a side view of a structural member assembly machine, showing non-engagement of the upper and lower panels with the irregularly corrugated joist, according to one embodiment of the invention;

FIG. 28 is a side view of a structural member assembly machine, showing engagement of the upper and lower panels with the irregularly corrugated joist, according to one embodiment of the invention;

FIG. 29 is a perspective view of a structural member assembly machine, showing a planar joist array, according to one embodiment of the invention;

FIG. 30 is a side view of a structural member assembly machine, showing an upper panel actuator in a raised position, according to one embodiment of the invention;

FIG. 31 is a side view of a structural member assembly machine, showing an upper panel actuator in a lowered position, according to one embodiment of the invention;

FIG. 32 is a perspective view of a corrugated upper panel, showing a slot cut to receive a joist, according to one embodiment of the invention;

FIG. 33 is a side view of a structural member assembly machine, showing fastener means external to the structural member, according to one embodiment of the invention;

FIG. 34 is a side view of a structural member assembly machine, showing fastener means internal to the structural member, according to one embodiment of the invention;

FIG. 35 is a perspective view of a welding device, according to one embodiment of the invention;

FIG. 36 is a side view of a structural member assembly machine, showing welding of a joist to upper and lower panels to extract the panels from the panel bays, according to one embodiment of the invention;

FIG. 37 is a perspective view of a structural member receiving means, according to one embodiment of the invention;

FIG. 38 is a perspective view of a structural member assembly machine, showing a line insertion spool, according to one embodiment of the invention;

FIG. 39 is a perspective view of a structural member assembly machine adjacent a structural member receiving means, according to one embodiment of the invention;

FIG. 40 is a perspective view of a truss attached below a structural member, according to one embodiment of the invention;

FIG. 41 is a perspective view of a structural member assembly machine adjacent a structural member receiving means, showing a wheeled support attachment, according to one embodiment of the invention; and

FIG. 42 is a side view of a truss attachment device, according to one embodiment of the invention.

In the drawings, one embodiment of the invention is illustrated by way of example. It is to be expressly understood that the description and drawings are only for the purpose of illustration and as an aid to understanding, and are not intended as a definition of the limits of the invention.

Modes for Carrying Out the Invention and Industrial Applicability

As shown in Fig. 1, according to one embodiment of the present invention, there is provided a structural member assembly machine 2. The machine has a support frame 4 having opposed entry 6 and exit 8 sides, opposes first 10 and second 12 ends; and defines a structural member assembly area 14 within the frame.

Joist feeder means comprising a plurality of joist feeders 16, for feeding a plurality of joists on-edge into the structural member assembly area 14, is disposed along the length of the entry side

of the frame. In this specification, "on-edge" means the spatial orientation in which the planar surface of a material is generally in a vertical position with one longitudinal edge below the planar surface and one longitudinal edge above the planar surface. A row of joist feeders is connected at spaced intervals at a medial position on the entry side of the support frame. Upper paneling feeder means 18 is connected to the support frame at a position above the joist feeders, for feeding upper paneling into the structural member assembly area. Similarly, lower paneling feeder means 20 is connected to the support frame below the joist feeders, for feeding lower paneling into the structural member assembly area.

Structural member assembly means (not shown) may be disposed in the structural member assembly area, for assembling a plurality of joists, upper paneling and lower paneling into a structural member. Structural member receiving means may be located adjacent the exit side of the support frame, for receiving a structural member. Drive means, for moving the structural member from the structural member assembly area to the structural member receiving means, may be located within or outside of the support frame.

In one embodiment, heating means, such as gas torches, may be connected to or in proximity to the support frame to heat rolls of joist or panelling material to increase ease of unrolling.

As shown in Figs. 2, 3 and 4, the drive means to provide horizontal movement of the structural member through the machine may be effected by feeding the joists 22 between a first surface 24 comprising one or more adjacent moving wheels, sprockets, chains or belts, and an opposing second surface 26 which may be either a stationary surface, such as a brace, or a second moving surface comprising one or more wheels, sprockets, chains or belts. These wheels, sprockets, chains or belts may be located between the joist feeder means and the structural member assembly area.

Fig. 5 depicts the horizontal movement of the structural member out of the exit side of the support frame. Upper paneling 28 and lower paneling 30 are connected to joists 22 by fastening means, such as a welding device 32. The upper and lower paneling of the structural member is threaded between a moving surface 34 of wheels, sprockets, chains or belts and an opposing surface 36 which is either a stationary surface (not shown) or a second moving surface of wheels, sprockets, chains or belts. These wheels, sprockets, chains or belts may be located adjacent against the upper or lower paneling, or both, on the exit side 8 of the upper paneling feeder

means 18 and lower paneling feeder means 20. In one embodiment, the upper or lower paneling materials may be fed into one or an opposed pair of gears for corrugating the paneling.

As shown in Figs. 6, 7 and 8, the joist feeder 16 may have a housing 38; at least two rollers 40, each rotationally connected to the housing; a roll of a joist material 42 wrapped on each roller; a template 44 connected to the housing in spaced relationship to each roll of joist material, wherein the template includes an opening defining a joist circumference, joist material from each roll guidable through the opening so as to position at least one portion of each joist material adjacent to at least one portion of at least one other piece of joist material at a welding position 48; at least one welding head 50 disposed in proximity to each welding position; connection means 52 for connecting each welding head to a welding machine (not shown); and sensor means 54 for selectively activating the welding machine to weld adjacent portions of joist material at each welding position to form a joist 22.

The at least two rollers may be four rollers and the joist circumference may be in the shape of an I-beam or a quadrilateral. Alternatively, the at least two rollers may be three rollers and the joist circumference may be in the shape of a triangle having concave sides. Other joist shapes are also contemplated as being within the scope of the present invention.

According to another embodiment of the present invention, as shown in Figs. 9 to 13, the joist feeder may comprise a joist section bay 56. Joist sections 58 may be extruded individually from the joist section bay by one or more horizontal actuators 60 which separate one joist section from the joist sections remaining in the bay by pushing the joist section out of the bay, then retracting and repeating the process. Sequentially separated joist sections may be attached at their ends to form a joist 22. The first joist section may be stopped by a press device 62 in alignment with a vertically mobile welding head 64 for welding the joist sections together. The press device may be used to align the trailing end of a first joist section with the leading end of the next joist section. The actuators may connect to the joist by pushing on the front edge of a cut-out in the joist's webbing. They may comprise a sub-actuator that penetrates the joist section or two opposed actuators which each press against the joist section as they move forward. The pair of actuators may keep the joist sections in alignment with the press device.

In the embodiment shown in Figs. 14 to 16, the joist sections 58 may be oppositely bevelled at each end to permit staggered overlapping of joist sections. The joist sections may be extruded

alternately from opposing sides of the joist section bay 56 by one or more horizontal actuators 60 which separate one joist section from the joist sections remaining in the corresponding side of the bay by pushing the joist section out of the bay, then retracting and repeating the process. Sequentially extracted joist sections may be laminated together to form a joist.

As shown in Fig. 17, perpendicular joists may be cantilevered to reduce immediate sagging and rotation by applying a first smooth rotating surface 66 near the entry side of the support frame above and in contact with the joists, and a second smooth rotating surface (not shown) near the exit side of the support frame below and in contact with the joist.

In an alternative embodiment (not shown), joists may have glue applied to upper and lower edges by a porous roller or dispenser located outside the joist bay to be extruded into the joist bay into installation positions. The joists may have pegs fastened to upper and lower edges prior to entering the joist bay. These pegs may be installed by punching the underside of a joist's flanges to create a metal extrusion which may act as a fastening peg. The upper and lower paneling is penetrable by the pegs during assembly of the structural member.

The structural member assembly machine may have joist fill means for inserting joist fill through the opening of the template into the interior space of each joist. The joist fill means may be at least one tube for passage of joist fill from a fill source into each joist. The joist fill may be a foam and a bonding agent, concrete, or other structural fill material having an additive or characteristic permitting bonding of the material to the interior of the joist.

As shown in Fig. 18, each joist feeder may include corrugation means for corrugating a planar joist material to form a corrugated joist material. The corrugation means may be one or more gears rotationally connected to the support frame between the joist feeder and the structural member assembly area, through which the planar joist material passes to form a corrugated joist material, and joist material bracing means 70 between the joist feeder and the structural member assembly area.

It is known to provide a device that extrudes a joist by passing a planar joist material through wheels and presses, as shown in Fig. 19. The joist feeder may have a housing 38 having a roller attached; a roll of a joist material 42 wrapped on the roller; a joist forming unit 72 connected to the housing adjacent to the roll of joist material, wherein the joist forming unit comprises a series

of wheels and presses for forming the joist material (not shown); at least one welding head 50 disposed at a welding position adjacent the formed joist material; means for connecting each welding head to a welding machine; and sensor means for selectively activating the welding machine to weld the formed joist material at each welding position into a joist.

This device can be used in the present invention, as shown in Fig. 20 in which the joist feeders are attached to the frame on the entry side and the force used to extrude the corrugated joists may be employed to provide the force to move the joists in the machine direction 74.

As shown in Fig. 22, bracing may be provided to prevent rotation of the joist and to ensure proper alignment with welding or other fastening devices. Bracing may be in the form of strips of material 76 which create a support channel for the joist which does not allow the joist to deviate from proper alignment.

As shown in Figs. 22 and 23, the upper paneling feeder means may include a housing 78; a roller 80 rotationally connected to the housing; a roll of upper paneling material 82 wrapped on the roller; and guide means 84 for positioning the upper paneling in an installation position adjacent the upper edges of the plurality of joists 86.

The upper paneling may be corrugated upper paneling, as shown in Figs. 24 and 25. The upper paneling means may further comprise corrugation means for corrugating planar upper paneling to form corrugated upper paneling, the corrugation means positioned between the upper paneling feeder and the guide means. The corrugation means may comprise a pair of gears 88 rotationally connected to the support frame 4 between the roll of upper paneling and the structural member assembly area, through which the upper paneling material passes to form corrugated upper paneling. Alternatively, the corrugation means may comprise at least one hydraulic press (not shown), each hydraulic press extending adjacent the frame between the upper paneling feeder and the structural member assembly area, for stamping a plurality of corrugation grooves into the upper paneling material to form corrugated upper paneling.

In another embodiment of the present invention, as best seen in Fig. 26, the upper paneling feeder means may comprise an upper paneling bay 90; a plurality of individual upper panels 92 stacked in the upper paneling bay; and guide means for positioning the upper paneling in an installation position adjacent the upper edges of the plurality of joists. The structural member

assembly machine may further comprise an actuator 94 connected to the support frame adjacent the entry side of the upper paneling feeder for horizontal dislocation of the lowermost upper panel from the upper paneling bay to an installation position adjacent the upper edges of the plurality of joists 86.

Individual upper panels may be stacked directly above the joists. One or more actuators push the lowest upper panel out from under the upper paneling bay. Upper panels are pushed into an installation position with the leading edge of the panel aligned with a welding head 50. The upper panels will fall into place on top of the joist array. The welding head connects the upper panel to the joists. The structural member 96 is then extruded until the trailing edge of the joists and panels is in alignment with the welding heads. Subsequent upper panels are positioned above the joists with the leading edge abutting the trailing edge of the preceding upper panel, then welded to the joist array. The process is repeated until the structural member is complete.

The upper paneling material may have a corrugated lower side with pattern which only allows the paneling to fall onto the joist when the corrugation of the upper edge of the joist corresponds to the paneling. For example, the paneling would have its largest indentation at its rear edge to prevent the rear edge from falling into the joist corrugation until the joist is in the appropriate installation position beneath the paneling.

Paneling with a corrugated lower edge may be lowered into position adjacent joists with male to female corresponding upper edges and paneling with a corrugated upper edge may be raised into a position adjacent the same joists having a corresponding lower edge. When the joists are extruded horizontally the paneling is caused to move. The lower paneling may be raised by a lower panel actuator which would keep upward pressure on the paneling until the uppermost panel has been entirely removed from the lower paneling bay. The upper panel may be lowered onto the joists by members attached to the upper paneling bay which support the panels from underneath. As the first upper panel is moved out of the machine, actuators (not shown) situated within the support members may extrude vertically to prevent the next panel from prematurely falling onto the joists'. When the panel is fully removed from the machine the vertical actuators descend allowing the next panel to fall onto the joist corrugation. Glue applicators for fastening the panels to the joists, may be located inside or outside of the paneling bay.

Each upper panel may have substantially planar upper and lower surfaces, irregular corrugations to prevent meshing of vertically adjacent upper panels, or synchronous corrugations with separators between upper panels to permit horizontal dislocation of a lowermost upper panel of vertically stacked upper paneling.

As shown in Figs. 27 and 28, each joist 22 may have irregular corrugation along the length of its upper edge corresponding to the irregular corrugation of the upper panels 92 in a manner which prevents meshing of each upper panel with the upper edge of the joist until the joist is in the appropriate position for receiving the lowermost upper panel. The joists may instead have planar edges, as shown in Fig. 29. Alternatively, each joist may have synchronous corrugation along the length of its upper edge corresponding to the synchronous corrugation of each upper panel in a manner which permits movement of each joist to cause co-linear movement of an upper panel intermittently lowered into an installation position adjacent the joist, as shown in Figs. 30 and 31.

As shown in Figs. 22 to 25, the lower paneling means may comprise a housing 100; a roller 20 rotationally connected to the housing; a roll of lower paneling 102 wrapped on the roller; guide means 104 for positioning the lower paneling in an installation position adjacent the lower edges of the plurality of joists. The lower paneling may be corrugated lower paneling.

The lower paneling means may further comprise corrugation means for corrugating lower paneling material to form corrugated lower paneling, the corrugation means positioned between the lower paneling feeder and the guide means. The corrugation means may comprise a pair of gears rotationally connected to the support frame between the roll of lower paneling material and the structural member assembly area, through which the lower paneling material passes to form corrugated lower paneling. Alternatively, the corrugation means may comprise at least one hydraulic press, each hydraulic press extending adjacent the frame between the lower paneling feeder and the structural member assembly area, for stamping a plurality of corrugation grooves into the lower paneling material to form corrugated lower paneling.

As shown in Fig. 26, the lower paneling feeder means may comprise a lower paneling bay 106; a plurality of individual lower panels stacked in the lower paneling bay; and guide means for positioning the lower paneling in an installation position adjacent the lower edges of the plurality of joists. An actuator 110 may be connected to the support frame adjacent the rear side of the

lower paneling feeder for horizontal dislocation of the uppermost lower panel from the lower paneling bay to an installation position adjacent the lower edges of the plurality of joists.

Individual lower panels may be stacked directly below an array of joists. One or more actuators may push the uppermost lower panel out from the lower paneling bay. Lower panels are pushed into an installation position with the leading edge of the panel aligned with a welding head. The structural member is then extruded until the trailing edge of the joists and panels is in alignment with the welding heads. The lower panel may be raised into position against the joist array by a vertical actuator (not shown). The welding head connects the lower panel to the joists. Upper and lower panels may be simultaneously positioned and welded. Subsequent lower panels are positioned below the joists with the leading edge abutting the trailing edge of the preceding lower panel, then welded to the joist array. The process is repeated until the structural member is complete.

Each lower panel may have substantially planar upper and lower surfaces, irregular corrugations to prevent meshing of vertically adjacent lower panels, or synchronous corrugations with separators between adjacent lower panels to permit horizontal dislocation of an uppermost lower panel of vertically stacked lower paneling.

According to another embodiment of the present invention, upper or lower paneling may be comprised of solid panels stacked on longitudinal edge, each panel hingedly connected to the next adjacent panels along its longitudinal edges. A first panel would be installed onto the joists and be extruded. Each subsequent panel would immediately begin to rotate flat into an installation position on the joists.

Each joist may have irregular corrugation along the length of its lower edge corresponding to the irregular corrugation of the lower panels in a manner which prevents meshing of each lower panel with the lower edge of the joist until the joist is in the appropriate position for receiving the uppermost lower panel. Alternatively, each joist may have synchronous corrugation along the length of its lower edge corresponding to the synchronous corrugation of each lower panel in a manner which permits movement of each joist to cause co-linear movement of an lower panel intermittently raised into an installation position adjacent the joist.

As shown in Fig. 32, corrugated paneling may have one or more continuous slots 112 cut through its underside for receiving the edge of extruded joists. As the joist is connected to the paneling the paneling acts as a structural flange. The paneling may be cut to an extent that only the upper portion of the corrugation would remain.

According to one embodiment of a method for securing joists having a planar upper and lower edge to corrugated paneling, the joist feeders may extrude a sufficiently long portion of joist to reach the fastening means, then paneling may be connected to the leading top and bottom edges of the joist. The joist feeders may extrude a further portion of the joists, thereby moving the structural member onto a structural member receiving structure. A glue dispenser may be used to apply glue to the upper and lower edges of a joist as it is being produced to permit attachment to upper and lower paneling.

The structural member assembly means may further comprise fastening means for fastening the upper paneling to the joist material and the joist material to the lower paneling. The fastening means may include mechanical fasteners such as screws, rivets, nails and staples, along with devices such as staple and nail guns for applying these mechanical fasteners. As shown in Figs. 33 and 34, one or more fastener guns 114 may be positioned on the leading edge of the frame to connect the paneling to the joists. Fastening guns may be positioned internal to or external to the structural member during assembly. Gluing may also be used to connect joists to paneling.

Materials which lack a broad upper and lower edge for receiving a mechanical fastener may be fastened together by welding. The fastening means may include at least one welding device, which may be adapted to weld together the joist and the upper paneling, as well as the joist and the lower paneling. Welding may be internal or external to the structural member. As shown in Fig. 35, welding devices 116 may be stationary and may use the horizontal movement of the structural member to make a continuous or intermittent welded connection. The welding heads 50 may continuously connect corrugated material by incorporating wheels 118 and a spring 120 or dampener which allows the welding head to move with the varying heights of the corrugation. This movement may occur along two axes by including stationary smooth braces outside of the spring. Plates made from a high heat resistance material may be positioned on the opposite side of the paneling from the welding heads to exert pressure firmly onto the joist during welding. These plates may be liquid cooled.

In a joist driven system paneling may be extruded by welding a small strip of paneling to the top and bottom edge of a joist, as shown in Fig. 36. The joist will extrude the paneling as it moves.

The structural member receiving means may be a constructed platform 122, as shown in Fig. 37. Alternatively, the structural member receiving means may be a horizontal construction surface of a building under construction or a vehicle bed.

Methods of structural member assembly production may incorporate material threading. As depicted in Fig. 38, the structural member assembly machine may include utility line insertion means for inserting utility lines during assembly of the assembled structural member. The lines and wires may include plumbing, HVAC ducts, electrical wires or any other duct, tube or wire-like material that is normally placed within walls or floors of a conventional building. In one embodiment, the wires and pipes 124 are coiled on spools 126 or in boxes at the entry side of the support frame and each is feedable between the paneling materials and connectable to the leading edge of the structural member. As the structural member moves in the machine direction, lines are installed in the assembly process, wires and pipes will be pulled along and threaded through the structural member. In an alternative embodiment, the line materials may be placed on the leading edge of the structural member, threaded through the joist bay and connected to an anchor point on or near the support frame. The line materials may be moved along with the structural member assembly as it is moved forward. In yet another embodiment, the line materials may be located on the exit side of the machine, threaded through the joist bay and connected to an anchor point on or near the machine.

The structural member assembly machine may include insulation insertion means for inserting insulation material during assembly of the assembled structural member. The insulation insertion means may include at least one insulation feeder tube having a dispensing end positioned adjacent the structural member assembly area for dispensing the insulation material into the interior of the structural member. The insulation material may be sprayable polyurethane foam insulation, loose-fill fibre insulation, or other sprayable or blow-in forms of insulation.

The structural member assembly machine may include finishing material application means for applying a finishing material to the assembled structural member. It may also include vapour barrier application means for applying a vapour barrier to the assembled structural member.

The application of carpet, linoleum or other material may have a corrugated underside which runs perpendicular to the paneling corrugation. Semi rigid or fully rigid floor or wall finishing panels may be placed on the corrugation. Concrete, plaster or similar material dispensers may be used to fill the corrugation. Trowels may be used to smooth the upper surface.

The structural member assembly machine may include a plurality of parallel trusses 128 extending perpendicularly to the joists between opposed ends (12, 14) of the frame and releasably fastened to each joist to provide structural support during assembly of the structural member. The truss will transfer the load of the structural member to a structural member receiving means 136. As shown in Figs. 39, 40 and 41, each parallel truss may be fastened to the upper edges of the joists or to the lower edges of the joists, may extend beyond the lateral edges of the structural member and may have wheeled support attachments 132 which may roll on the structural member receiving means to reduce friction. The support trusses may be installed above or below the joists of the structural member. The attachment of these support trusses may be automated. As shown in fig. 42, a computer-controlled arm 138 may align a truss with fasteners which temporarily fasten the truss to the joists through the paneling.

As shown in Fig. 40, the structural member assembly can be supported by an extrusion 134 near the edge of a truss. In this embodiment, the support truss does not require vertical extensions, but must contact the edge of the structural member receiving means suspending the structural member assembly. The weight of the structural member is transferred to the structural member receiving means.

Each support truss is connectable to the joists of the structural member at positions corresponding to the maximum span of the extruded joists. After production, the support trusses may be disconnected to allow the structural member to rest on its permanent support structure.

In order to provide a flat surface on a structural member made with corrugated paneling, a second roll of non-corrugated paneling may be connected to the outer surface of the corrugated paneling by applying glue to the upper ridges of the surface then pressing on the non-corrugated paneling, or by mechanically fastening the flat surface to the corrugation by pressing both surfaces together then puncturing both surfaces to maintain a flush external finish.. The opening through which the paneling is extruded is selected to be the same height as the corrugated material plus the flat paneling.

According to another embodiment of the present invention, there is provided a method of constructing a structural member, comprising the steps of extruding initial portions of a plurality of parallel joists from a plurality of joist feeders into a structural member assembly area to form a joist array having opposing upper and lower faces; positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array; fastening each of the upper paneling and lower paneling to the joists of the joist array; extruding subsequent portions of the plurality of parallel joists into the structural member assembly area; repeating the steps of positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array; fastening each of the upper paneling and lower paneling to the joists of the joist array; and extruding subsequent portions of the plurality of parallel joists into the structural member assembly area until a desired joist length has been achieved; and repeating the steps of positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array; and fastening each of the upper paneling and lower paneling to the joists of the joist array a final time to complete the structural member.

The method of constructing a structural member may include any of the additional steps of inserting utility lines during assembly of the structural member, inserting insulation during assembly of the structural member, applying a finishing material to the structural member, or applying a vapour barrier to the structural member.

According to another embodiment of the present invention, there is provided an apparatus for manufacturing a longitudinal structural element, comprising a housing; at least two rollers, each rotationally connected to the housing; a roll of structural material wrapped about each roller; means for feeding the end of each roll of structural material through a template connected to the housing in spaced relationship to each roll of structural material, wherein the template includes an opening defining a structural circumference, structural material from each roll guidable through the opening so as to position at least one portion of each piece of structural material adjacent to at least one portion of at least one other piece of structural material at a welding position; a welding head disposed in proximity to each welding position; means for connecting each welding head to a welding machine; and sensor means for selectively activating the welding machine to weld adjacent portions of structural material at each welding position to form a longitudinal structural element.

The at least two rollers may be four rollers and the structural circumference may be in the shape of an I-beam or a quadrilateral. The at least two rollers may be three rollers and the structural circumference may be in the shape of a triangle having concave sides. The longitudinal structural elements may be joists, ducting, concrete forms or other similar structural members. The welding apparatus may also include structural fill means for inserting structural fill through the opening of the template into the interior space of each longitudinal structural element.

According to other embodiments of the invention, several methods may be used to manufacture a joist or similar longitudinal structural element using rolled joist material. Rolls of joist material may be fed through a template that brings the edges or faces of the rolled material together, allowing them to be connected to form a structural joist. Alternatively, rolls of pre-corrugated material may be unrolled to form a joist. In another embodiment, a roll of joist material may unrolled and fed into opposed gears that press corrugation into it. These gears can also act as drive means to move the joist in the machine direction.

According to another embodiment of the present invention, there is provided a method of manufacturing a longitudinal structural element, comprising the steps of feeding at least two flexible structural material feedstocks in spaced orientation through a first side of a template, wherein the template guides at least one portion of each feedstock into a position adjacent to a corresponding portion of at least one other feedstock; welding each of the pairs of adjacent portions together in the vicinity of the template to form a longitudinal structural element; repeating these steps until the longitudinal structural element is of a desired length; and separating the longitudinal structural element from the at least two structural material feedstocks.

The at least two feedstocks may be four feedstocks and the template circumference may be in the shape of an I-beam or a quadrilateral. Alternatively, the at least two feedstocks may be three feedstocks and the template circumference may be in the shape of a triangle having concave sides. The longitudinal structural elements may be joists, ducting, concrete forms or similar.

It will be appreciated by those skilled in the art that other variations of the preferred embodiment may also be practised without departing from the scope of the invention.

CLAIMS

What is claimed is:

1. A structural member assembly machine, comprising:
 - (a) a support frame having opposed entry and exit sides and opposed first and second ends;
 - (b) a structural member assembly area within the support frame;
 - (c) joist feeder means for feeding a plurality of joists on-end into the structural member assembly area, comprising a plurality of joist feeders releasably connected at spaced intervals on the entry side of the support frame;
 - (d) upper paneling feeder means connected to the support frame above the joist feeders for feeding upper paneling into the structural member assembly area;
 - (e) lower paneling feeder means connected to the support frame below the joist feeders for feeding lower paneling into the structural member assembly area;
 - (f) structural member assembly means in the structural member assembly area for assembling a plurality of joists, upper paneling and lower paneling into a structural member;
 - (g) structural member receiving means adjacent the exit side of the support frame for receiving a structural member, and
 - (h) drive means for moving the structural member from the structural member assembly area to the structural member receiving means.
2. The structural member assembly machine of claim 1, wherein each joist feeder comprises:
 - (a) a housing;
 - (b) at least two rollers, each rotationally connected to the housing;

- (c) a roll of a joist material wrapped on each roller;
 - (d) a template connected to the housing in spaced relationship to each roll of joist material, wherein the template includes an opening defining a joist circumference, joist material from each roll guidable through the opening so as to position at least one portion of each joist material adjacent to at least one portion of at least one other piece of joist material at a welding position;
 - (e) a welding head disposed in proximity to each welding position;
 - (f) means for connecting each welding head to a welding machine; and
 - (g) sensor means for selectively activating the welding machine to weld adjacent portions of joist material at each welding position to form a joist.
3. The structural member assembly machine of claim 2, wherein the at least two rollers comprises four rollers and the joist circumference is in the shape of an I-beam.
4. The structural member assembly machine of claim 2, wherein the at least two rollers comprises three rollers and the joist circumference is in the shape of a triangle having concave sides.
5. The structural member assembly machine of claim 2, wherein the at least two rollers comprises four rollers and the joist circumference is in the shape of a quadrilateral.
6. The structural member assembly machine of claim 1, wherein each joist feeder comprises:
- (a) a housing having a roller attached thereto;
 - (b) a roll of a joist material wrapped on the roller;
 - (c) a joist forming unit connected to the housing adjacent to the roll of joist material, wherein the joist forming unit comprises a series of wheels and presses for forming the joist material;

- (d) at least one welding head disposed at a welding position adjacent the formed joist material;
 - (e) means for connecting each welding head to a welding machine; and
 - (f) sensor means for selectively activating the welding machine to weld the formed joist material at each welding position into a joist.
7. The structural member assembly machine of claim 1, further comprising joist fill means for inserting joist fill through the opening of the template into the interior space of each joist.
8. The structural member assembly machine of claim 7, wherein the joist fill means comprises at least one tube for passage of joist fill from a fill source into each joist.
9. The structural member assembly machine of claim 7, wherein the joist fill is comprised of a foam and a bonding agent.
10. The structural member assembly machine of claim 7, wherein the joist fill is concrete.
11. The structural member assembly machine of claim 1, wherein each joist feeder comprises corrugation means for corrugating a planar joist material to form a corrugated joist material.
12. The structural member assembly machine of claim 11, wherein the corrugation means comprises a pair of gears rotationally connected to the support frame between the joist feeder and the structural member assembly area, through which the planar joist material passes to form a corrugated joist material, and corrugated joist material bracing means between the joist feeder and the structural member assembly area.
13. The structural member assembly machine of claim 1, wherein the upper paneling feeder means comprises:
- (a) a housing;
 - (b) a roller rotationally connected to the housing;

- (c) a roll of upper paneling material wrapped on the roller; and
 - (d) guide means for positioning the upper paneling in an installation position adjacent the upper edges of the plurality of joists.
14. The structural member assembly machine of claim 13, wherein the upper paneling is corrugated upper paneling.
15. The structural member assembly machine of claim 1, wherein the upper paneling means further comprises corrugation means for corrugating upper paneling material to form corrugated upper paneling, the corrugation means positioned between the upper paneling feeder and the guide means.
16. The structural member assembly machine of claim 15, wherein the corrugation means comprises a pair of gears rotationally connected to the support frame between the roll of upper paneling material and the structural member assembly area, through which the upper paneling material passes to form corrugated upper paneling.
17. The structural member assembly machine of claim 15, wherein the corrugation means comprises at least one hydraulic press, each hydraulic press extending adjacent the frame between the upper paneling feeder and the structural member assembly area, for stamping a plurality of corrugation grooves into the upper paneling material to form corrugated upper paneling.
18. The structural member assembly machine of claim 1, wherein the upper paneling feeder means comprises:
- (a) an upper paneling bay having an entry side and an exit side;
 - (b) a plurality of individual upper panels of upper paneling stacked in the upper paneling bay; and
 - (c) guide means for positioning each upper panel in an installation position adjacent the upper edges of the plurality of joists.

19. The structural member assembly machine of claim 18, further comprising an actuator connected to the support frame adjacent the entry side of the upper paneling bay for horizontal dislocation of the lowermost upper panel from the upper paneling bay to an installation position adjacent the upper edges of the plurality of joists.
20. The structural member assembly machine of claim 19, wherein each upper panel has substantially planar upper and lower surfaces.
21. The structural member assembly machine of claim 19, wherein each upper panel has irregular corrugations to prevent meshing of vertically adjacent upper panels.
22. The structural member assembly machine of claim 19, wherein each upper panel has synchronous corrugations and is separated from each adjacent upper panel by at least one separator to permit horizontal dislocation of a lowermost upper panel of vertically stacked upper panels.
23. The structural member assembly machine of claim 18, wherein each joist has irregular corrugation along the length of its upper edge corresponding to the irregular corrugation of the upper panels in a manner which prevents meshing of each upper panel with the upper edge of the joist until the joist is sufficiently extruded to entirely receive the lowermost upper panel.
24. The structural member assembly machine of claim 18, wherein each joist has synchronous corrugation along the length of its upper edge corresponding to the synchronous corrugation of each upper panel in a manner which permits movement of each joist to cause co-linear movement of each upper panel intermittently lowered into an installation position adjacent the joist.
25. The structural member assembly machine of claim 1, wherein the lower paneling means comprises:
 - (a) a housing;
 - (b) a roller rotationally connected to the housing;
 - (c) a roll of lower paneling material wrapped on the roller;

- (d) guide means for positioning the lower paneling in an installation position adjacent the lower edges of the plurality of joists.
26. The structural member assembly machine of claim 25, wherein the lower paneling is corrugated lower paneling.
27. The structural member assembly machine of claim 1, wherein the lower paneling means further comprises corrugation means for corrugating lower paneling material to form corrugated lower paneling, the corrugation means positioned between the lower paneling bay and the guide means.
28. The structural member assembly machine of claim 27, wherein the corrugation means comprises a pair of gears rotationally connected to the support frame between the roll of lower paneling material and the structural member assembly area, through which the lower paneling material passes to form corrugated lower paneling.
29. The structural member assembly machine of claim 27, wherein the corrugation means comprises at least one hydraulic press, each hydraulic press extending adjacent the frame between the lower paneling feeder and the structural member assembly area, for stamping a plurality of corrugation grooves into the lower paneling material to form corrugated lower paneling.
30. The structural member assembly machine of claim 1, wherein the lower paneling feeder means comprises:
- (a) an lower paneling bay;
 - (b) a plurality of lower panels stacked in the lower paneling bay; and
 - (c) guide means for positioning the lower panels in an installation position adjacent the lower edges of the plurality of joists.
31. The structural member assembly machine of claim 30, further comprising an actuator connected to the support frame adjacent the rear side of the lower paneling feeder for horizontal dislocation of the uppermost lower panel from the lower paneling bay to an installation position adjacent the lower edges of the plurality of joists.

32. The structural member assembly machine of claim 31, wherein each lower panel has substantially planar upper and lower surfaces.
33. The structural member assembly machine of claim 31, wherein each lower panel has irregular corrugations to prevent meshing of vertically adjacent lower panels.
34. The structural member assembly machine of claim 31, wherein each lower panel has synchronous corrugations and is separated from each adjacent lower panel by at least one separator to permit horizontal dislocation of an uppermost lower panel of vertically stacked lower panels.
35. The structural member assembly machine of claim 30, wherein each joist has irregular corrugation along the length of its lower edge corresponding to the irregular corrugation of the lower panels in a manner which prevents meshing of each lower panel with the lower edge of the joist until the joist is sufficiently extruded to entirely receive the uppermost lower panel.
36. The structural member assembly machine of claim 30, wherein each joist has synchronous corrugation along the length of its lower edge corresponding to the synchronous corrugation of each lower panel in a manner which permits movement of each joist to cause co-linear movement of each lower panel intermittently raised into an installation position adjacent the joist.
37. The structural member assembly machine of claim 1, wherein the structural member assembly means further comprises fastening means for fastening the upper paneling to the joist material and the joist material to the lower paneling.
38. The structural member assembly machine of claim 37, wherein the fastening means comprises mechanical fasteners selected from the group consisting of screws, rivets, nails and staples.
39. The structural member assembly machine of claim 37, wherein the fastening means comprises at least one welding device.

40. The structural member assembly machine of claim 39, wherein the at least one welding device is adapted to weld together the joist and the upper paneling, as well as the joist and the lower paneling.
41. The structural member assembly machine of claim 1, wherein the structural member receiving means comprises a constructed platform.
42. The structural member assembly machine of claim 1, wherein the structural member receiving means comprises a horizontal construction surface of a building under construction.
43. The structural member assembly machine of claim 1, wherein the structural member receiving means comprises a vehicle bed.
44. The structural member assembly machine of claim 1, further comprising utility line insertion means for inserting utility lines during assembly of the assembled structural member.
45. The structural member assembly machine of claim 1, further comprising insulation insertion means for inserting insulation material during assembly of the assembled structural member.
46. The structural member assembly machine of claim 1, wherein the insulation insertion means comprises at least one insulation feeder tube having a dispensing end positioned adjacent the entry side of the structural member assembly area for dispensing the insulation material into the interior of the structural member.
47. The structural member assembly machine of claim 46, wherein the insulation material is sprayable polyurethane foam insulation.
48. The structural member assembly machine of claim 46, wherein the insulation material is loose-fill fibre insulation
49. The structural member assembly machine of claim 1, further comprising finishing material application means for applying a finishing material to the assembled structural member.

50. The structural member assembly machine of claim 1, further comprising vapour barrier application means for applying a vapour barrier to the assembled structural member.
51. The structural member assembly machine of claim 1, further comprising a plurality of parallel trusses having opposed ends extending perpendicularly to the joists between opposed ends of the support frame and releasably fastened to each joist to provide structural support during assembly of the structural member.
52. The structural member assembly machine of claim 51, wherein each parallel truss is fastened to the upper edges of the joists.
53. The structural member assembly machine of claim 51, wherein each parallel truss is fastened to the lower edges of the joists.
54. The structural member assembly machine of claim 51, wherein the plurality of parallel trusses extends beyond the ends of the support frame and further comprises rollable support means fixed to the ends of each truss for supporting the truss and the attached structural member.
55. A method of constructing a structural member, comprising the steps of
- (a) extruding initial portions of a plurality of parallel joists on-end from a plurality of joist feeders into a structural member assembly area to form a joist array having opposing upper and lower faces;
 - (b) positioning upper paneling adjacent the upper face of the joist array and lower paneling adjacent the lower face of the joist array;
 - (c) fastening each of the upper paneling and lower paneling to the joists of the joist array;
 - (d) extruding subsequent portions of the plurality of parallel joists into the structural member assembly area;
 - (e) repeating steps (b), (c) and (d) until a desired joist length has been extruded; and
 - (f) repeating steps (b) and (c) a final time to complete the structural member.

56. The method of constructing a assembled structural member of claim 55, further comprising the step of inserting utility lines during assembly of the structural member;
57. The method of constructing a structural member of claim 55, further comprising the step of inserting insulation during assembly of the structural member.
58. The method of constructing a structural member of claim 55, further comprising the step of applying a finishing material to the structural member.
59. The method of constructing a structural member of claim 55, further comprising the step of applying a vapour barrier to the assembled structural member.
60. A welding apparatus for manufacturing a longitudinal structural element, comprising
 - (a) a housing;
 - (b) at least two rollers, each rotationally connected to the housing;
 - (c) a roll of structural material wrapped about each roller;
 - (d) means for feeding the end of each roll of structural material through a template connected to the housing in spaced relationship to each roll of structural material, wherein the template includes an opening defining a structural circumference, structural material from each roll guidable through the opening so as to position at least one portion of each piece of structural material adjacent to at least one portion of at least one other piece of structural material at a welding position;
 - (e) a welding head disposed in proximity to each welding position;
 - (f) means for connecting each welding head to a welding machine; and
 - (g) sensor means for selectively activating the welding machine to weld adjacent portions of structural material at each welding position to form a longitudinal structural element.
61. The welding apparatus of claim 60, wherein the at least two rollers comprises four rollers and the structural circumference is in the shape of an I-beam.

62. The welding apparatus of claim 60, wherein the at least two rollers comprises three rollers and the structural circumference is in the shape of a triangle having concave sides.
63. The welding apparatus of claim 60, wherein the at least two rollers comprises four rollers and the structural circumference is in the shape of a quadrilateral.
64. The welding apparatus of claim 60, wherein the longitudinal structural element is selected from the group consisting of joists, ducting and concrete forms.
65. The welding apparatus of claim 60, further comprising structural fill means for inserting structural fill through the opening of the template into the interior space of each longitudinal structural element.
66. A method of manufacturing a longitudinal structural element, comprising the steps of
- (a) feeding at least two structural material feedstocks in spaced orientation through a first side of a template, wherein the template guides at least one portion of each feedstock into a position adjacent to a corresponding portion of at least one other feedstock;
 - (b) welding each of the pairs of adjacent portions together in the vicinity of the template to form a longitudinal structural element;
 - (c) repeating steps (a) and (b) until the longitudinal structural element is of a desired length; and
 - (d) separating the longitudinal structural element from the at least two structural material feedstocks.
67. The method of manufacturing a longitudinal structural element of claim 66, wherein the at least two feedstocks comprises four feedstocks and the template circumference is in the shape of an I-beam.
68. The method of manufacturing a longitudinal structural element of claim 66, wherein the at least two feedstocks comprises three feedstocks and the template circumference is in the shape of a triangle having concave sides.

69. The method of manufacturing a longitudinal structural element of claim 66, wherein the at least two feedstocks comprises four feedstocks and the template circumference is in the shape of a quadrilateral.
70. The method of manufacturing a longitudinal structural element of claim 66, wherein the longitudinal structural element is selected from the group consisting of joists, ducting and concrete forms.

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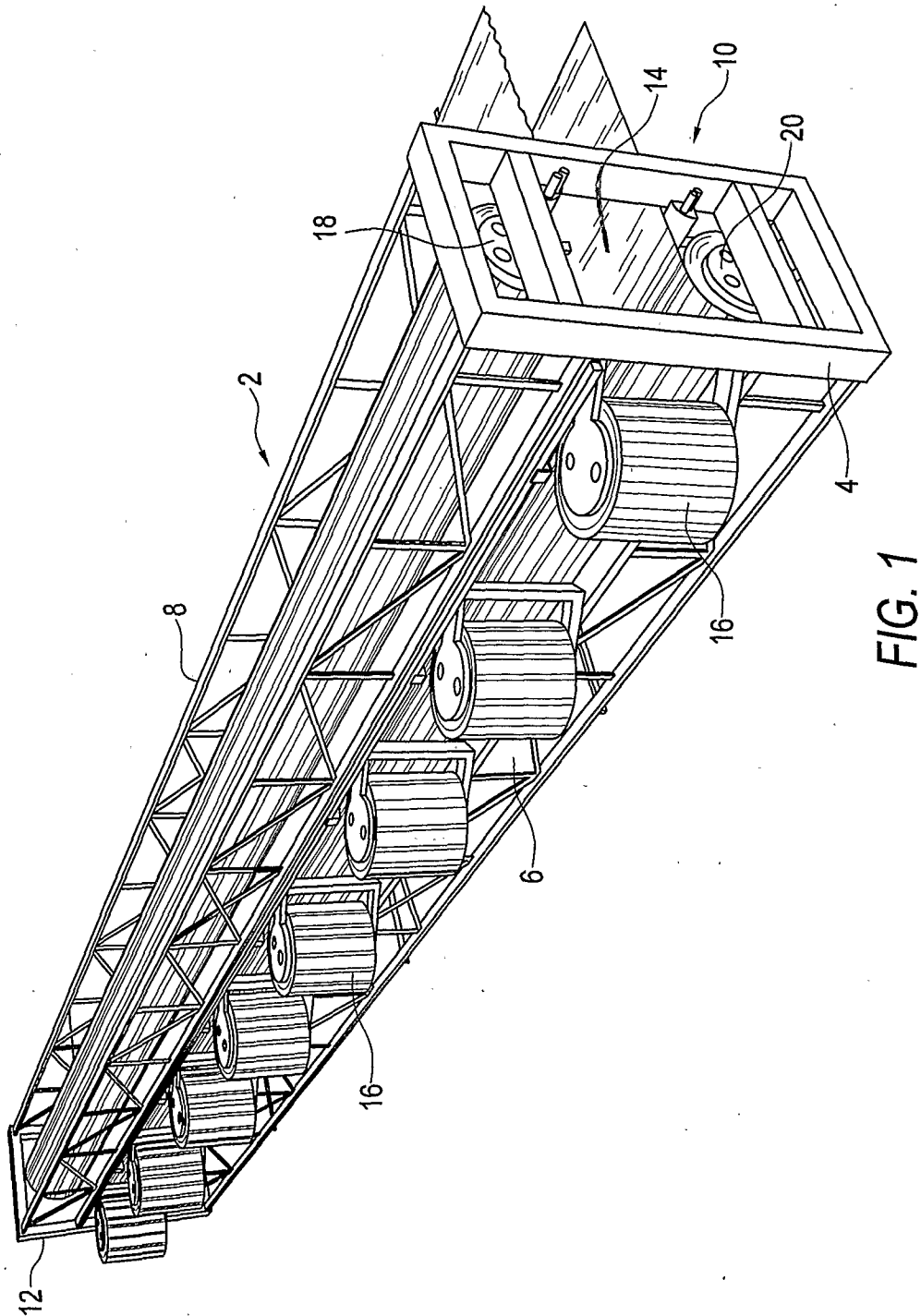


FIG. 1

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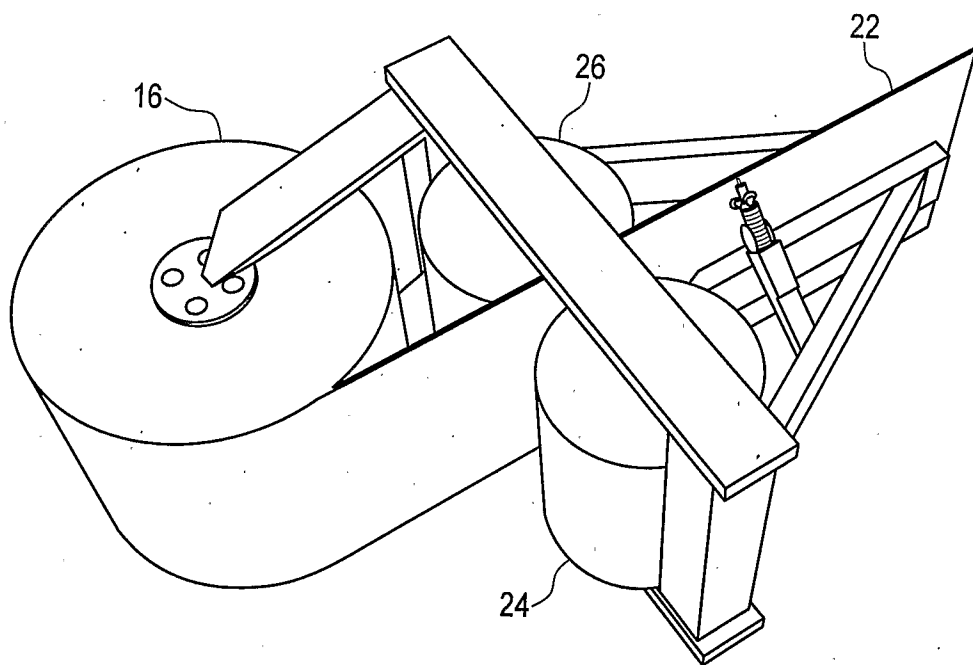


FIG. 2

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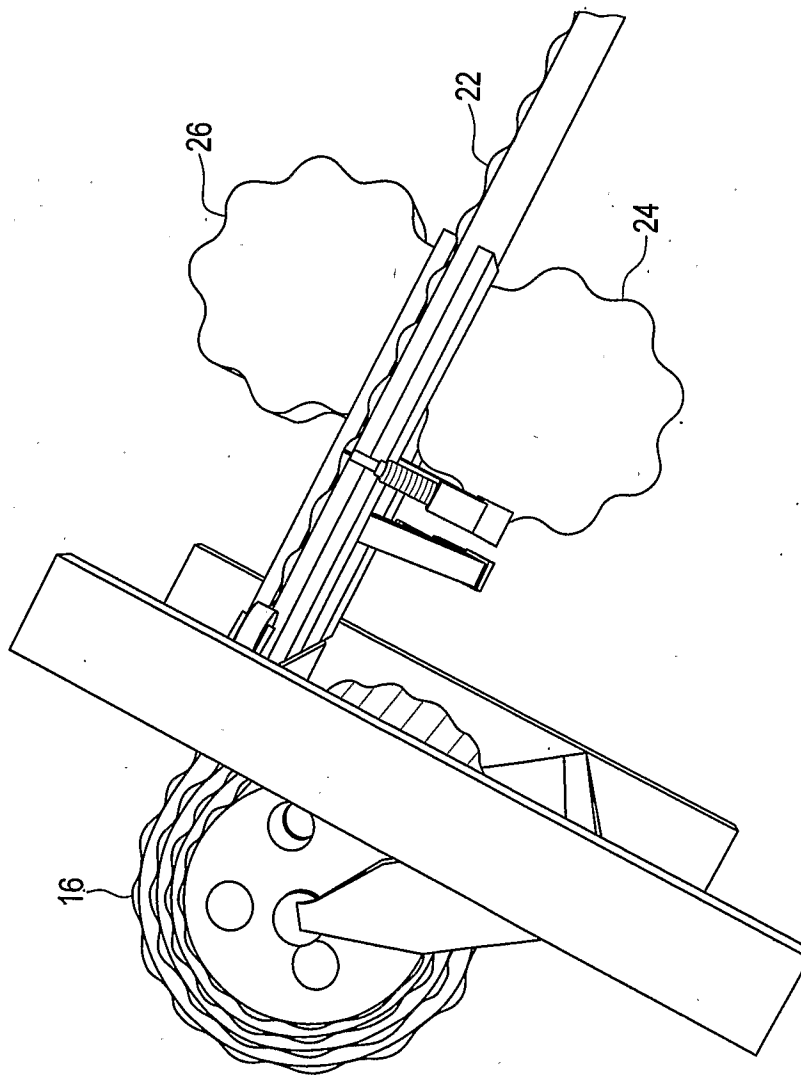


FIG. 3

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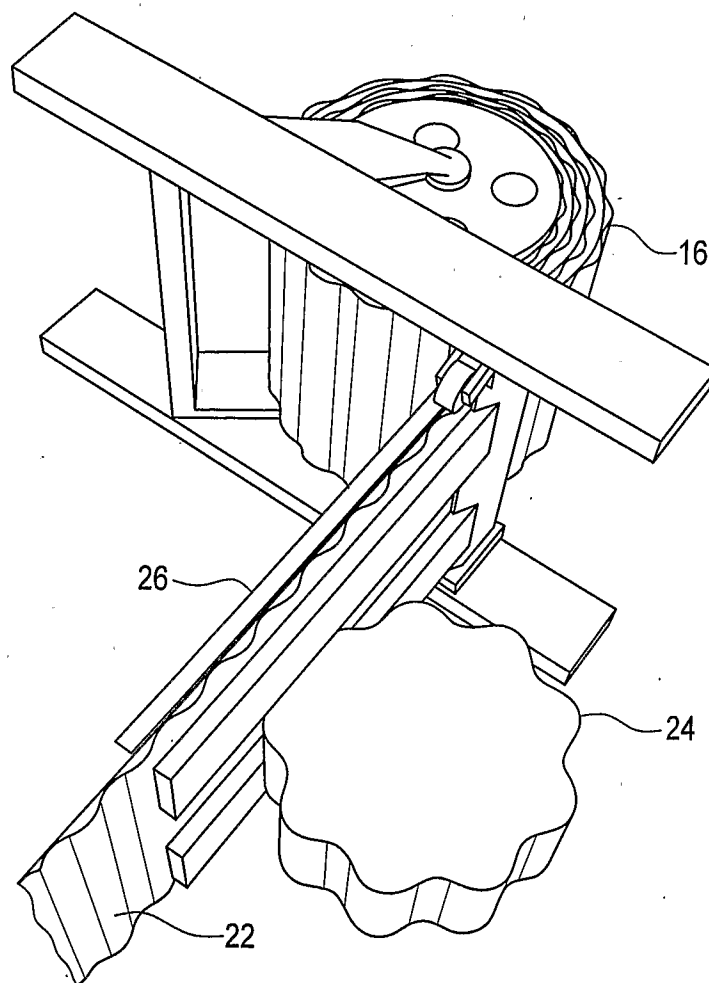
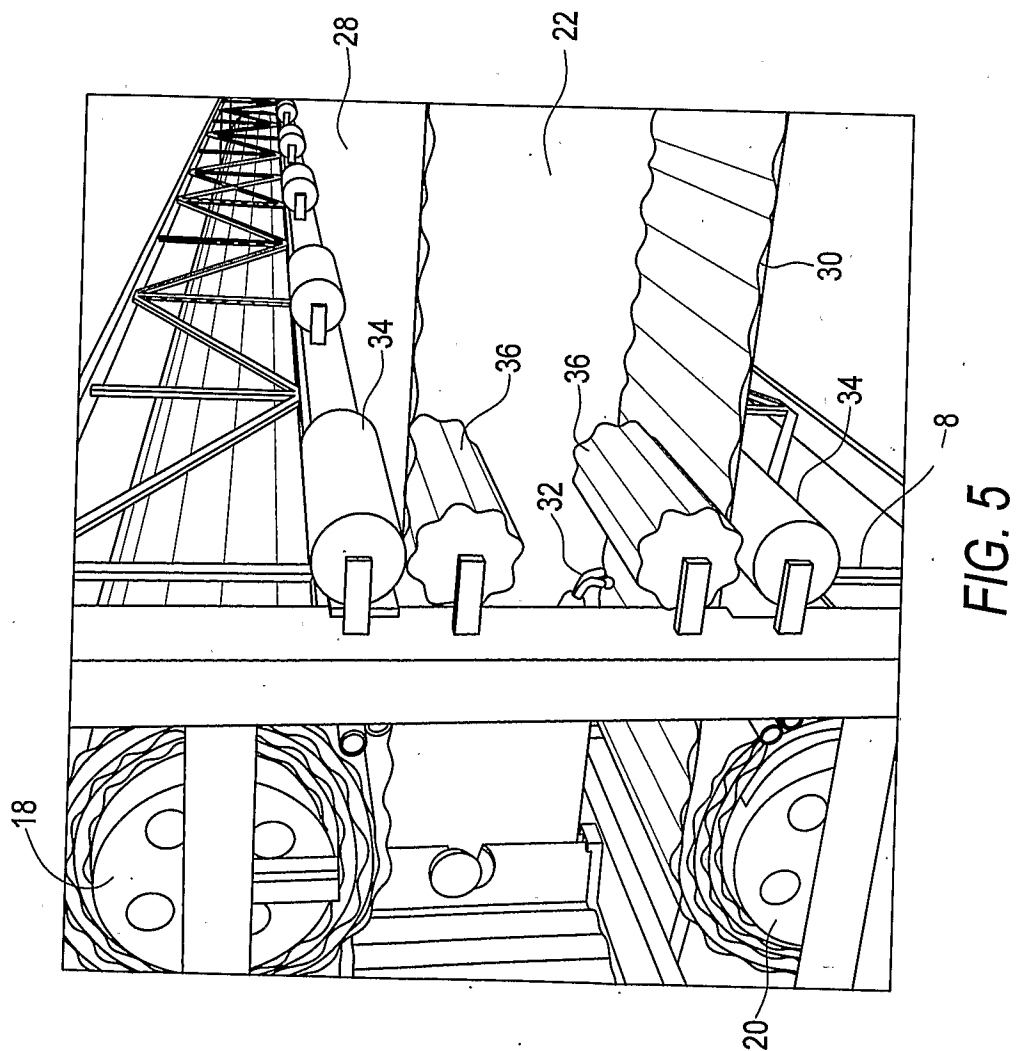


FIG. 4

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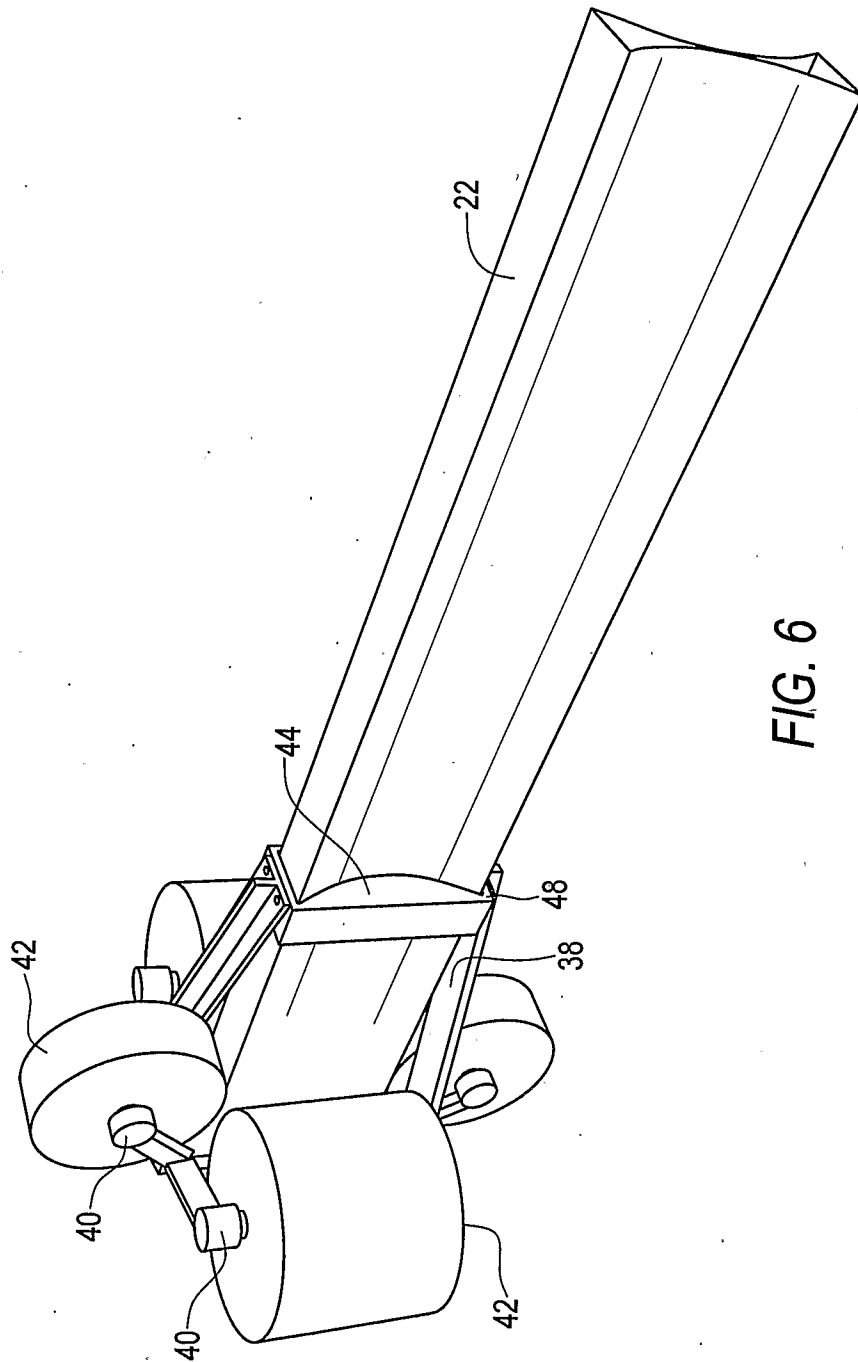


FIG. 6

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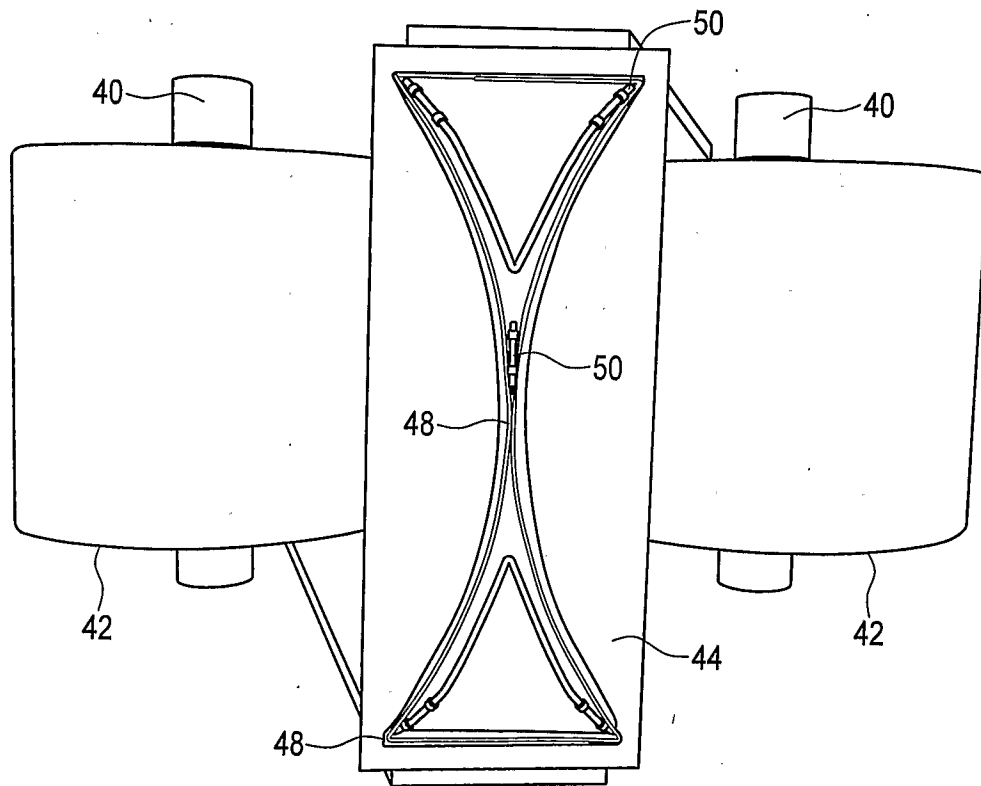


FIG. 7

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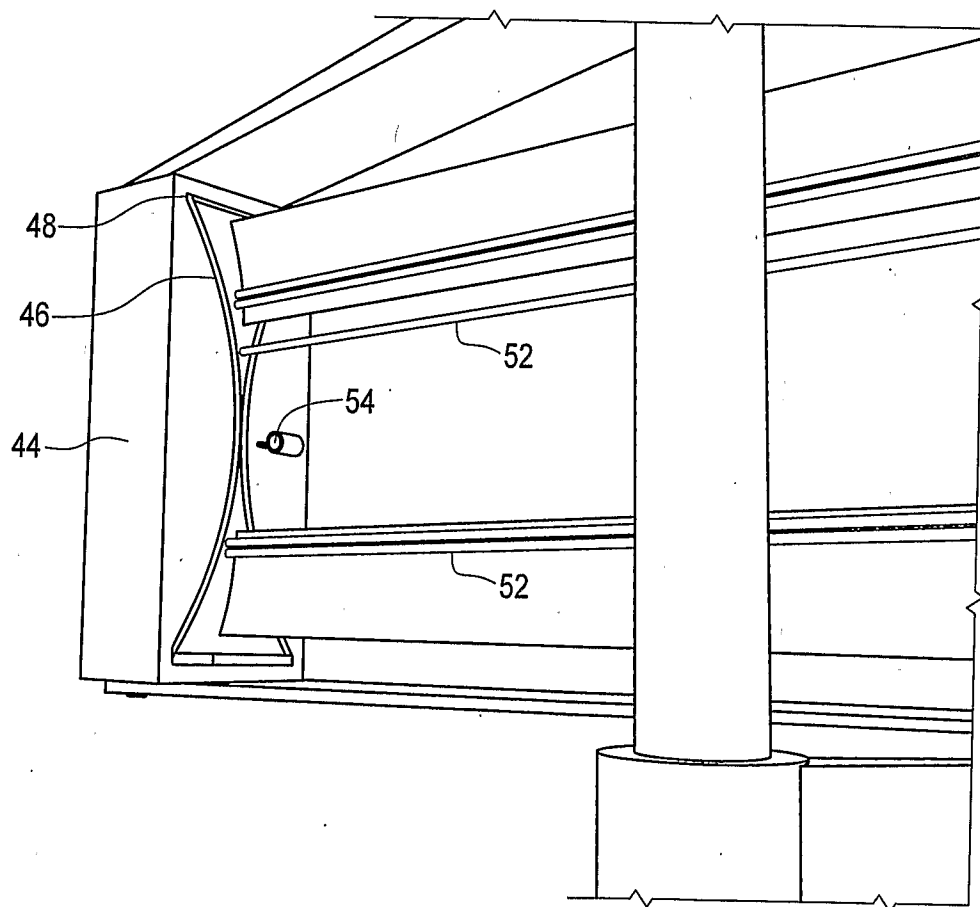
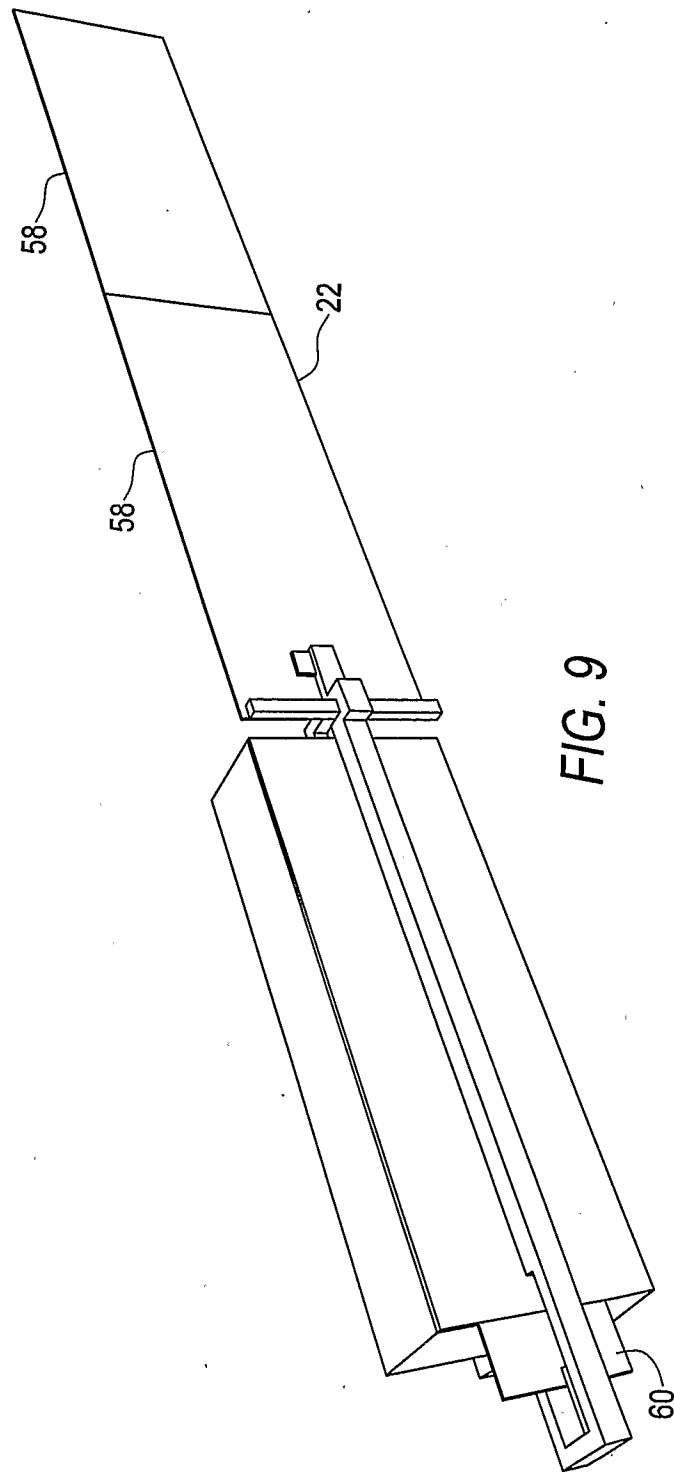


FIG. 8

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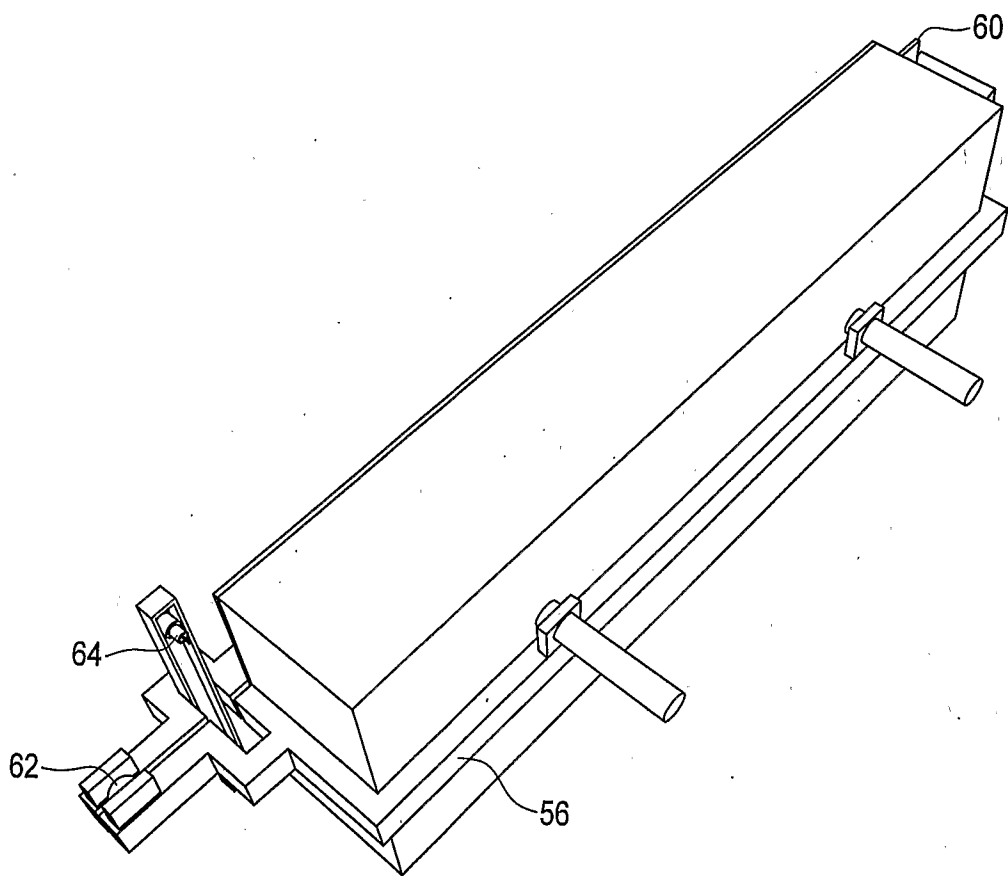


FIG. 10

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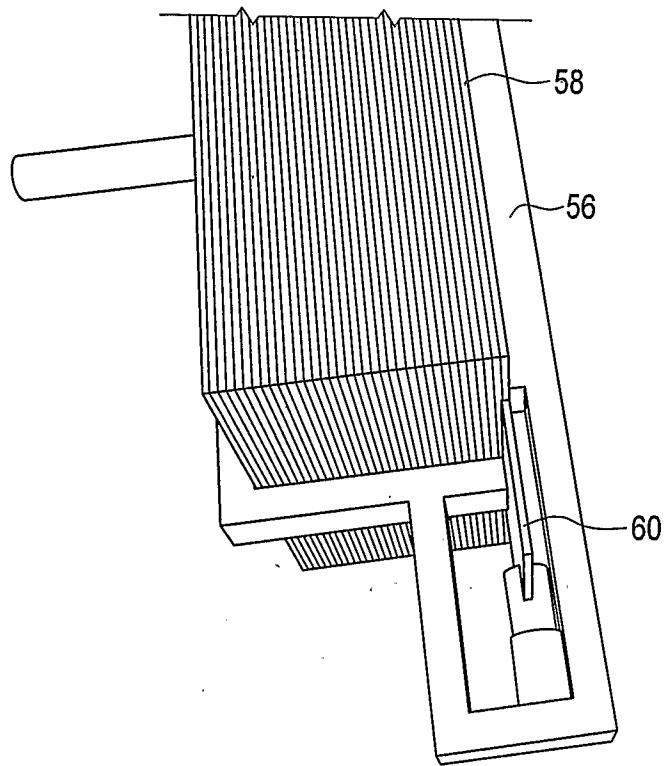


FIG. 11

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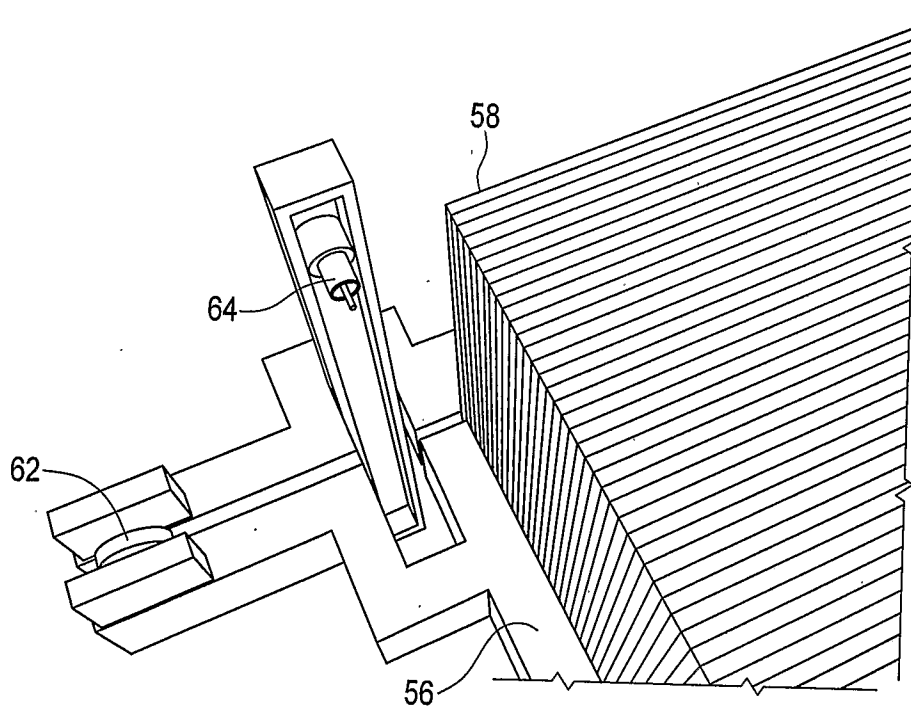


FIG. 12

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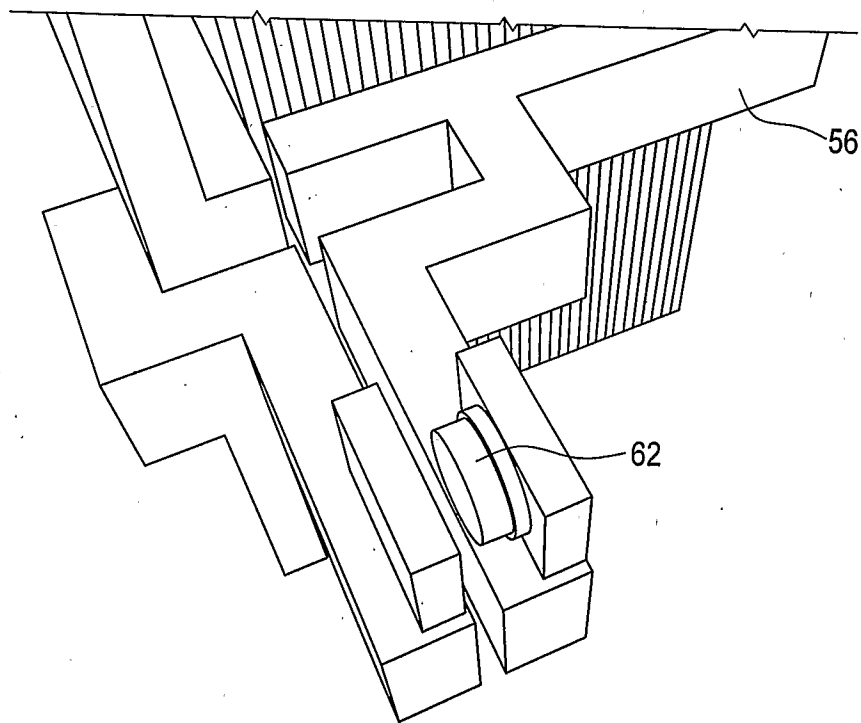


FIG. 13

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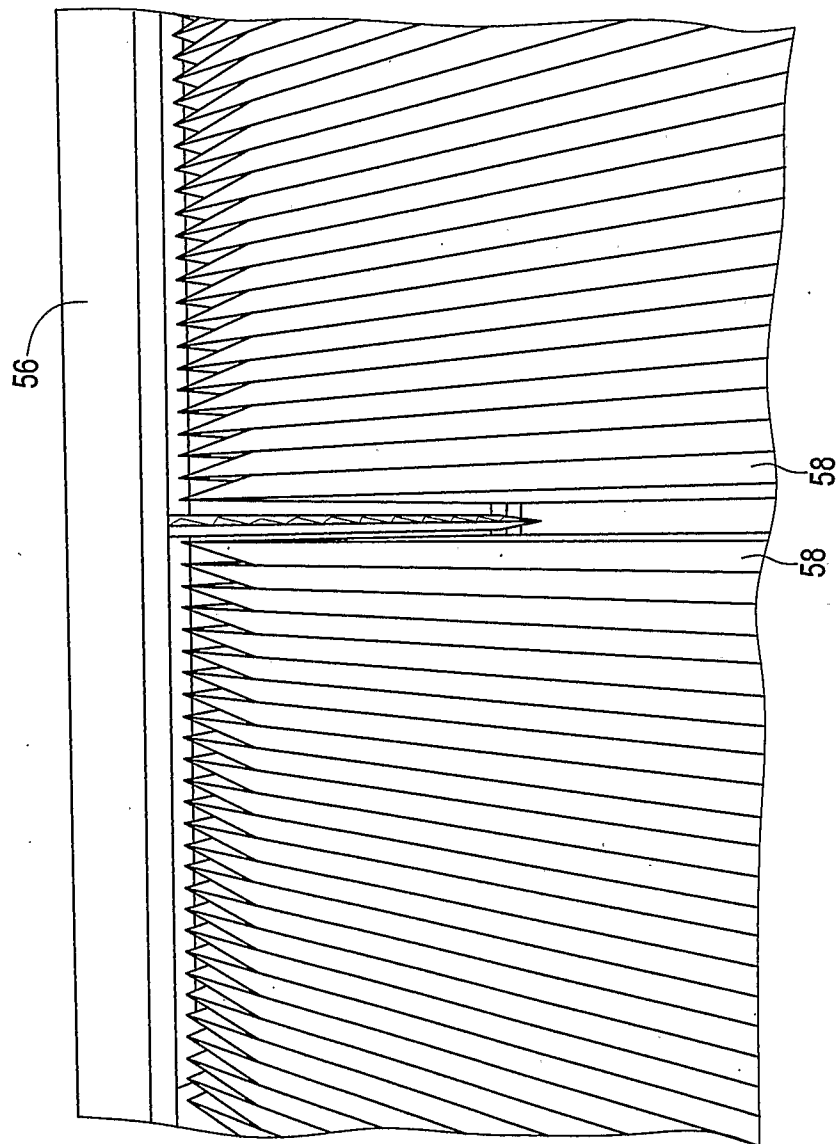


FIG. 14

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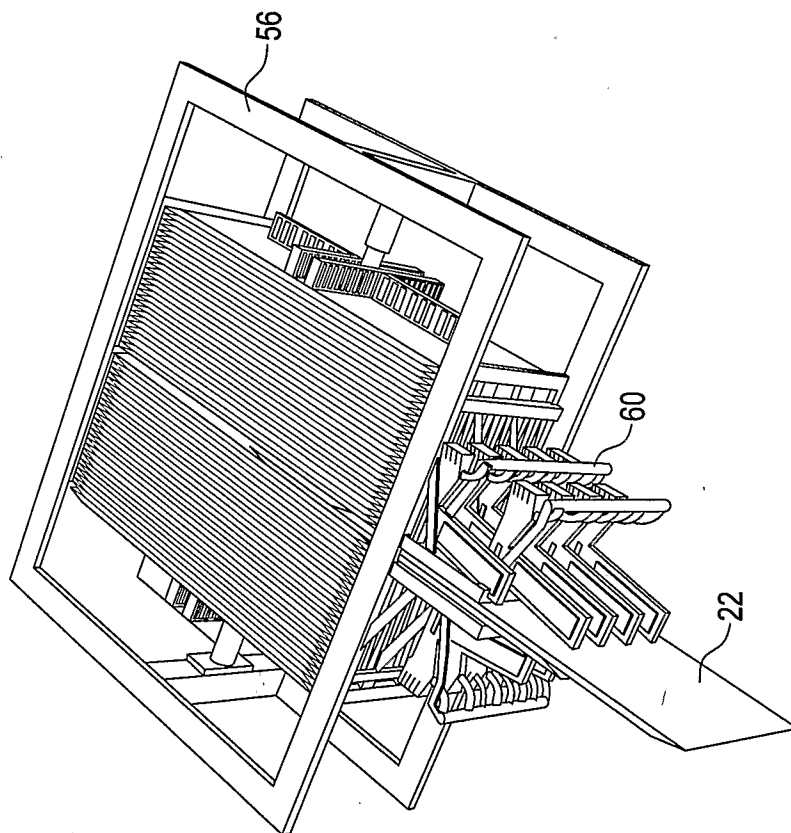


FIG. 15

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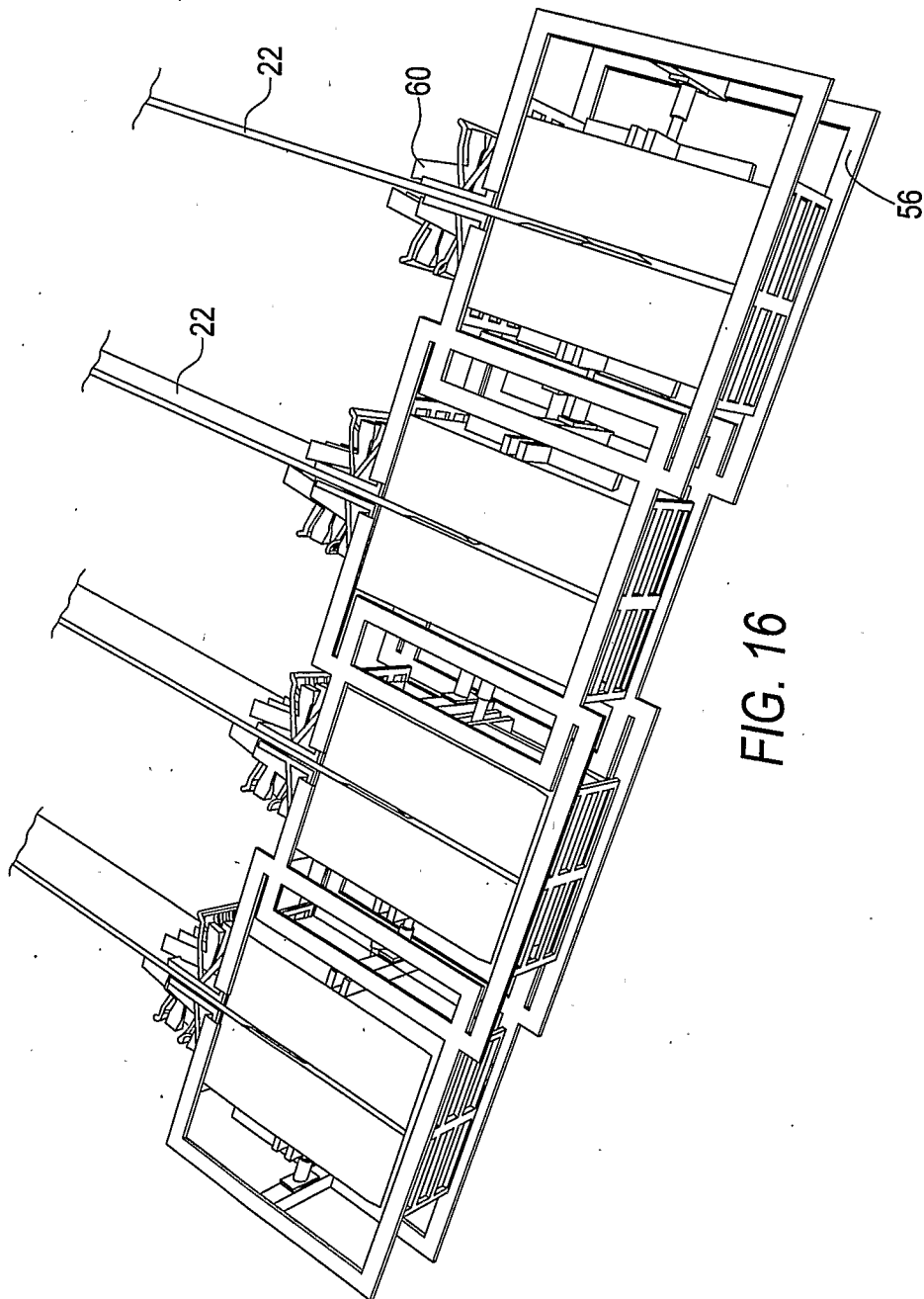


FIG. 16

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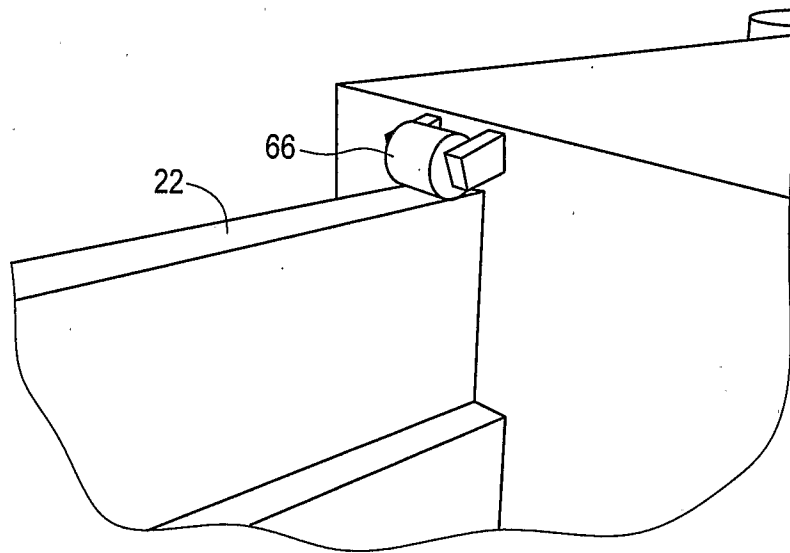


FIG. 17

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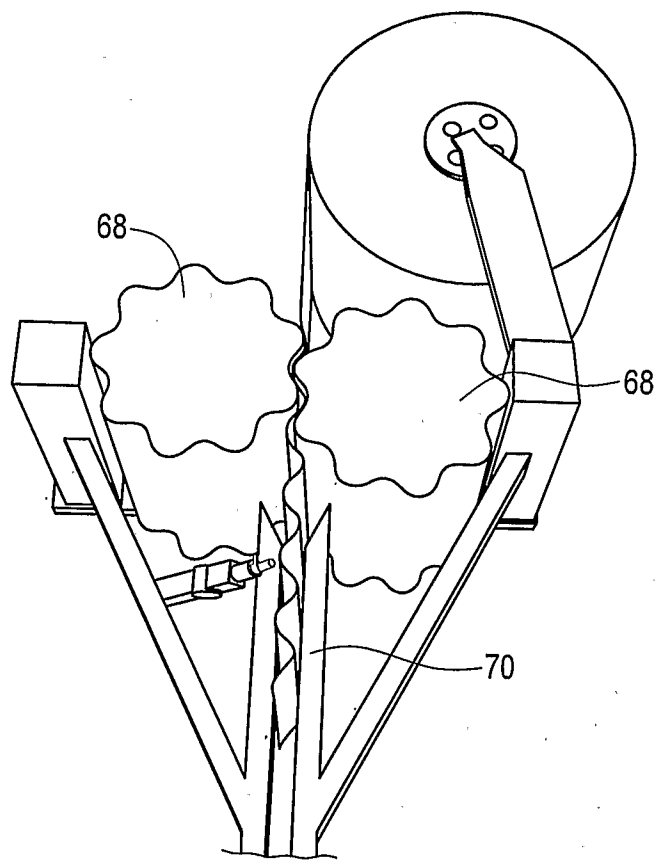


FIG. 18

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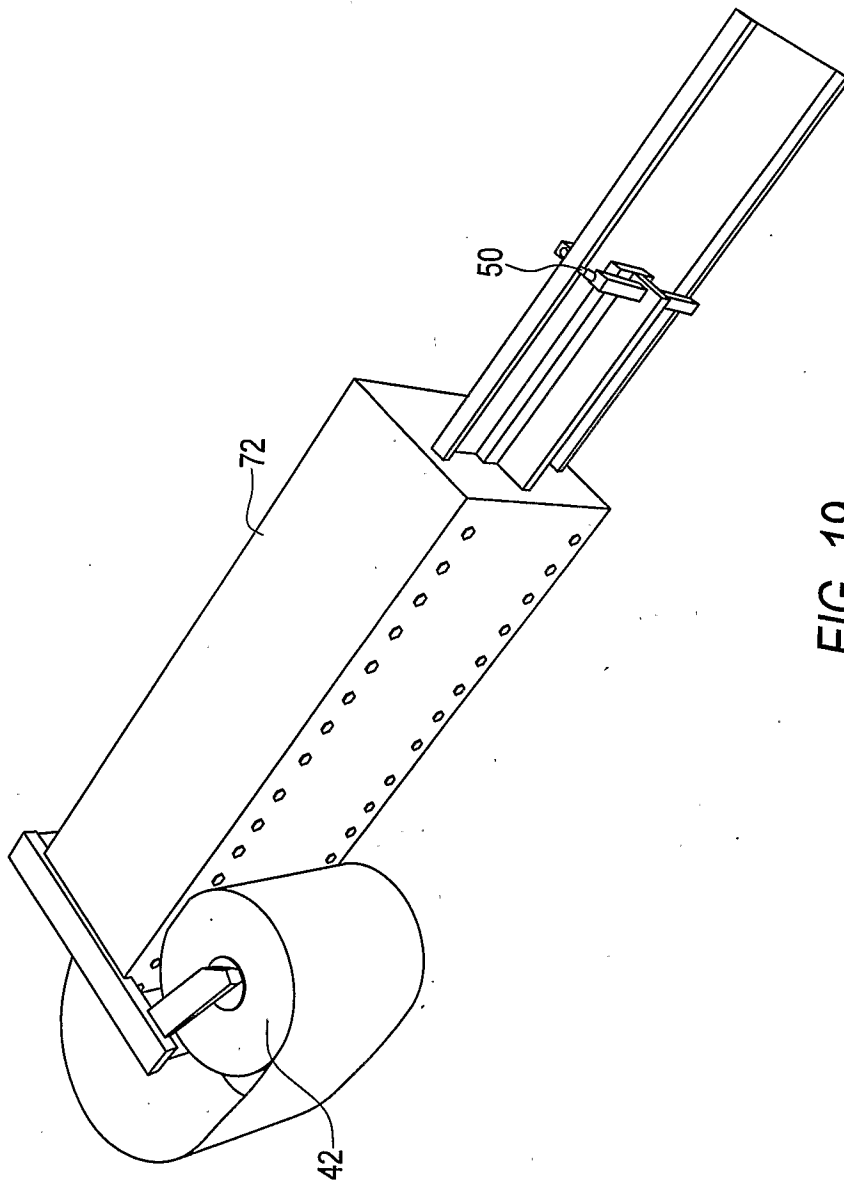


FIG. 19

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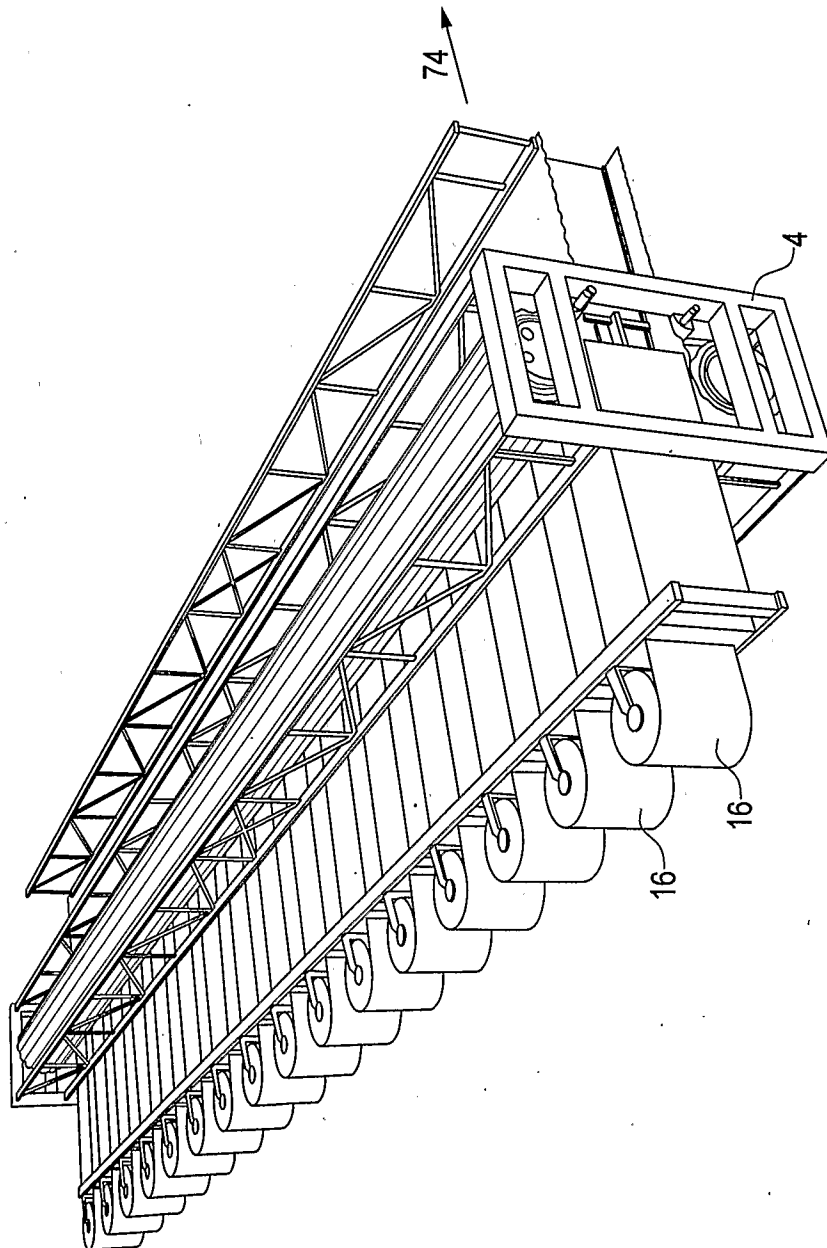


FIG. 20

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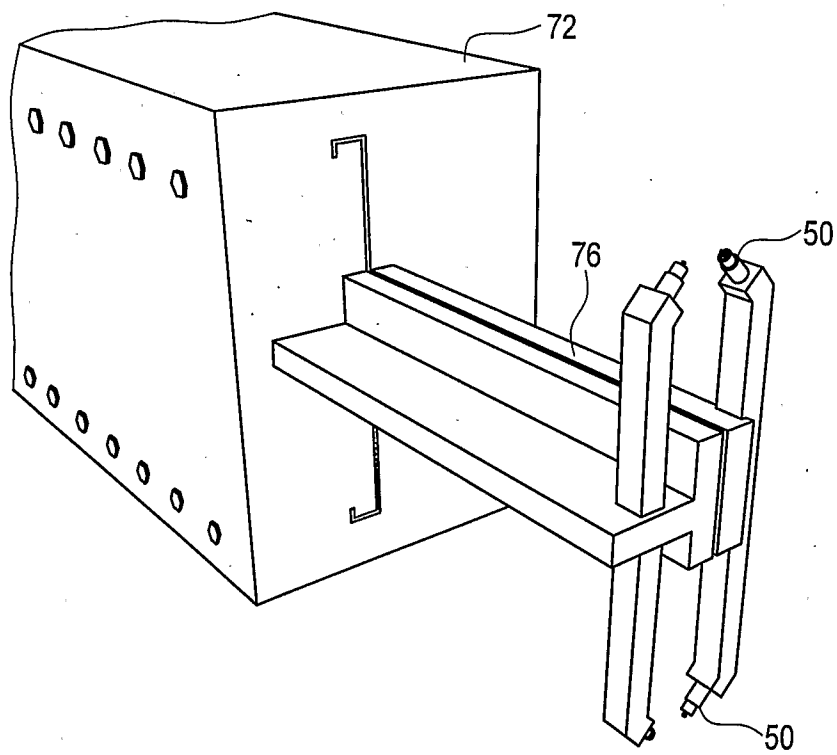
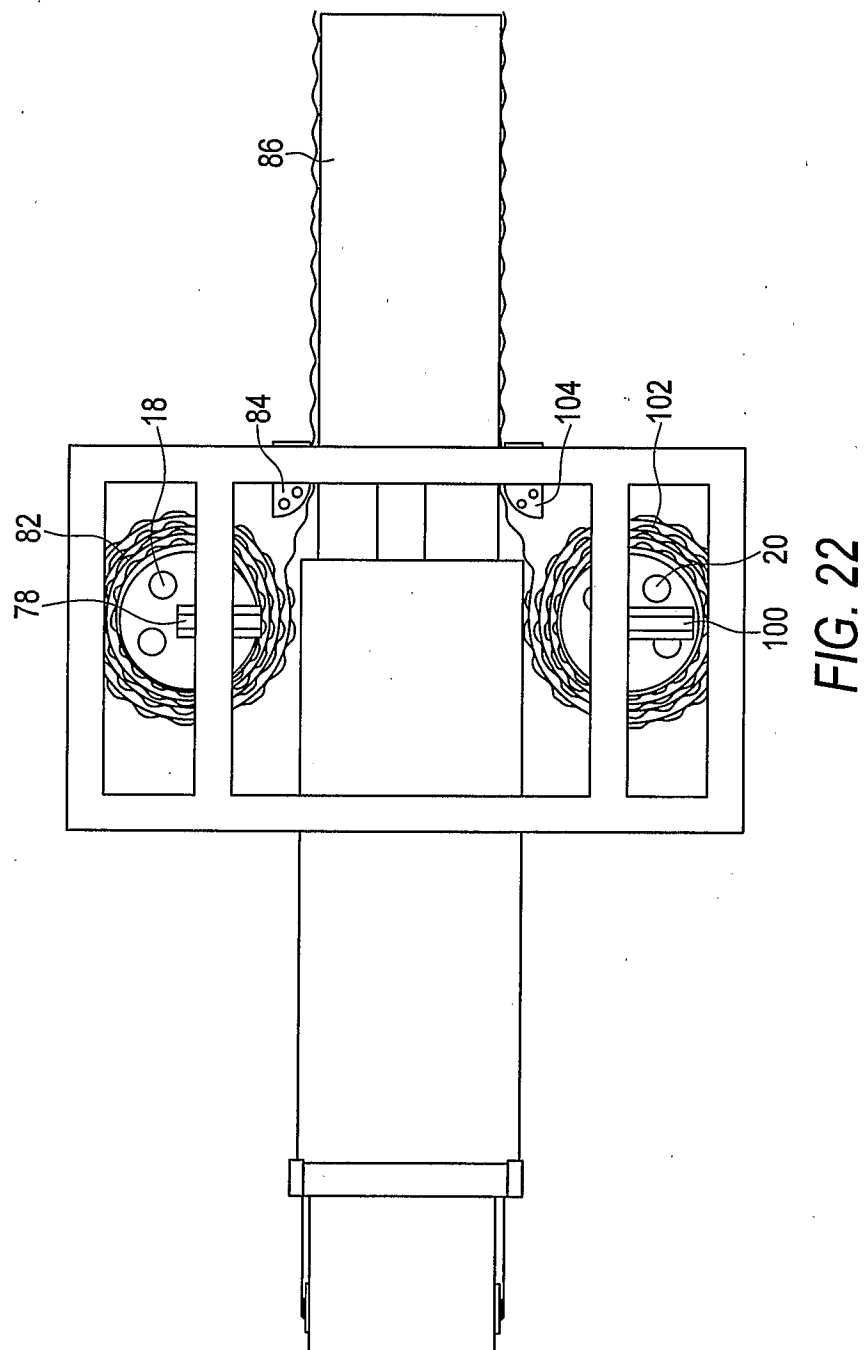


FIG. 21



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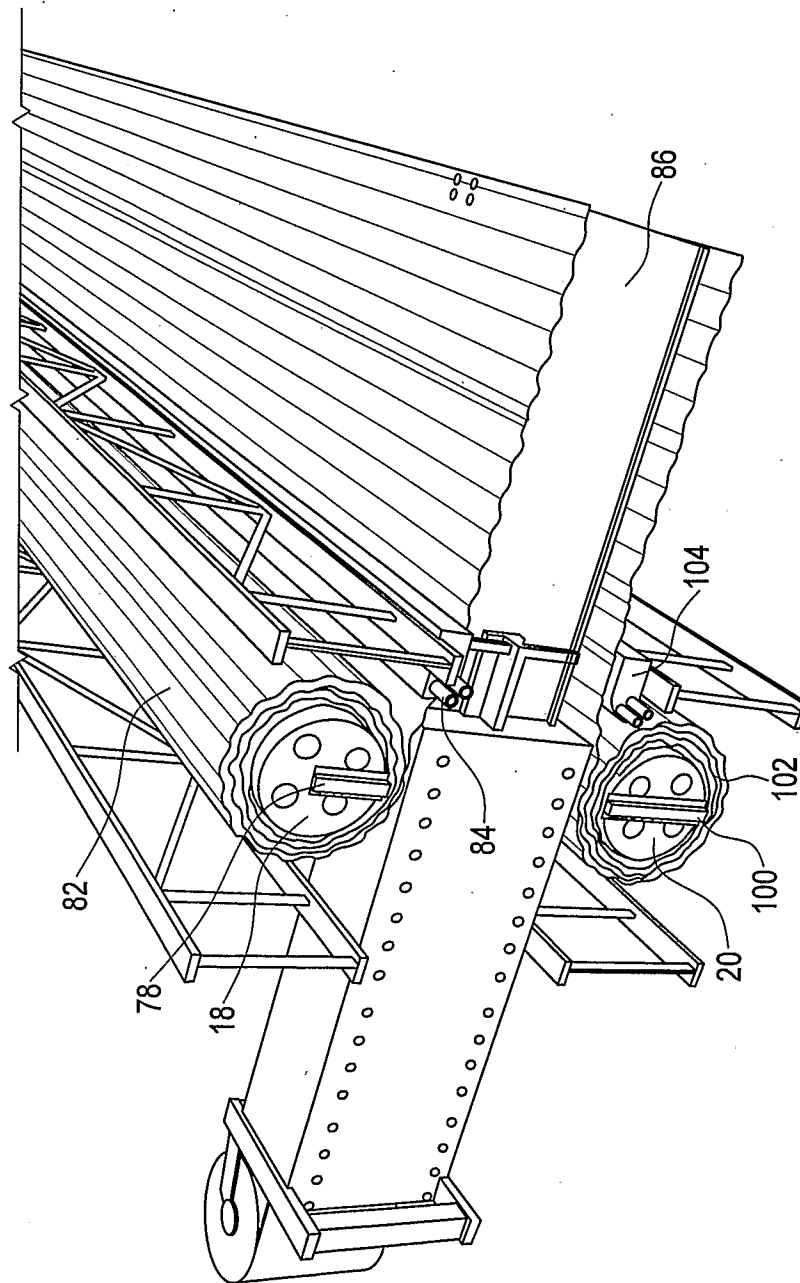


FIG. 23

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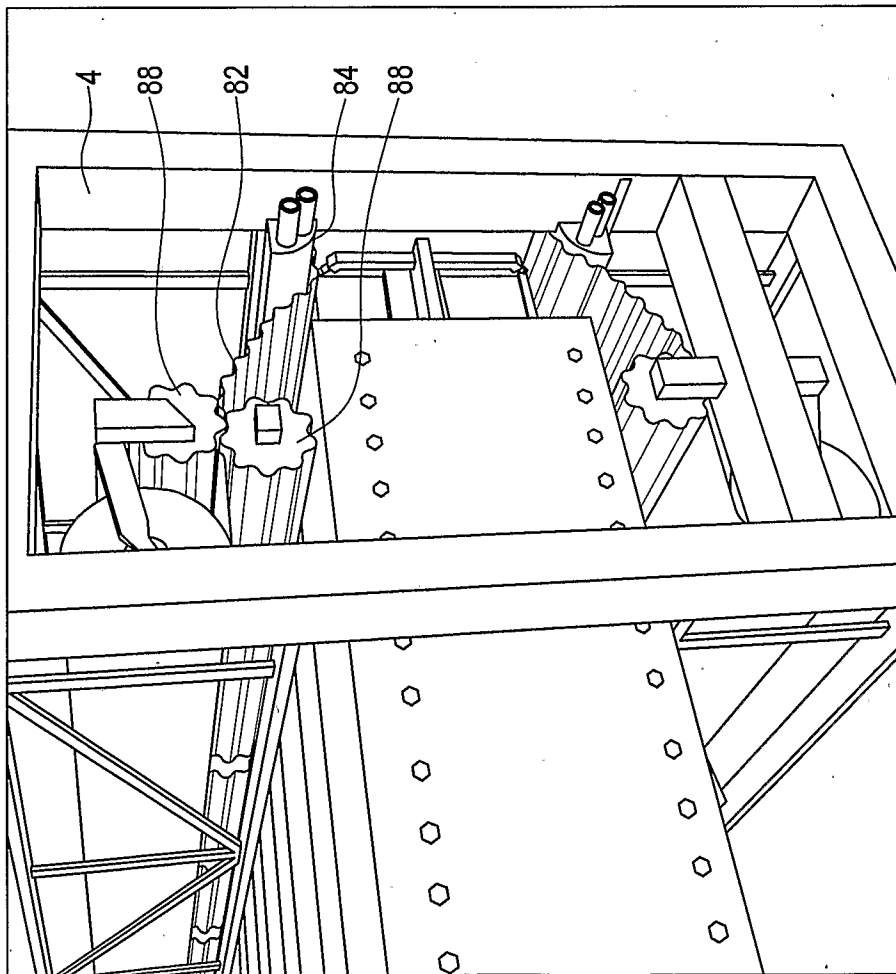


FIG. 24

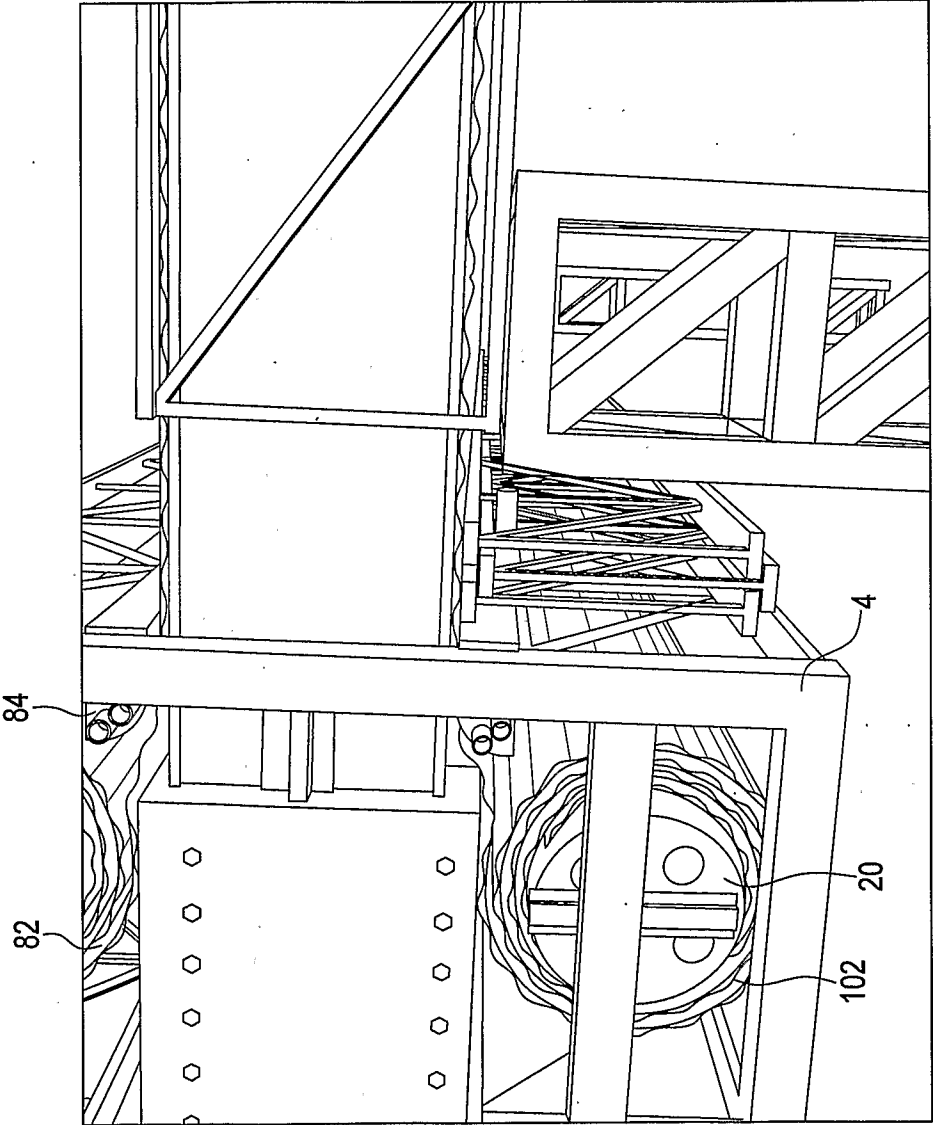
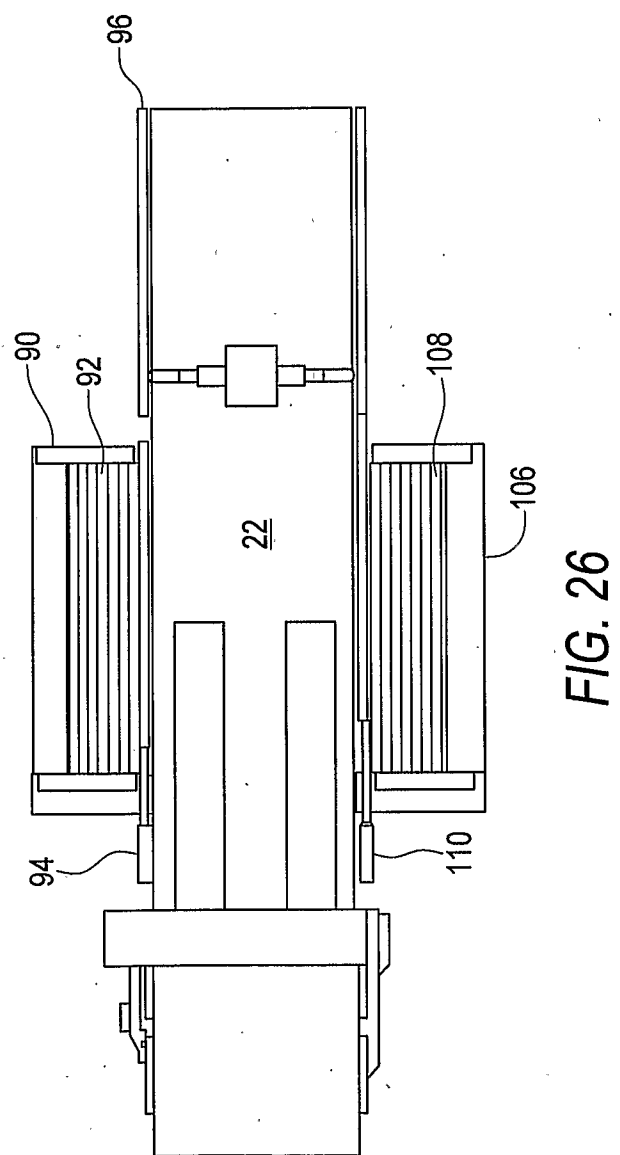


FIG. 25



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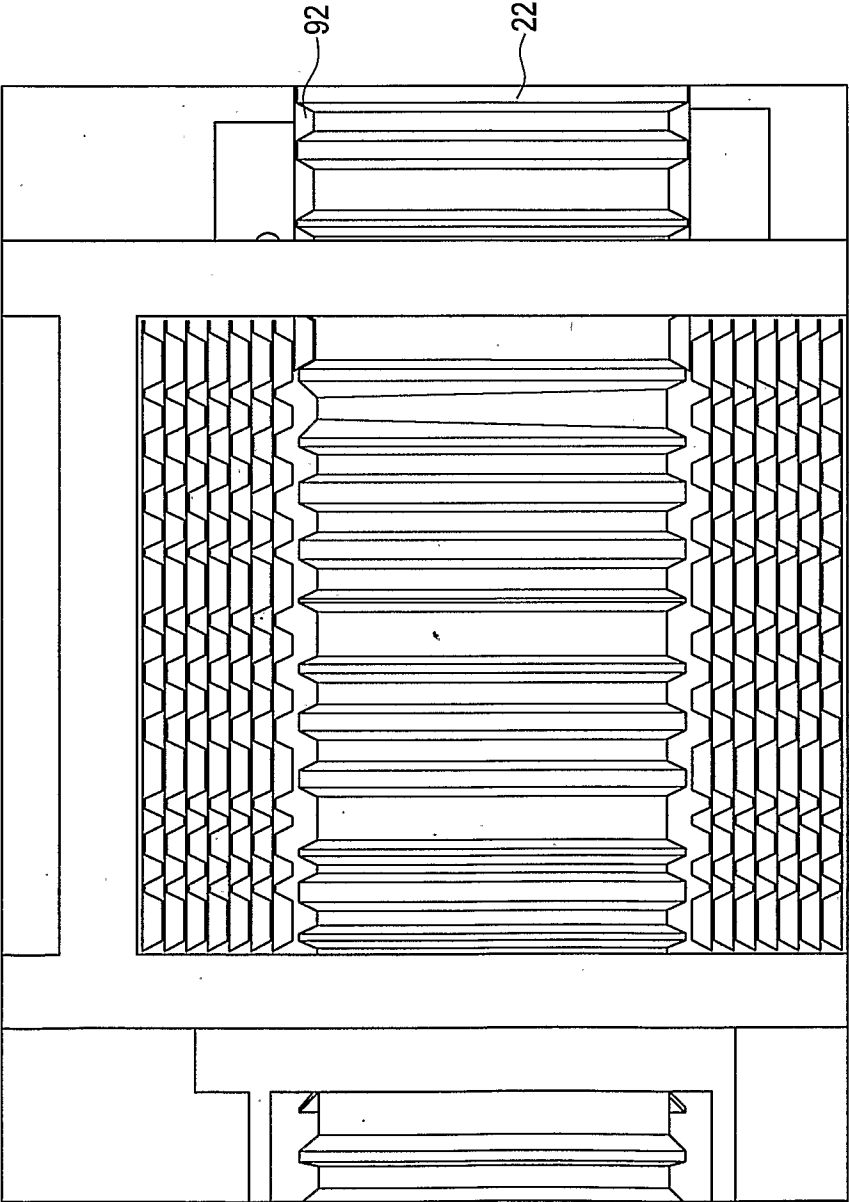


FIG. 27

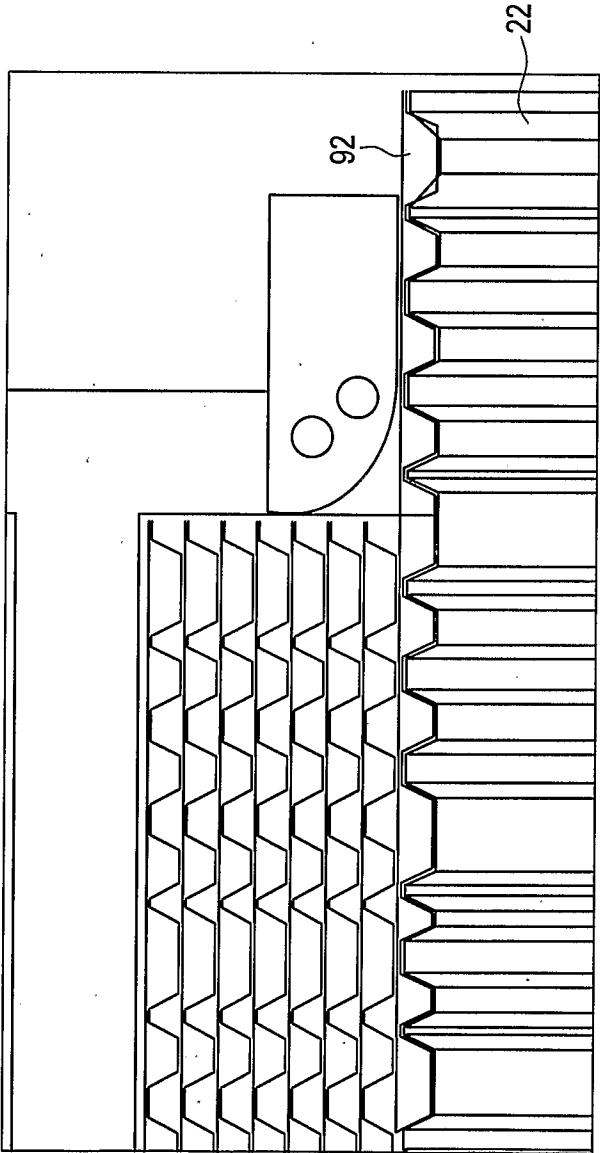


FIG. 28

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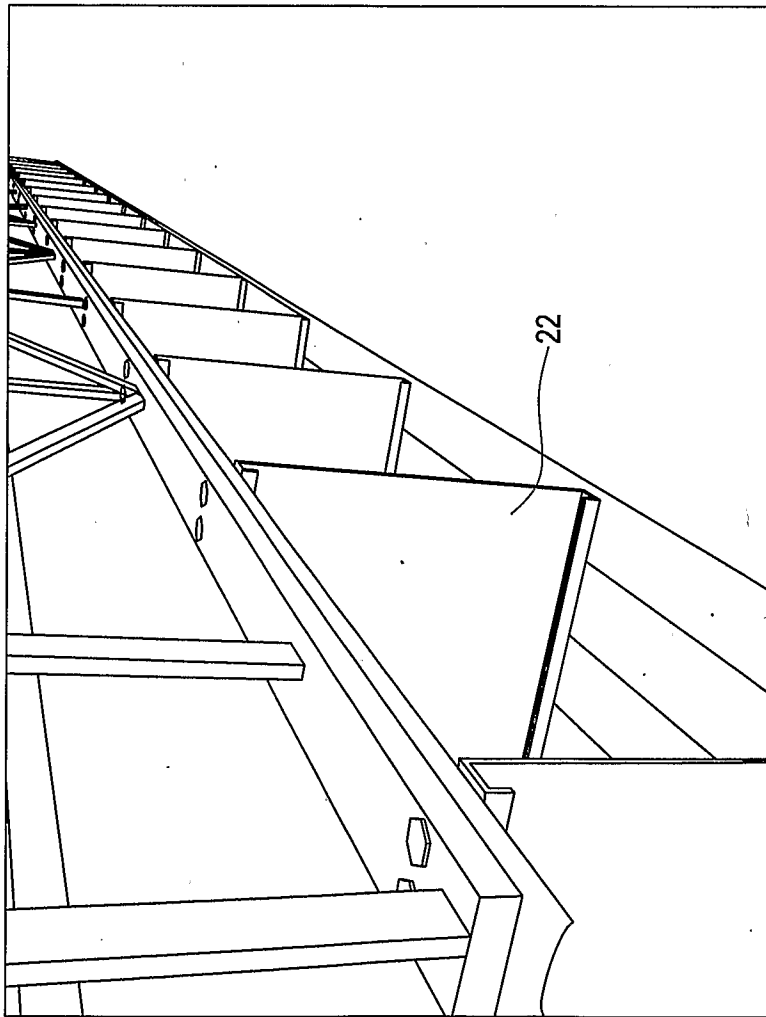


FIG. 29

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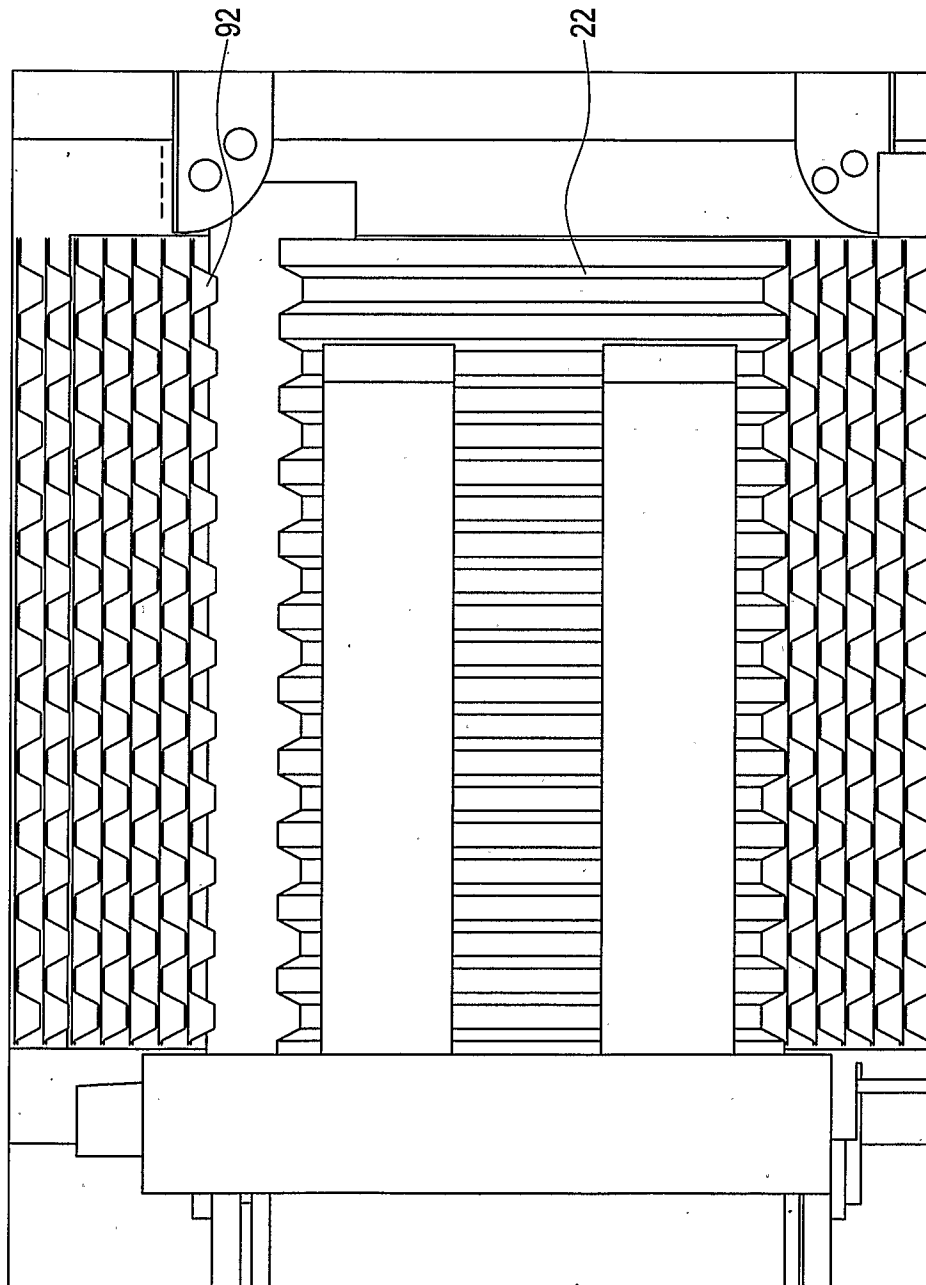


FIG. 30

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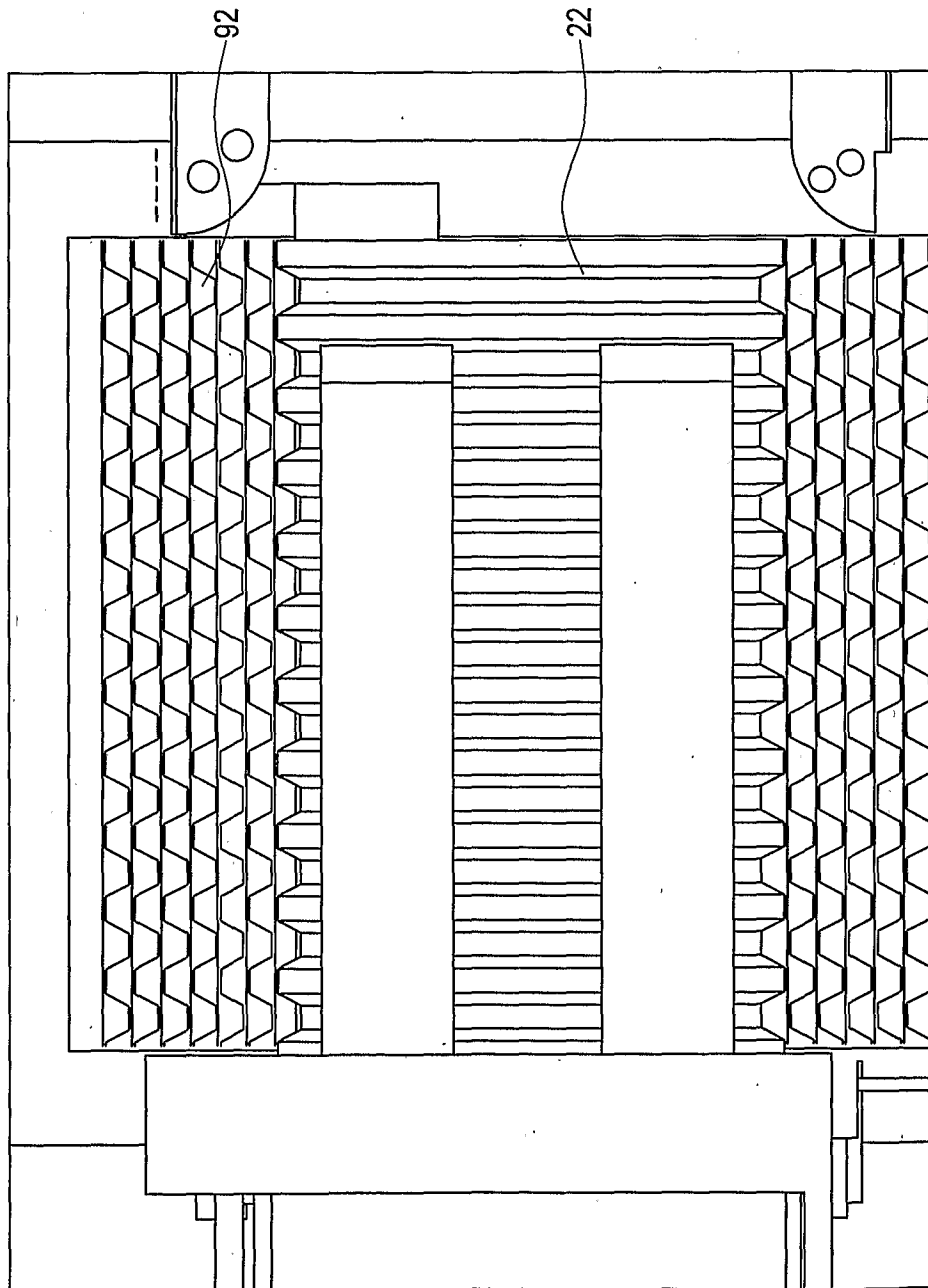


FIG. 31

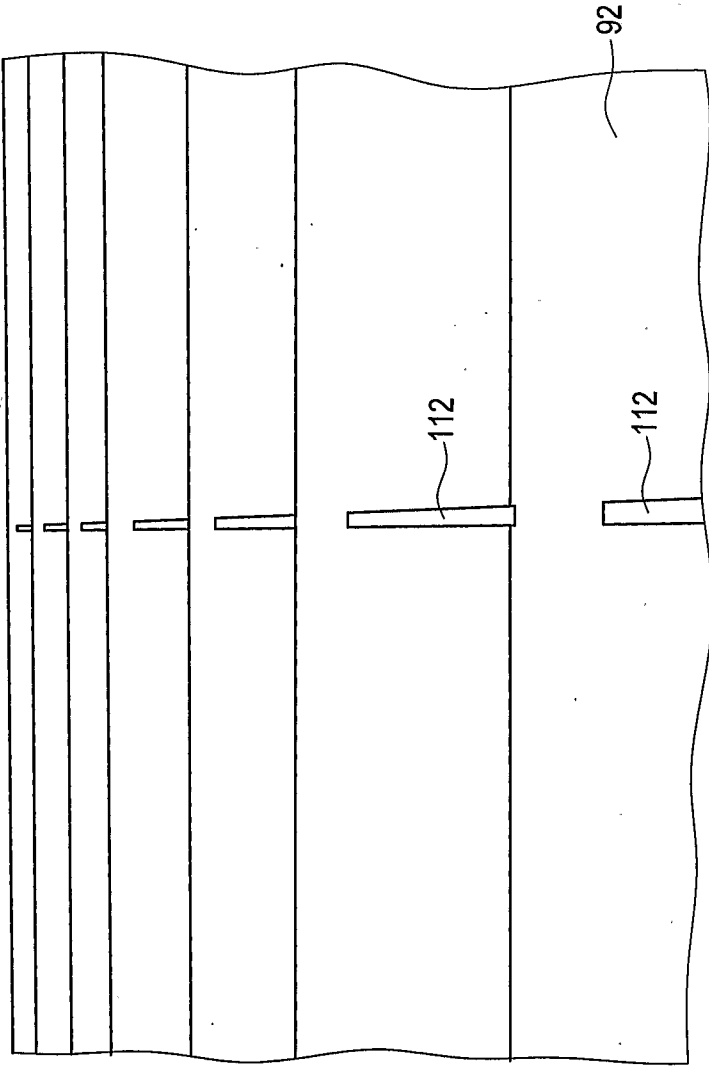


FIG. 32

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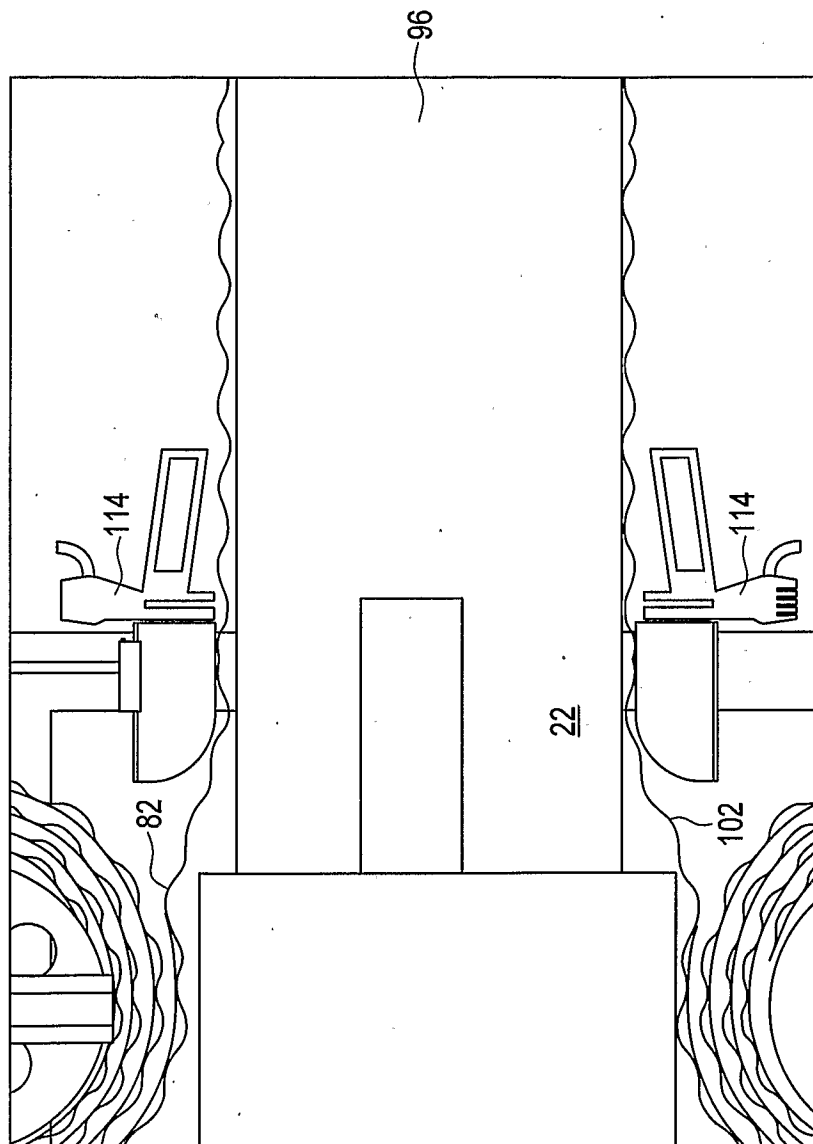


FIG. 33

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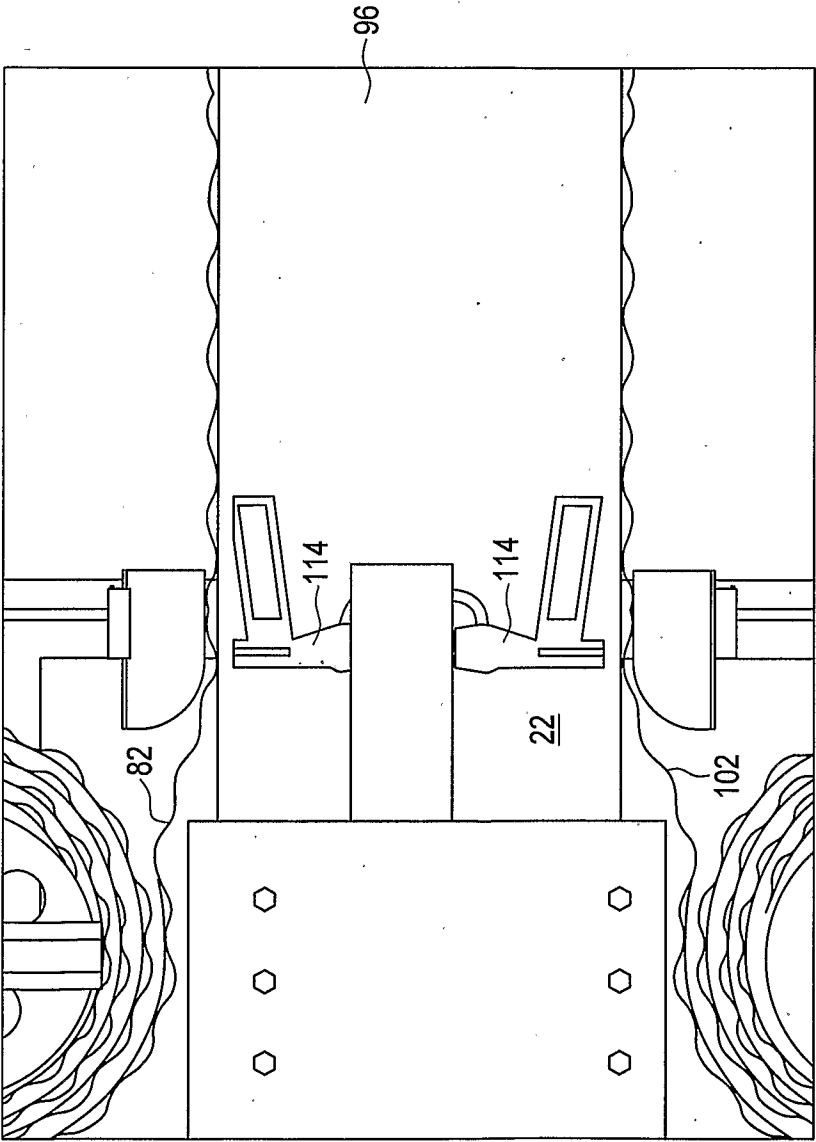


FIG. 34

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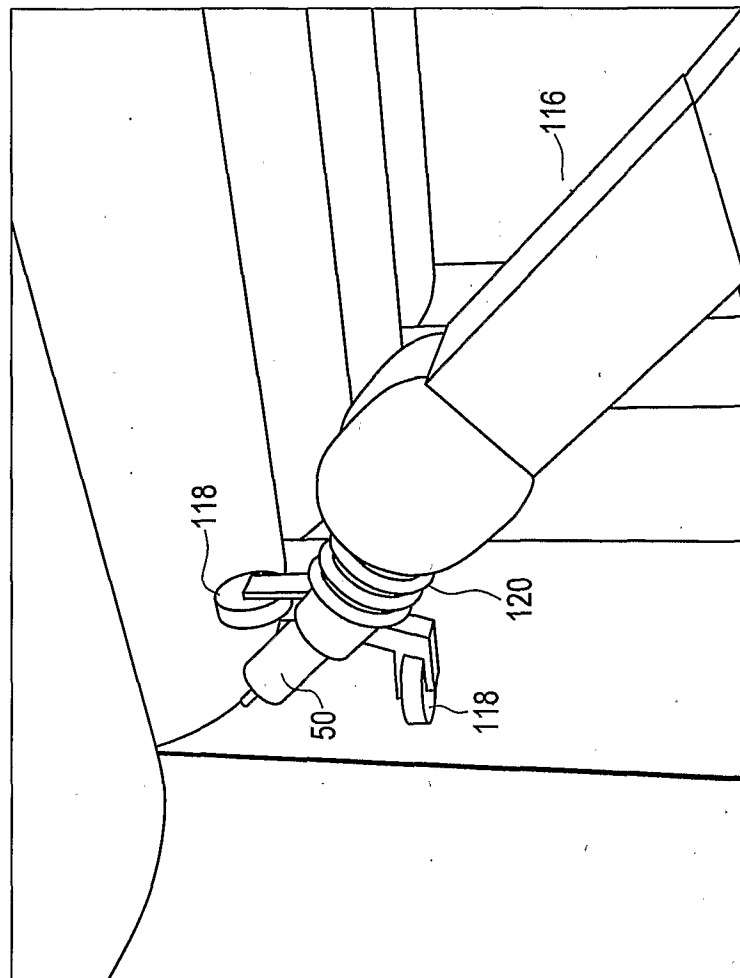


FIG. 35

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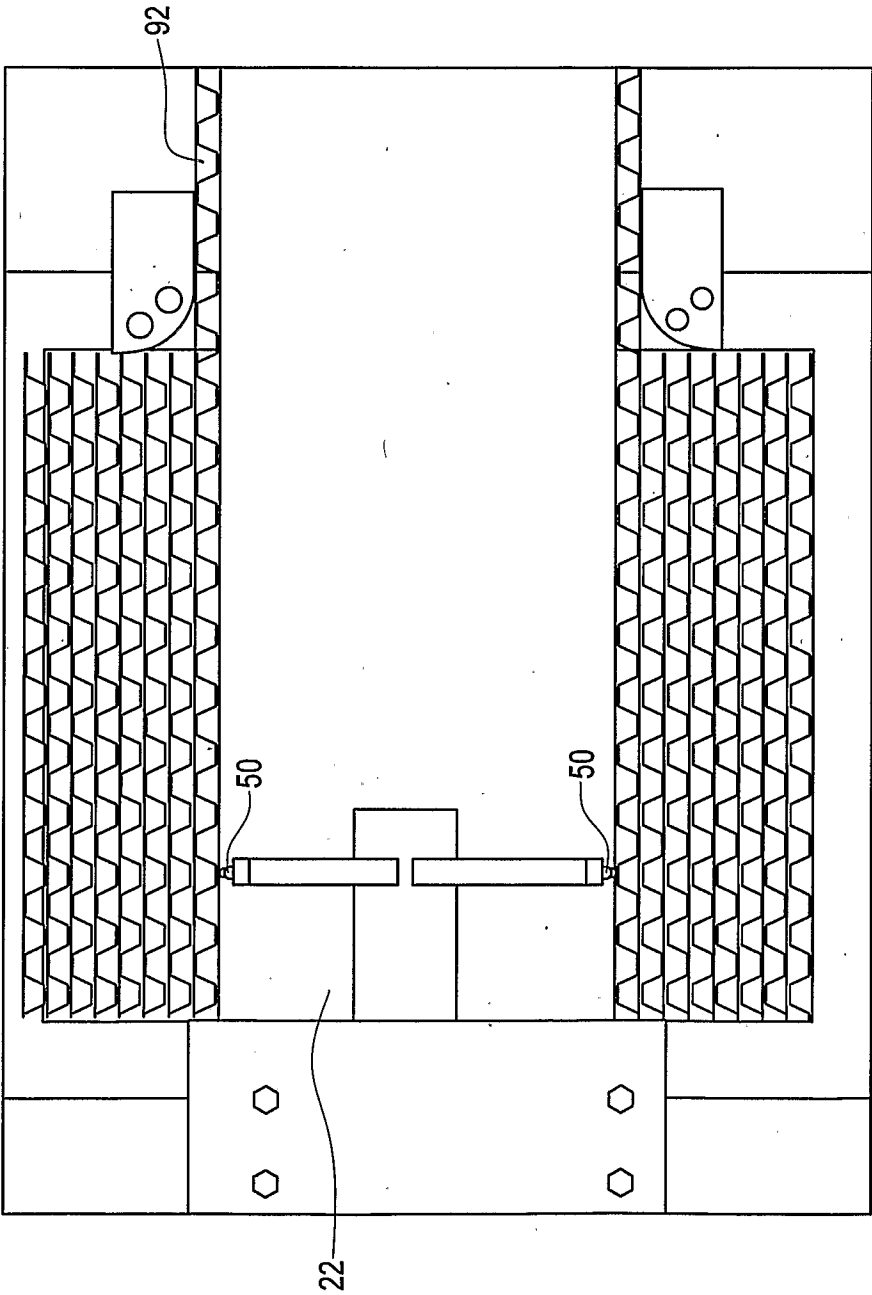


FIG. 36

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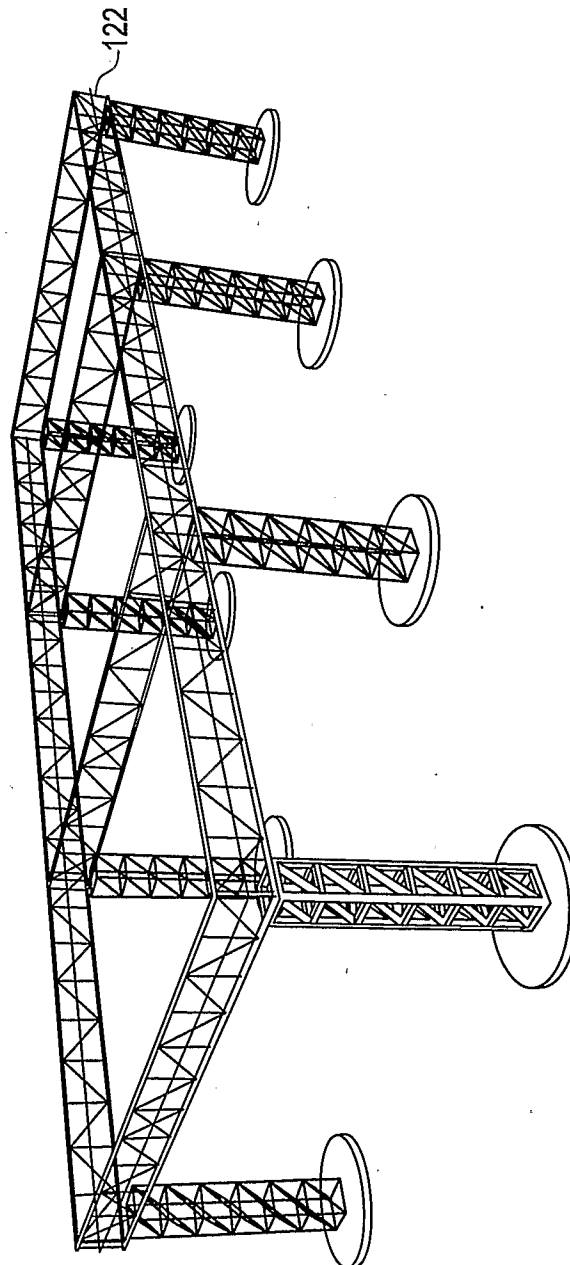


FIG. 37

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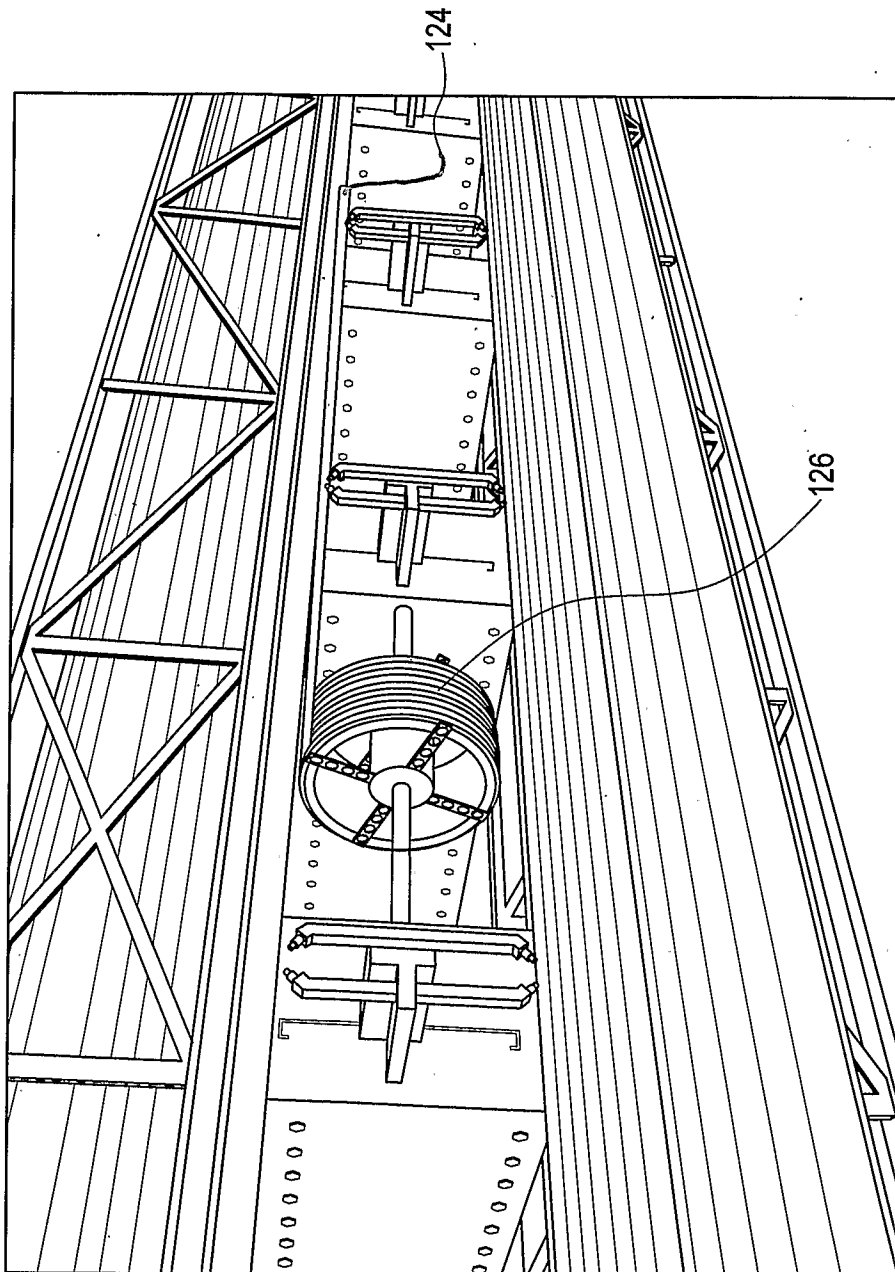


FIG. 38

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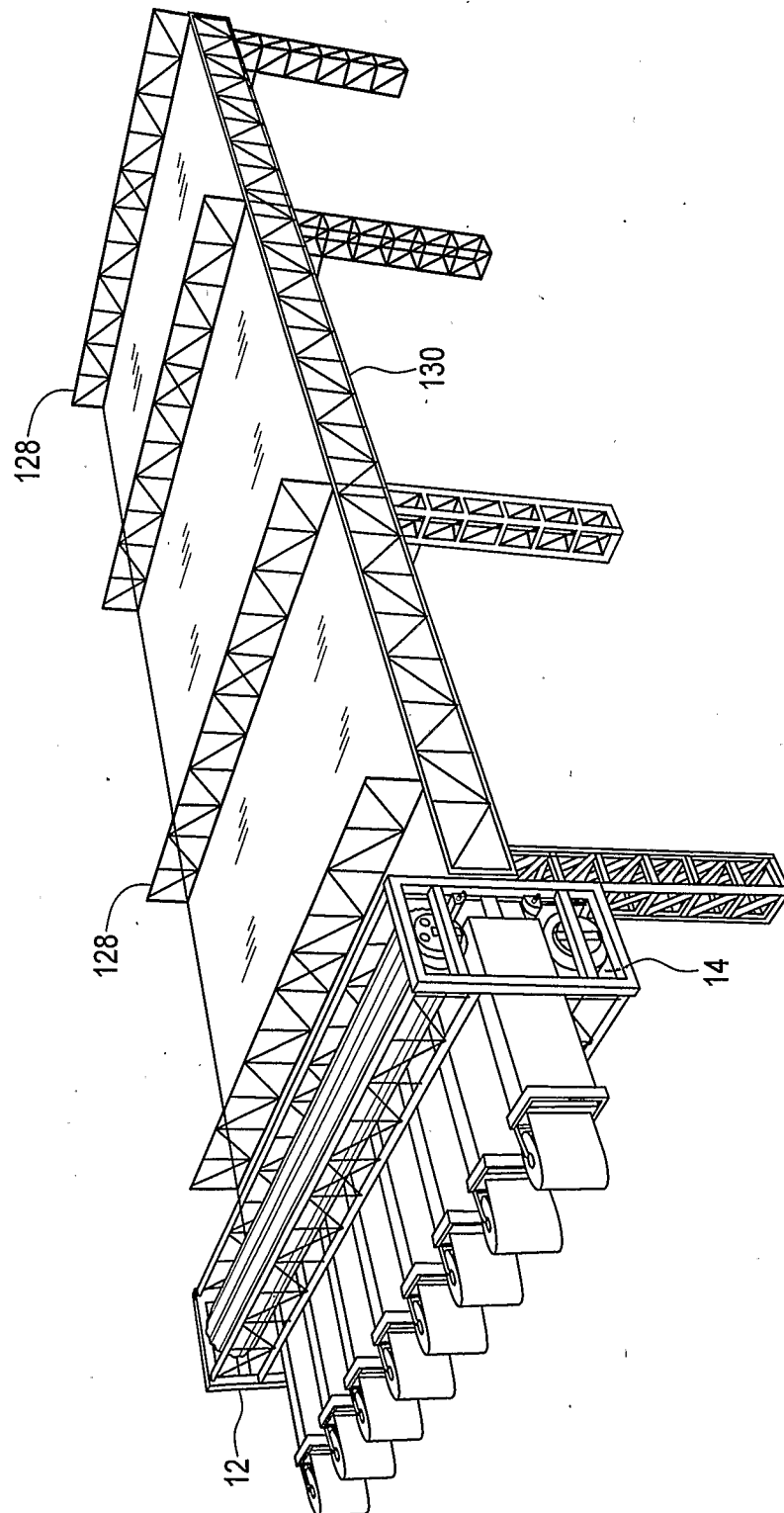


FIG. 39

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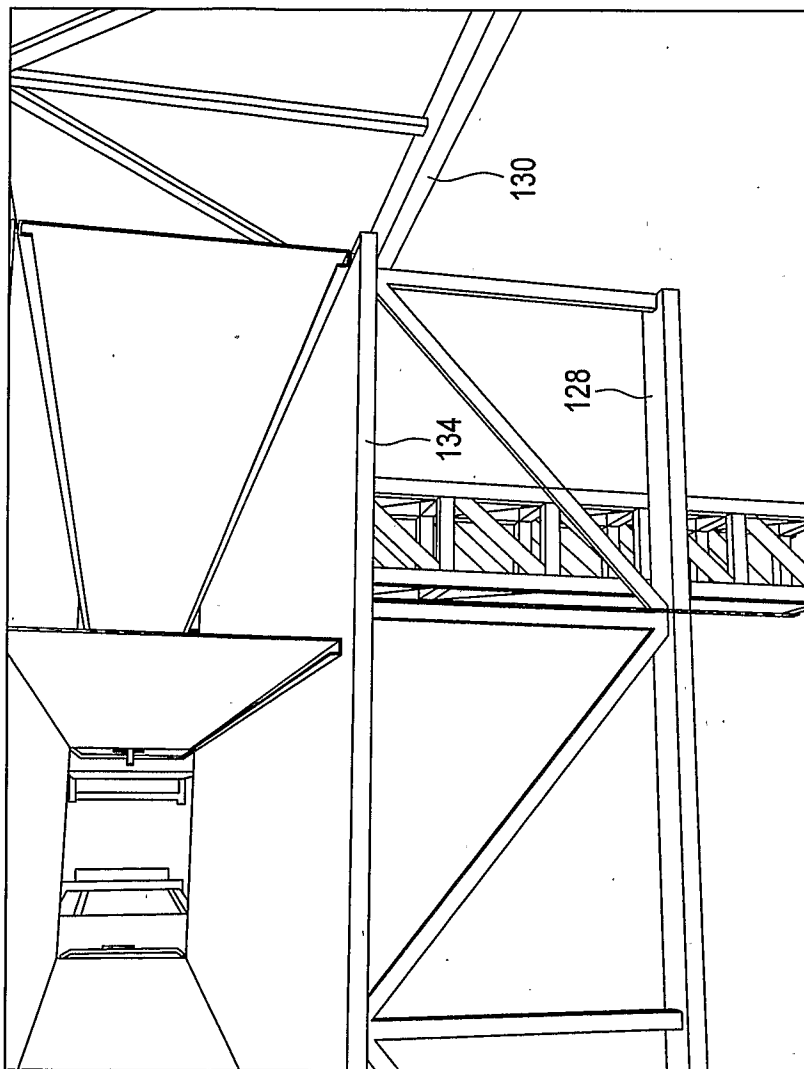


FIG. 40

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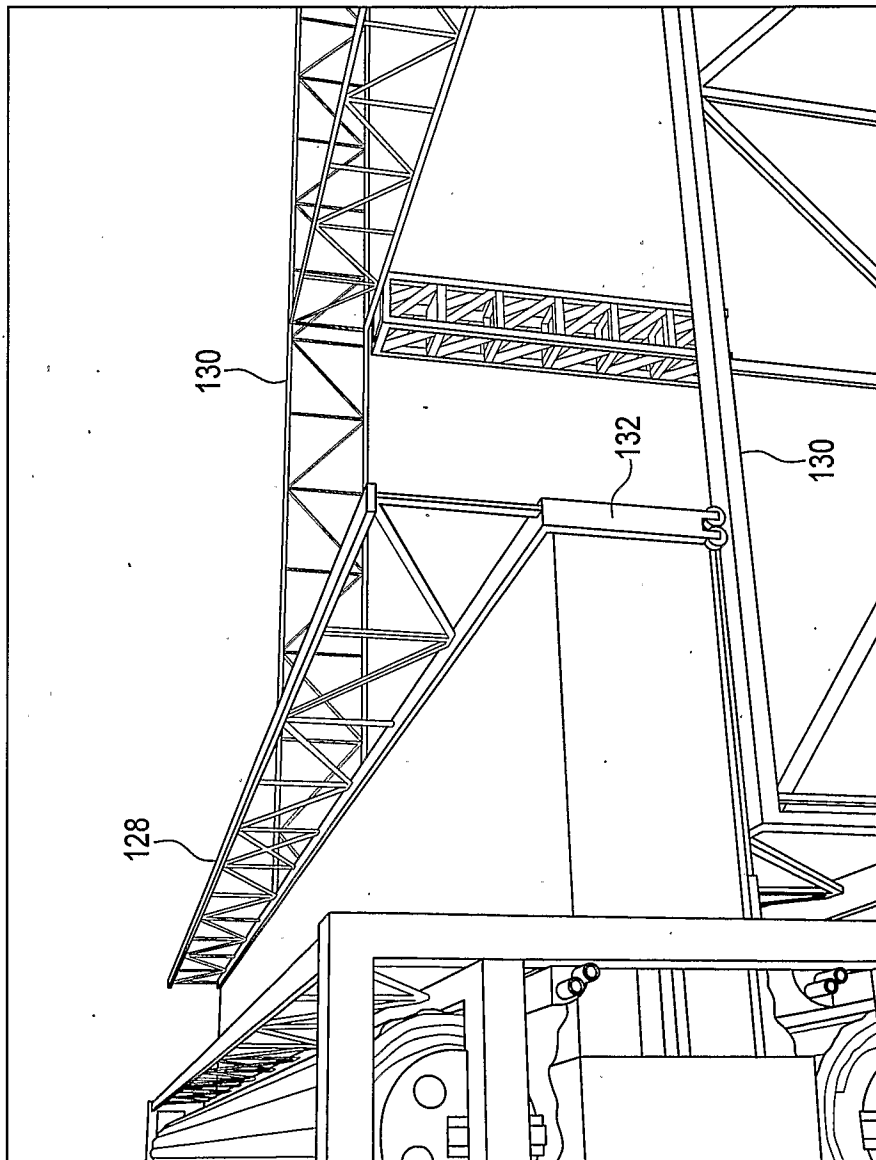


FIG. 41

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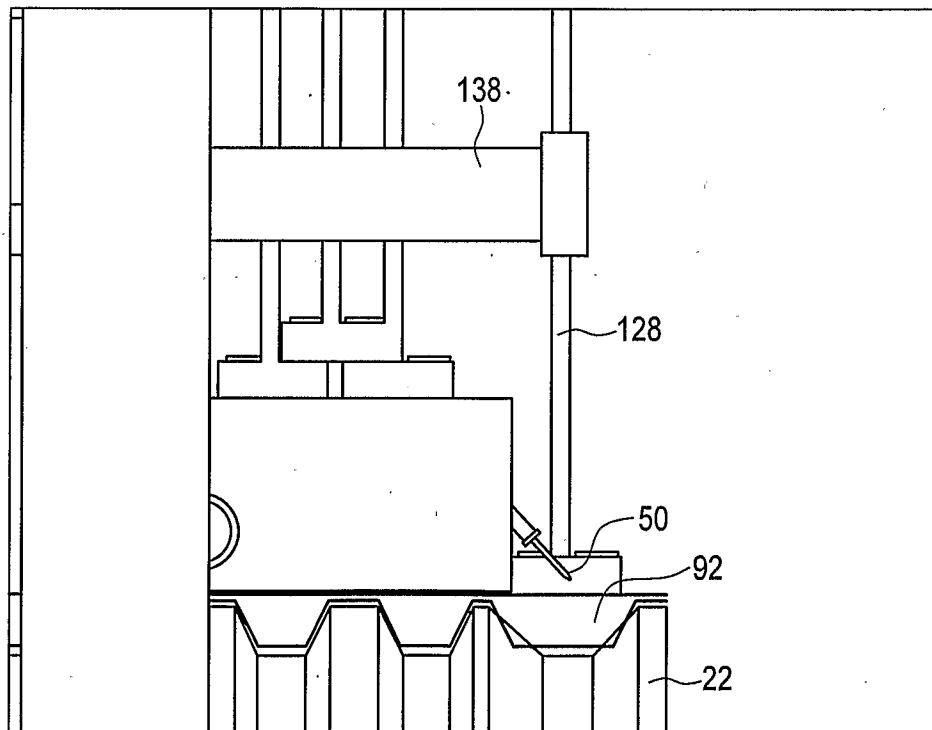


FIG. 42

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2007/000924

A. CLASSIFICATION OF SUBJECT MATTER

IPC (2006.01): **E04G 21/00** , **B23K 37/04** , **B23P 21/00** , **E04B 1/00** ,
E04G 21/14 , **F16S 1/14** , **F16S 3/06**
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC (2006.01): **E04G 21/00** , **B23K 37/04** , **B23P 21/00** , **E04B 1/00** ,
E04G 21/14 , **F16S 1/14** , **F16S 3/06** , **B23K 11/06** , **B23K 31/02** , **E04B 5/10**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Canadian Patents Database, Esp@cenet, Delphion, using keywords: automated, modular, joist, stud, welding, panel, machine, feeder, prefabricated, extrude, roll, coil, assembly.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US4485608 (KAUFMAN et al.) 04 December 1984 (04-12-1984) *whole document*	1, 7-54
X	US6288355B1 (BONSEN) 11 September 2001 (11-09-2001) *whole document*	60-65
X	US5123587 (ASHMORE) 23 June 1992 (23-06-1992) *whole document*	66-70
A	US2004/0200172A1 (BECK et al.) 14 October 2004 (14-10-2004) *whole document*	1-54
A	US3962773 (VAN DER LELY) 15 June 1976 (15-06-1976) *whole document*	1-54
A	EP1057579B1 (CAPRIOGLIO et al.) 30 July 2003 (30-07-2003) *whole document*	60-70

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

05 September 2007 (05-09-2007)

Date of mailing of the international search report

11 September 2007 (11-09-2007)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 001-819-953-2476

Authorized officer

Arthur Gary Grant 819- 953-9698

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/CA2007/000924**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. ☐ Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. ☐ Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :

3. ☐ Claim Nos. :
because they are dependant claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

Group A: Claims 1-59 are directed to a structural member assembly machine and a method of constructing a structural member characterized by upper and lower paneling.

Group B: Claims 60-65 are directed to a welding apparatus characterized by sensor means.

Group C: Claims 66-70 are directed to a method of manufacturing a longitudinal structural element, characterized by the step of welding each of pairs of adjacent portions together.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. :
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/CA2007/000924

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB2379675A (PALMER) 19 March 2003 (19-03-2003) *whole document*	1-54
A	US5074457 (MATSUKI et al.) 24 December 1991 (24-12-1991) *whole document*	60-70

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2007/000924

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US4485608	1984-12-04	US4573292 CA1203063A1	1986-03-04 1986-04-15
US6288355B1	2001-09-11	US6098869 US6288355 JP10052759A2 EP0803312B1 EP08033312A3 EP0803312A2 DK0803312T3 DE59707832C0 CH0692910A	2000-08-08 2001-09-11 1998-02-24 2002-07-31 1998-02-04 1997-10-29 2002-10-07 2002-09-05 2002-12-13
US5123587	1992-06-23	MX9202798A1 CA2070950C CA2070950AA	1993-01-28 1995-07-04 1992-12-12
US2004/0200172A1	2006-01-26	US20040200172A1 CN1683725A CN1683724A CA2464189AA	2004-10-14 2005-10-19 2005-10-19 2004-10-14
US3962773	1976-06-15	JP49076180A2 DE2334615A1	1974-07-23 1974-05-09
EP1057579B1	2003-07-30	ES2205753T3 EP1057579A1 DE69909977T2 DE69909977C0	2004-05-01 2000-12-06 2004-05-19 2003-09-04
GB2379675A	2003-03-19	GB2379675B2 GB2379675A1 GB0122331A0 GB0122331A	2003-10-29 2003-03-19 2001-11-07 2001-11-07
US5074457	1991-12-24	JP06098510B4 JP03008594A2 JP03008575A2 JP02560112B2 JP02560111B2 JP02052199A2 EP0354574B1 EP0354574A3 EP0354574A2 DE68927840T2 DE68927840C0	1994-12-07 1991-01-16 1991-01-16 1996-12-04 1996-12-04 1990-02-21 1997-03-12 1992-05-06 1990-02-14 1997-06-19 1997-04-17