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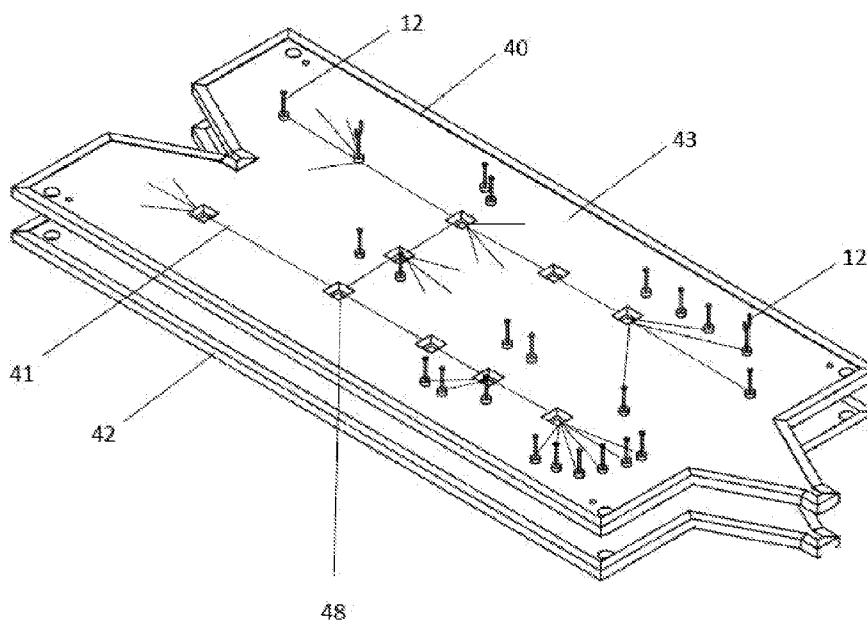


FIG. 2

(57) Abstract: An assembly line for assembling a wiring harness comprising a plurality of wiring harness assembly boards supported a conveyor. Each assembly board comprises a plurality of wiring supports, such as routing forks, for holding the wires of the wiring harness in position on the assembly board, and a plurality of body clip holders. The assembly line includes a series of assembly stations located along the assembly line. The conveyor moves the assembly boards along the assembly line to each assembly station. Several assembly stations include robots operative to automatically complete assembly operations. Manual operative stations are also located along the assembly line. The assembly boards are moved along the assembly line in a horizontal orientation, which provides optimal access for the robots and manual operators to work simultaneously on the line.



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AUTOMATED ASSEMBLY LINE FOR WIRING HARNESS

FIELD OF INVENTION

5 [001] The present disclosure relates to an assembly line for a wiring harness, and in particular an assembly line in which one or more assembly steps are automated.

BACKGROUND

10 [002] A vehicle wiring harness or wiring loom is a bundle of electrical cables used in automotive applications to transmit electrical power supply or data signals around a vehicle. Wiring harnesses are pre-assembled with the cables arranged in the correct routing lengths and configurations and bound together for example using tape, clips, cable ties, or conduits. The terminal ends of the cables are provided with connector
15 elements for electrical connection to the associated in-vehicle components. The wiring harness is also provided with body clips at various locations along its limbs for mechanically connecting the cable harness to various structures within the vehicle.

[003] In a common assembly process a wiring harness is manufactured on a harness
20 assembly board or workbench. The harness assembly board typically comprises a schematic of the wiring routes and labelling indicating the components required at each associated location along the harness. A series of routing forks mounted on the harness assembly board support the wiring bundles. The electrical components are retained in mountings on the assembly board for connection to the cables. The harness assembly
25 board also includes body clip holders to hold and retain the body clips during assembly.

[004] A wiring harness assembly board is generally oriented substantially vertically. An assembly operator manually inserts body clips in each body clip holder. A range of different body clips are used, and each body clip holder must receive the correct body clip
30 type for its location on the harness. Each harness may require 7 or 8 different body clip

types and around 50-60 body clips in total. The wiring bundles are manually routed along the wiring pathways and inserted into the routing forks. A series of cables ties are then applied along the cables to hold the wires together and secure the bundles to the body clips. Adhesive tape is also applied along the wires to create a sleeve that binds the individual wires together and groups them in bundles for improved connectivity. Cable ties are also used to secure the wire bundles to the body clips.

[005] This process is very labour intensive and prone to operator error that may lead to rejection of the wiring harness by the automotive manufacturer. Attempts have been made to automate certain aspects of the assembly process. However, the structure of the harness assembly board prohibits the use of robotic arms for many of the tasks. One of the main barriers to automation are the routing forks and body clip holders, which project a significant distance from the assembly board and interfere with the movement of a robotic arm across the board. For example, the automated taping of wiring bundles is known in other applications. However, automated wire taping is not possible on a conventional wiring harness assembly board due to the presence of the body clip holders immediately beneath the wires that prevent

[006] It is therefore desirable to provide an improved assembly line for a wiring harness, a wiring harness assembly board or assembly station, and/or a method of assembling a wiring harness which addresses the above-described problems and/or which offers improvements generally.

SUMMARY

[007] According to the present disclosure there is provided an assembly line for a wiring harness as described in the accompanying claims.

[008] In an aspect of the disclosure there is provided an assembly line for assembling a wiring harness, the assembly line comprising a plurality of assembly boards, each

assembly board comprising a plurality of wiring supports, such as routing forks, for holding the wires of a wiring harness in position on the assembly board, and a plurality of body clip holders; a series of assembly stations located along the assembly line; and a conveyor for moving the assembly boards along the assembly line to each assembly station. At least one of the assembly stations comprises at least one robot operative to automatically complete an assembly operation. The assembly boards are preferably moved along the assembly line in a horizontal orientation, which provides optimal access for robots and manual operators to work simultaneously on the line.

[009] The robot is preferably operable to move along the assembly line between a start position and a finish position at a speed corresponding to the speed of the conveyor such that the robot remains stationary relative to moving assembly board during the assembly operation. This enables automation of assembly operations while also allowing the assembly line to move continuously rather than pausing at each automated station.

[0010] The assembly boards may move along the conveyor from a first end defining the start of the assembly line to a second end defining the end of the assembly line. A wiring harness removal station is located at the second end, and the assembly line comprises a second conveyor for returning the assembly boards from the second end to the first end following the wiring harness removal station. The second conveyor may be a continuation of the first conveyor. The use of the second conveyor enables the assembly line to operate continuously without the requirement to replenish the assembly boards.

[0011] The second conveyor may be located beneath the first conveyor and the assembly line further comprises a lowering apparatus located at the first end that is arranged to lower the assembly boards to the second conveyor and a lifting apparatus located at the first end arranged to lift the assembly boards to the first conveyor.

[0012] The at least one robot is preferably operative to complete an assembly operation comprising one or more of (i) inserting body clips into the body clip holders; (ii) applying tape to wires supported on the wiring supports; and (iii) applying fasteners to secure the

body clips supported in the body clip holders and to the wires supported on the wiring supports. The fasteners are preferably cable ties but may be any fastener suitable for securing the body clips to the wiring harness. The cable tie straps are cut to length and applied around the wires by the robot and through a corresponding aperture of the body clip. A locking element is applied to the strap, with both ends of the strap being received within and locked by the locking element. This enable the cable ties to be supplied as a continuous reel, with the locking elements supplied as separate components rather than being integrally moulded with the strap.

10 [0013] The body clip holders may be movable between a raised position and a lowered position. The assembly line may comprise a controller operative to position the body clip holders at a predetermined raised or lowered position at one or more assembly stations.

15 [0014] One of the series of assembly stations may comprise a body clip application station including a robot operative to insert body clips into the body clip holders. The controller is operative to move the body clip holders to the raised position at the body clip application station to improve access to the body clip holders by the robot.

20 [0015] One of the series of assembly stations may comprise a tape application station including a robot operative to apply tape to wires supported on the wiring supports, and the controller is operative to position the body clip holders at the lowered position at the tape application station to prevent interference between the robot and the body clip holders.

25 [0016] One of the series of assembly stations may comprise a fastener station for applying the cable ties or other fasteners including a robot operative to apply fasteners to secure the body clips supported in the body clip holders to the wires supported on the wiring supports, and the controller is operative to position the body clip holders at the raised position at the fastener station to bring the body clips close the wires to which they are to be fastened. Fastening preferably comprises the cables being tied to the body clip with a cable tie.

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[0017] One of the series of assembly stations may comprise a routing station configured for the manual routing of wires on the wiring supports of the assembly board, and the controller is operative to position the body clip holders at the lowered position at the routing station.

[0018] One of the series of assembly stations may comprises a harness removal station configured for the manual removal of the wiring harness from the assembly board, and the controller is operative to position the body clip holders at the lowered position at the harness removal station.

[0019] The assembly boards may comprise an upper wiring board having the wiring supports mounted thereon and a lower body clip board having the body clip holders mounted thereon. The upper wiring board includes a plurality of apertures through which the body clip holders extend and the upper wiring board and lower body clip board are able to translate vertically relative to each other between a raised configuration in which the body clip holders are held at a raised first position above the upper surface of the upper wiring board and a lowered configuration in which the body clip holders are held at second position that is lower than the raised first position relative to the upper wiring board. The second position may also be at a position spaced above the upper surface of the upper wiring board or may be recessed within the apertures of the upper wiring board or positioned below. In the first raised position the body clip holder may be positioned at a first height above the upper surface of the upper wiring board and in the second lowered position the body clip holders may be positioned at a second height above the upper surface of the upper wiring board, wherein second height is less than first height. The first height may be substantially equal to the height of the routing forks.

[0020] The upper wiring board may be supported on the conveyor in a horizontal orientation and the lower body clip board is moved vertically relative to the upper wiring board to reconfigure the assembly board between the raised and lowered configurations. The lower body clip board may be slidably connected to the upper wiring board. The

lower board may be movably supported beneath the upper wiring board on guide members, which may be guide rods, connected to the upper wiring board. The guide members may support the lower body clip board in a lowermost position. When the assembly board is oriented horizontally the lower body clip board is vertically movable
5 relative to the upper wiring board.

[0021] The assembly line may comprise one or more actuators located along the assembly line arranged to engage the lower body clip board to raise the lower body clip board to the raised configuration. The actuators may be linear actuators such as
10 pneumatic cylinders. Alternatively, the actuator may be a cam arrangement.

[0022] The conveyor may have a horizontal direction of travel and the one or more actuators may be configured to move in the direction of travel of the conveyor when engaged with the lower body clip board and to move in an opposing return direction when they disengage from the lower body clip board. The actuators may engage the body
15 clip board at a start position and raise the body clip board to the raised configuration, move with the assembly board while in the raised configuration, lower the body clip board at a finish position and then return in the opposite direction to the start position.

[0023] The lower body clip board may comprise docking features for receiving the and
20 locating the actuators.

[0024] Each body clip holder comprises a sensor configured to generate a signal indicating the presence of a body clip in the body clip holder and communicating that signal to a processor. The body clip holders may also include sensor means for
25 determining the presence of the correct body clip type. Communication of the signal generated by the sensor may be via Wifi or Bluetooth (RTM).

[0025] One of the series of assembly stations may comprise a harness removal station configured for the manual removal of the wiring harness from the assembly board, and
30 wherein when the assembly board is at the harness removal station the processor is

operative to provide a signal to the operator based on the signals from the body clip holders indicating whether all of the body clips are present.

5 [0026] The controller may be operative to position the body clip holders at the lowered position at the harness removal station.

[0027] The robot of the body clip application station may include a dispensing head arranged to dispense body clips to the body clip holders and one or more storage containers configured to automatically supply body clips to the dispensing head.

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[0028] The one or more storage containers may comprise a plurality of cassettes and the robot further comprises indexing means operative to selectively move the cassettes respectively into registration with the dispensing head.

15 [0029] In another aspect of the disclosure there is provided a wiring harness assembly board comprising an upper wiring board having a plurality of wiring supports mounted thereon; a lower body clip board arranged below the upper wiring board and having a plurality of body clip holders upwardly extending from the surface of the lower body clip board. The upper wiring board includes a plurality of apertures corresponding in location
20 to the position of the body clip holders of the lower body clip board, the upper wiring board and lower body clip board being arranged parallel to each other and having a vertical axis defined perpendicular to a planar upper surface of the upper wiring board, the upper wiring board and lower body clip board are configured to move vertically relative to each other between a raised configuration in which the body clip holders
25 extend through the apertures to a raised first position above the upper surface of the upper wiring board and a lowered configuration in which the body clip holders are held at second lowered position that is lower than the raised first position relative to the upper surface of the upper wiring board.

30 [0030] The lower body clip board preferably comprises a plurality of elongate support members extending vertically therefrom, the body clip holders are mounted on the

elongate support members and the elongate support members extend through the corresponding apertures of the upper wiring board and are arranged to vertically translate within said apertures as the upper wiring board and lower body clip are reconfigured between the raised configuration and the lowered configuration.

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[0031] In the lowered configuration the lower wiring board may be vertically spaced from the upper wiring board by a first distance and in the raised configuration the lower wiring board is vertically spaced from the upper wiring board by a second distance that is less than the first distance. That is to say, the lower body clip board is lifted closer to the upper wiring board in the raised configuration.

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[0032] The lower board is preferably moved to a raised position and a lowered position to reconfigure the assembly board in the raised configuration and the lowered configuration respectively.

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[0033] In the second position the body clip holders may be positioned at a spaced location above the upper surface of the upper wiring board or may be recessed within the apertures of the upper wiring board or positioned below.

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[0034] In the first raised position the body clip holder is positioned at a height h_1 above the upper surface of the upper wiring board and in the second lowered position the body clip holders may be positioned at a height h_2 above the upper surface of the upper wiring board, wherein h_2 is less than h_1 . The height h_1 may be substantially equal to the height of the routing forks.

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[0035] The lower body clip board is slidably connected to the upper wiring board by one or more guide members, such as guide rods. The body clip holders are mounted to the lower body clip board on support rods.

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[0036] In another aspect of the disclosure there is provided an automatic body clip applicator for a wiring harness assembly line, the automatic body clip applicator comprises a robot having a dispensing head configured to apply body clips to a body clip

holder, and a storage cassette arranged to store a plurality of body clips and to automatically feed said body clips to the dispensing head.

[0037] In another aspect of the disclosure there is provided a method of assembling a wiring harness comprising providing a plurality of assembly boards, each assembly board comprising a plurality of wiring supports, such as routing forks, for holding the wires of a wiring harness in position on the assembly board, and a plurality of body clip holders; a series of assembly stations located along the assembly line; mounting the assembly boards on a conveyor arranged to move the assembly boards along an assembly line; at a first body clip application station along the assembly using a robot to automatically insert body clips into the body clip holders; at a second routing the wires of the wiring harness on the wiring supports of the assembly board; at a third tape application station using a robot to automatically apply tape to wires supported on the wiring supports; at a fastener station using a robot to automatically apply fasteners to secure the body clips supported in the body clip holders to the wires supported on the wiring supports; and removing the completed harness from the assembly board.

[0038] The assembly boards may comprise an upper wiring board having the wiring supports mounted thereon and a lower body clip board having the body clip holders mounted thereon. The upper wiring board includes a plurality of apertures through which the body clip holders extend and the upper wiring board and lower body clip board are able to translate vertically relative to each other between a raised configuration in which the body clip holders are held at a raised first position above the upper surface of the upper wiring board and a lowered configuration in which the body clip holders are held at second position that is lower than the raised first position relative to the upper wiring board.

[0039] The method may further comprise positioning the body clip holders at the raised position at the body clip application station to improve access to the body clip holders by the robot.

[0040] The method may further comprise moving the body clip holders to the lowered position at the routing.

[0041] The method may further comprise maintaining the body clip holders at the
5 lowered position at the tape application station.

[0042] The method may further comprise moving the body clip holders to the raised position at the fastener station to bring the body clips into close proximity to the wires supported on the wiring supports.

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[0043] The method may further comprise positioning the body clip holders at the raised position at the fastener station to bring the body clips close the wires to which they are to be fastened.

15

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] The present disclosure will now be described by way of example only with reference to the following illustrative figures.

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[0045] Figure 1 is an illustrative plan view of an assembly line according an embodiment of the disclosure;

[0046] Figure 2 is a lower body clip board according an embodiment of the disclosure;

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[0047] Figure 3 is an assembly board according an embodiment of the disclosure shown in a lowered configuration;

[0048] Figure 4 is an assembly board according an embodiment of the disclosure shown
30 in a raised configuration;

[0049] Figure 5 is an illustrative cross-sectional view of an assembly board according an embodiment of the disclosure in a lowered configuration;

5 [0050] Figure 6 is an illustrative cross-sectional view of an assembly board according an embodiment of the disclosure in a raised configuration;

[0051] Figure 7 is an illustrative view of a robot head with a body applicator and storage cassette according an embodiment of the disclosure;

10 [0052] Figure 8 is an illustrative view of a robot head with a body applicator and carousel storage cassette arrangement according an embodiment of the disclosure;

[0053] Figure 9 is a main view of a split-type harness operation station according to an embodiment of the present disclosure;

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[0054] Figure 10A is a top view of the split-type harness operation station as shown in Figure 9;

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[0055] Figure 10B is a side view of the split-type harness operation station of the Figure 9;

[0056] Figure 11 is a side view of the split-type harness operation station of the Figure 9;

25 [0057] Figure 12 illustrates a robotic arm equipped with an automatic clip loading apparatus according to an embodiment of the present disclosure; and

[0058] Figures 13A-13D illustrate an automatic clip loading apparatus according to an embodiment of the present disclosure.

30 **DESCRIPTION OF EMBODIMENTS**

[0059] The following description presents exemplary embodiments and, together with the drawings, serves to explain principles of the disclosure. The scope of the disclosure is not intended to be limited to the precise details of the embodiments or exact adherence with all method steps. Variations will be apparent to a skilled person and are deemed also to be covered by the description. Terms for features used herein should be given a broad interpretation that also encompasses equivalent functions and features. In some cases, several alternative terms (synonyms) for structural features have been provided but such terms are not intended to be exhaustive.

[0060] Descriptive terms should also be given the broadest possible interpretation; e.g. the term "comprising" as used in this specification means "consisting at least in part of" such that interpreting each statement in this specification that includes the term "comprising", features other than that or those prefaced by the term may also be present. Related terms such as "comprise" and "comprises" are to be interpreted in the same manner. Directional terms such as "vertical", "horizontal", "up", "down", "upper" and "lower" are relative terms that may be used for convenience of explanation usually with reference to the illustrations and are not intended to be ultimately limiting if an equivalent function can be achieved with an alternative dimension and/or direction.

[0061] The description herein refers to embodiments with particular combinations of configuration steps or features. However, it is envisaged that further combinations and cross-combinations of compatible steps or features between embodiments will be possible. The description of multiple features in relation to any specific embodiment is not an indication that such features are inextricably linked, and isolated features may function independently from other features and not necessarily require implementation as a complete combination.

[0062] Referring to Figure 1, an assembly line 1 is provided for assembling a wiring harness. The assembly line 1 includes a conveyor 2 having a series of assembly stations located along its length. The conveyor 2 includes an upper conveyor 4 moving in a first direction, and a lower conveyor 6 located beneath the upper conveyor 4 moving in an

opposing second direction. A lifting station 8 is located at a first end of the conveyor 2 and a lowering station 9 is located at an opposing second end of the conveyor 2.

[0063] A series of assembly boards 10 are located on the upper conveyor 4 in a horizontal orientation. The assembly boards 10 each include a wiring schematic indicating the wiring route plan. The wiring schematic is printed or otherwise displayed on an upper surface of each assembly board 10. Each assembly board 10 further includes a plurality routing forks 12 located along the wiring schematic for supporting and routing the wires. A plurality of body clip holders 14 are also provided to hold and support the body clips at predetermined locations along the wiring routes. The upper conveyor 4 is controlled to move at a predetermined speed to convey the assembly boards from the first end of the conveyor 2 to the second end.

[0064] The assembly line 1 includes a body clip station 16. The body clip station 16 comprises one or more robots 18 operative to insert body clips into the body clip holders 14. The robot 18 is operated by a controller that is programmed with the location along the wiring schematic of each body clip holder 14 and corresponding body clip type for each body clip holder 14. The robot 14 is provided with a range of body clips corresponding to each location on the wiring schematic. The robot 14 automatically inserts each body clip in the corresponding body clip holder 1 in a pre-programmed sequence. Each body clip holder 14 has an x,y location on the upper conveyor 4, with x corresponding to the width of the conveyor and y corresponding to the length. As the assembly boards 10 move along the upper conveyor 4 the x location of the body clip holder 14 remains constant while the y location varies with time and is dependent on the speed at which the upper conveyor 4 travels. The body clip robot 18 is movably mounted to, or next to the assembly line 1 on a rail or similar mechanism and a motor and drive mechanism is provided to enable the robot 18 to move along the assembly line 1 with, and at the same speed as the assembly board 10, in order that the longitudinal y location of the robot 18 relative to the assembly board remains constant for the duration of the body clip application process. The entire robot 18 may be arranged to move, or the body of the robot 18 may be fixed and only the arm of the robot 18 arranged to move along

the assembly line. The body clip robot 18 begins operation at a start position and moves along the assembly line with the assembly board 10 to a finish position at which the body clip placement operation has been completed. The robot 18 is then returned to the start position to re-commence the body clip placement operation with next assembly board.

5 Alternatively, the placement schedule of the robot 18 may be programmed to account for movement of the assembly board. The control means for the robot may determine the instantaneous x,y location of each body clip holder 14 based on the position of each body clip holder 14 on the assembly board 10, the start position of each assembly board 10 on the upper conveyor 4 and the speed of the upper conveyor 4.

10 [0065] A routing station 20 follows the body clip station 16 along the conveyor 2. The routing station is located longitudinally adjacent the body clip station 16 along the conveyor 2. The routing station 20 comprises an operator zone 22 for accommodating an operator. The operator zone 22 is configured to allow the operator sufficient space to
15 route the wires on the assembly board 10. When the assembly board arrives at the routing station the operator proceeds to route the wires by following the wiring schematic displayed on the assembly board 10. and placing the wires into the routing forks 12 along the wiring pathway. The upper conveyor 4 continues to move at a constant speed during the routing operation and the length of the routing station 20. The operator
20 zone 22 is located on the opposing side of the conveyor 2 to the robot 14, to ensure there is no interference between the robot 14 and the operator.

[0066] Following the routing station 20 the assembly boards 10 move to a taping station 24. The taping station 24 includes a taping robot 26 located on the same side of the
25 conveyor 2 as the body clip robot 14. The taping robot 26 is operative to wind adhesive tape around predetermined sections of the wiring harness to bind individual wires together in bundles. The taping robot 26 is movably mounted in the same manner as the body clip robot 18 to move along the conveyor with the assembly board 10 from a start position to a finish position and to return to the start position when the taping operation
30 is completed. Alternately, the controller operating the taping robot 26 is programmed to accommodate the movement of the conveyor when moving the taping robot 26 to and

along each respective section of the wiring harness. An operator zone 28 is located longitudinally adjacent the taping station 24, wherein an operator may manually apply additional tape to sections of the wiring harness that are inaccessible to the taping robot 26.

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[0067] A body clip tie station 30 is located after the taping station. Each body clip includes a body clip head comprising an attachment feature such as aperture or 'eye' that is configured to receive a cable tie or similar connector for securing the cable tie to the wiring harness. The body clip station includes a tie applicator robot 32 operative to pass a
10 cable tie through the attachment point of the cable tie head and around a wiring bundle to secure the body clip to the wiring bundle. The tie applicator robot 32 is located on the same side of the conveyor 2 as the body clip robot 18 and taping robot 26. The tie applicator robot 32 applies the cable ties while the body clips are supported immediately beneath the wiring bundles by the body clip holders 14. The body tie robot 32 is movably
15 mounted in the same manner as the body clip robot 18 and taping robot 26 to move along the conveyor with the assembly board 10 from a start position to a finish position and to return to the start position when the tie application operation is completed.

[0068] Following the body clip tie station 30, the wiring harness is removed from the
20 assembly board 10 at a final manual operator station 36. Each of the body clip holders 14 includes a sensor configured to identify the presence of a body clip. The body clip holders 14 may also include sensors configured to identify the presence of the correct body clip type in each body clip holder 14. The signals from the body clip holders 14 are received by a processor running software configured to determine whether all of the body clips are
25 present in the holders 14 and may also determine whether the correct body clip types are present. If all of the body clips are present the software provides a signal indicating to the operator that the harness may be removed. In the absence of a positive signal the harness is not removed from the assembly board 10 and the assembly line may be stopped while a check of the body clips is conducted. Once the wiring harness has been
30 removed the assembly board 10 is moved to the lowering station 9 and a lowering mechanism moves the assembly board to the lower conveyor 6, which conveys the

assembly board 10 to the first end of the conveyor 2. When the assembly board 10 reaches the lifting station 8 at the first of the conveyor 2 it is lifted to the upper conveyor 4 and is moved to the body clip station 16 to begin the cycle again.

- 5 [0069] As shown in Figure 2, each assembly board 10 includes a wiring board 40 and a body clip board 42. The wiring board 40 forms an upper layer. The body clip board 42 is located beneath the wiring board 40 and forms a lower layer. The wiring board 40 and body clip board 42 are laterally aligned and arranged parallel to each other. Both boards 40,42 are rectangular and substantially the same shape and size. The boards include
- 10 interlocking alignment elements comprising a triangular projection extending from a front edge and a corresponding triangular cutaway located at a rear edge. The triangular projection is configured to locate within the triangular cutaway of a leading assembly board 10 to register and align the boards along the assembly line. The projection and cutaway may be any suitable interlocking shapes and are not limited to being triangular.
- 15 In other embodiments the assembly boards 10 may be rectangular and are not provided with the interlocking alignment elements. The upper wiring board 40 has a wiring schematic 41 displayed on the surface thereof. The wiring schematic may be printed on the surface of the wiring board 40 or may for example comprise a removable printed schematic. The wiring board 40 comprises a plurality of routing forks 12 mounted on its
- 20 upper surface 43 and upwardly extending therefrom. The routing forks 12 are arranged along the wiring pathways of the wiring schematic 41 at predetermined nodes to support the wiring bundles. The routing forks 12 project a height h_1 from the upper surface of the wiring board 40. The wiring board 40 may also include electrical connectors arranged to be connected to corresponding connectors (not shown) at the ends of the limbs of the
- 25 wiring harness. The wiring board 40 further includes a series of apertures 48 located at predetermined nodes along the wiring pathways for receiving body clip holders 14, as described in further detail below.

- [0070] Referring to Figure 3, the body clip board 42 includes a plurality of body clip
- 30 holders 14 mounted on support rods 44. The support rods 44 extend upwardly in a direction perpendicular to the planar upper surface 45 of the body clip board 42. The

body clip holders 14 are mounted at the ends of the support rods 44 and have a diameter greater than the support rods 44. Each body clip holder has an aperture (not shown) at its upper ends for receiving and retaining a body clip. Each body clip holder also includes one or more sensors for detecting the presence and type of body clip located within the holder, and a wireless transmitter for transmitting a signal from the one of more sensors.

[0071] The body clip board 42 is movably connected to the wiring board 40 such that it is able to vertically translate relative to the wiring board 40. In the arrangement of Figure 2, the body clip board 42 is vertically spaced from the wiring board in a first lowered configuration. The body clip holders 14 are in a lowered position relative to the upper surface 43 of the wiring board 40. In this embodiment the body clip holders 14 are recessed within the apertures 48 in the lowered position. In other embodiments the body clip holders 14 may have a diameter greater than the apertures 48 and remain above the upper surface 43 in the lowered position. With the body clip holders 14 in lowered position, the operator is able to route the wires through the routing forks 12 without interference from the body clip holders 14. This enables the operators to route the wires more efficiency. It also obviates the risk of the operators knocking body clips out of the body clip holders 14 while routing the wires, which happens in the manual assembly boards of the prior art where the body clip holders remain in a fixed raised position close to the height of the routing forks. The lowered position of the body clip holders 14 also enables a taping robot 26 to automatically tape the wiring without risk of interference with the body clip holders 14.

[0072] In Figure 4 the body clip board has been lifted to a raised configuration in which the vertical spacing from the wiring board 40 is reduced. The body clip holders 14 are supported at a raised position relative to the upper surface 43 of the wiring board 40 that is higher than the lowered position. In the raised position the body clip robot 18 is able to access the body clip holders 14 to insert body clips without interference with the routing forks 12.

[0073] Figure 5 is an illustrative cross section of the assembly board 10 in the lowered configuration. The wiring board 40 is movably supported on the upper conveyor 4. The

body clip board 42 is supported and hangs beneath the wiring board 40 in the lowered configuration on guide rods 46. The guide rods 46 extend downwardly from the body clip board 40. The body clip board 42 includes guide holes 49 through which the guide rods 46 extend. The guide rods 46 are not fixed to the body clip board 42 and are slidingly
5 received in the guide holes 49. Stop elements 50 are located at the lower ends of the guide rods 46 and define a lowermost position for the body clip board 42 relative to the wiring board 40. The body clip board 42 further includes guide members 52 secured to the upper surface of the body clip board 42 that each have an inner guide channel 54 arranged co-centrally with the guide holes 49. The inner bore 54 of each guide channel
10 52 has a diameter greater than the guide rods 46 such that the guide rods 46 are slidingly received within the guide channels 52.

[0074] The support rods 44 of the body clip holders 14 extend through corresponding apertures 48 formed through the wiring board 40. The position of the apertures 48 of the
15 wiring board corresponds to the position of the body clip holders 14 on the wiring board 42. The body clip holders 14 are supported at the upper ends of the support rods 44 in a position adjacent and spaced above the upper surface 43 of the wiring board 40. The diameter of the body clip holders 14 is greater than the diameter of the apertures 48. The body clip holders 14 are located above the upper surface 43 in the lowered position and
20 so the size of the apertures 48 is able to be minimised to maximise space on the upper surface 43 of the wiring board 40.

[0075] Linear actuators 56, which may be hydraulic or pneumatic cylinders, are located beneath the upper conveyor 4 at stations where it is required to move the body clip
25 board to the raised configuration. Each cylinder 56 includes a piston rod 58 arranged to move vertically. Docking elements 60 are located on the lower surface 62 of the body clip board 42 that include channels configured to receive and locate the piston rods 58. In the arrangement of Figure 5 the piston rods 58 are in a lowered position and the wiring board is able to move over the actuators 56, which are stationary relative to the assembly board

30 10.

[0076] In Figure 6 the piston rods 58 are raised to move the body clip board 14 into the raised configuration. The piston rods 58 are raised when the docking elements 60 are located above the actuators 56. The ends of the piston rods 58 are received within the docking elements 60. As the piston rods 58 are raised further they engage the lower surface 62 of the body clip board 14 or the inner end of the channel of the docking element 60. The piston rods 58 push upwards on the body clip board 40. The body clip board 40 moves upwards and slides along the guide rods 46. The support rods 44 slide through the apertures 48 as the body clip board 40 is raised. As the body clip board 40 continues to move upwards, the body clip holders 14 are raised further above the upper surface 43.

[0077] In the maximum raised configuration, body clip holders 14 are positioned relative to the upper surface 43 at a height just below the height of the routing forks 12. The actuators 56 are arranged to move longitudinally along the assembly line towards the second ends while the body clip board 40 is held in the raised position. Each station along the assembly line at which the body clip board 40 is required in the raised position includes a set of movable actuators 56. The piston rods 58 are raised at a start position and at the longitudinal position along the assembly line where the body clip board 40 is required to return to the lowered configuration, the piston rods 58 are lowered, which represents the finish position. The actuators 56 then move in the opposite direction to the assembly board 10 to return to the start position and operate the next assembly board 10 on the assembly line.

[0078] At the start of the assembly line, when the assembly board 10 is first raised, the body clip board 40 is in the lowered configuration. The body clip board 40 is then moved to configuration at the start of the body clip station 16. The body clip robot 18 applies the body clips to the body clip holders 14 and at the end of the body clip station 16 the body clip board 40 is returned to the lowered configuration. At this stage the body clip holders 14 are supporting a complete set of body clips. The body clip board 40 remains in the lowered configuration through the routing station 22 and the taping station 24. The body clip board 40 is then lifted to the raised configuration at the body clip tie station 30. At

this stage the wiring harness is supported on the routing forks 12 and the wiring bundles have been taped. The body clip holders 14 move to the raised position where the body clips are supported immediately beneath the respective sections of the wiring bundles to which they are to be secured. The tie applicator robot 32 applies the cable ties, tightens the ties and clips them, to secure the body clips to the wiring harness. At the end of the body clip tie station 30 the body clip board 40 is returned to the lowered configuration. If a positive signal is received that all the body clips are present, the wiring harness is then removed. The assembly board 10 is lowered to the lower conveyor 6 and returned to the start of the assembly line.

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[0079] In another aspect of the disclosure, Figure 7 shows a body clip applicator 70 for a robot arm, having an automatic body clip dispenser 72. Presently the manual application to body clips involves an operator individually selecting body clips from a storage arrangement adjacent the assembly board. For each body clip holder, the correct corresponding body clip must be selected and inserted, and this varies from holder to holder. Attempts have been made to automate this process. However, such automated systems simply replicate the manual process, with robots selecting a body clip from a storage area, which may comprise for example a bowl feeder, and moving to the assembly board to insert the body clip, and then returning to the storage area to select the next body clip. Selecting and applying body clips one by one in this manner consumes cycle time and slows the assembly process.

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[0080] The body clip applicator 70 includes a body clip applicator head 74 having a body clip chamber 76 and an actuator 78 such as pneumatic cylinder arranged to move a body clip 79 held within the body clip chamber 76 into a body holder 14. The body clip applicator 70 includes a connection face for connecting to the head 80 of the body clip robot. The body clip dispenser 72 is arranged to supply body clips to the body clip chamber 76. A body clip dispenser 72 includes a vertically arranged cassette 82 containing a plurality of body clips 79. The cassette 82 comprises a pair of guide rails 84 spaced by a gap 86. The gap 86 and the rails 84 are arranged such that the body clips 79 are able to slide within the gap 86, with the head of the body clip 79 arranged on one side of the

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guide rails 84 and a flange section of the body clip located on the opposing side of the guide rails 84 to retain the body clips 79 with the gap 86. The guide rails 84 include a first vertical storage section 88 and a substantially horizontal feeder section 90.

5 [0081] The body clips 79 are inserted into the cassette 82 at the upper end of the vertical storage section 88 and slide down under gravity to the feeder section 90. The feeder section 90 is connected to the body clip chamber 76 such that body clips 79 in the feeder section 90 slide into the body clip chamber 76 ready for dispensing. Once a first body clip 79 is dispensed the next body clip 79 in the feeder section slides into the body
10 clip chamber 76. The applicator head 84 includes a trigger mechanism that retains the stowed body clips 79 while a body clip is held in the body clip chamber 76 and releases a stowed body clip into the body clip chamber 76 when the first body clip 79 has been dispensed.

15 [0082] As described above, a typical assembly board requires a range of different body clip types. The cassette 82 could be supplied with a range of different body clip types arranged in a specific order corresponding to the dispensing schedule. However, this is complicated to load and inflexible if the dispensing schedule is varied from board to board. The arrangement of Figure 8 comprises a multiple cassette arrangement
20 configured to store and dispense a range of different body clips 79. The body clip applicator 170 comprises a plurality of cassettes 182a-f. Each cassette 182a-f is configured to receive a different body clip type. The cassettes 182a-f are mounted on a rotatable support frame 183 in a carousel arrangement. The storage cassette carousel is operable to rotate to move a selected cassette 182a-f such that the feeder section 190 of that
25 cassette 182a-f is aligned with the body clip chamber 176. The controller is configured to rotate the support frame 183 to align a selected cassette 182a-f as the robot is operated to the dispense the required body clip type at each body clip holder location of the wiring schematic. Alternatively, each cassette may be preloaded, and a single cassette dispensed until it is empty, and which point the next cassette is rotated to the dispensing position to
30 continue dispensing, thereby avoiding the need to re-charge the cassette. This arrangement provides a means for automatically feeding a range of body clip types to the

body clip applicator head and obviates the requirement for the robot to return to a bowl feeder after each placement to acquire the next body clip and significantly decreases the cycle time.

5 Split-Type Harness Operation Station

[0083] According to another embodiment of the present disclosure, a split-type harness operation station 100 is proposed. As shown in Figure 9, the operation station 100 comprises a wiring board 101, clip board 102, translating mechanism 103, lifting mechanism 104, guiding means 105, rack 106, guard plate 107, feet 108 and electric control system. The structure is thus compact.

[0084] The split-type harness operation station 100, according to the operation areas, can be divided into two major parts: the wiring board 101 at an upper layer, and the clip board 102 at a lower layer. The translating mechanism can drive the wiring board 101 at the upper level to move along the guiding means 105 to a position above the clip board 102 at the lower level, and the lifting mechanism can drive the clip board 102 to move upwards or downwards. The split-type harness operation 100 further comprises a sensor to sense if the wiring board 101 has moved to a position above the clip board 102.

[0085] As shown in Figure 9, the lower clip board 102 has clip holder (fixture), into which the clip head can be inserted.

[0086] As shown in Figure 10A, a plurality of holes 109 are formed on the wiring board 101, the positions of the holes 109 are corresponding to the mounting positions of the clip holders on the clip board 102, such that when the wiring board moves to a position above the clip board 102 and the clip board 102 is lifted, the clip holders will penetrate through the holes 109 and reach to a point above the surface of the wiring board 101.

[0087] Based on the split-type harness operation 100, the following assembling operation process can be implemented.

[0088] At an initial state, the wiring board 101 is positioned at an outer side such that the operator can perform wiring operations; the clip board 102 is positioned at inner side where the clip heads can be inserted into the clip holders (fixture) on the board.

5 [0089] The operator at the outer side can do the wiring according to an arrangement on the wiring board 101, meanwhile the robotic arm (not shown in Figure 9) at the inner side can insert clips into holders on clip board 102 according to the process requirement.

[0090] After the wiring is completed and the clips are all inserted into position, the
10 translating mechanism can drive the wiring board 101 to the inner side. When the sensor detects that the wiring board 101 is at a position above the clip board 102, the translating movement ceases; then the lifting mechanism 104 will drive the clip board 102 up to a raised position.

15 [0091] Although not shown in the figure, it can be understood that the split-type harness operation 100 may comprise control apparatus (e.g. PLC) to control the above assembling operations.

[0092] Then the robotic arm at the inner side can begin to work, performs the
20 assembling operations according to a pre-set process pathway, until the assembling is finished. After that, the lifting mechanism 104 will receive a signal and begin to descend. After complete separation of the two boards, the translating mechanism 103 will drive the wiring board 101 to exit. The operator can then retrieve the harness with clips mounted. Then the process begins for the next harness.

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[0093] As an example, the operations to be finished by the inner robotic arm may comprise: picking up clip, inserting clip, clipping. The above-described way to implement these operations shall not constitute a limitation to this embodiment. As described below, a high-efficiency clip loading apparatus according to another aspect of this invention can
30 be used to implement at least part of the operations for the inner side robotic arm.

[0094] The technology as represented by the split-type harness operation station 100 can achieve system flexibility and is good for engineering modification. Meanwhile, the system has high scalability, for different harnesses, as only the forks and clip holders need to be replaced. The operator only needs to put the harness on and fetch the harness off
5 with some or all of the remaining processes being automated. The efficiency is highly increased.

Automatic Clip Loading Apparatus

[0095] According to another embodiment of the present disclosure, an automatic clip
10 loading apparatus is proposed. Such an automatic clip loading apparatus can be, as shown in Figure 12, amounted onto the robotic arm 330 as a component 310. The concrete structure of this clip loading apparatus is shown in Figs. 13A-13D. The clip loading apparatus 400 of Figures 13A-13D mainly consists of clip holder 402, indication light 403, turntable 404 and connection part 405. The clip 401 can be attached on the clip holder
15 402 by means of a sucker means or other similar means.

[0096] The entirety of the clip loading apparatus may be attached to the end of the robotic arm 330 of Figure 12 through its connection part 405. The operator can put clip materials into a proper container. The container can be, for example, a vibration plate (a
20 means to convey and order items through vibration). The vibration plate can make the clips in order, and the robotic arm 330 can drive the clip loading apparatus 400 to move to a pickup position, rotate for attitude alignment and then move downwards. The clip holder 402 on the clip loading apparatus 400 can pick up the clip by suction, and the indication light will be on. After picking up one clip, the robotic arm 300 will drive the
25 rotation 404 to rotate for a degree and then pick up another clip. The process will be repeated successively until the pickup is done.

[0097] After pickup, the robotic arm 330 can quickly move to the assembling area, and the robotic arm 300 can drive the clip loading apparatus 400 to move slowly to the
30 assembling position according to a pre-set path, adjust the attitude, and align the position of clip holder 402 on the turntable 404 with the assembling position. After the clip 401 is

placed at assembling position, the clip holder 402 will intake air and then release the clip, and the indication light 403 will be off. After that, the robotic arm 330 will drive the turntable 404 to rotate and place another clip. The process continues until all the clips are released and then the clip loading apparatus 400 will go back to pickup position.

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[0098] The robotic arm 300 of Figure 12 can be further equipped with a clipping gun 320 so as to perform the clipping operation. In connection with the embodiment of Figure 9, when the harness, after wiring, is moved into the inner side of the operation station, the robotic arm 300 will take the clipping gun 320 to a position above the clip holder, and the
10 air cylinder on the end of the robotic arm will actuate the trigger of the clipping gun 320, such that the clip will be applied, tightened, and cut off.

[0099] Although not shown in the figures, it is understood that the system may further comprise control apparatus for control the operations of robotic arm 330 and the clip
15 loading apparatus 400.

[00100] The technology represented by the clip loading apparatus 400 is compatible with most of the commonly used clips and thus has high scalability. For different clips, only the clip holders need to be replaced. In addition, multiple clips can be picked up and released
20 one time, thus the efficiency is significantly increased.

[00101] The split-type harness operation station and the automatic clip loading apparatus can be combined to increase the efficiency of the harness assembling production line, and they can also be implemented separately or independently.

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[00102] Furthermore, one or more of the numbered clauses below may describe and relate to further aspects or features within the context of the present disclosure.

1. A split-type harness operation station, comprising:
30 a wiring board and a clip board which are separate with each other;

a translating mechanism to move the wiring board along a guiding means to a point above the clip board; and
a lifting mechanism to drive the clip board up or down.

- 5 2. The split-type harness operation station of clause 1, wherein clip fixtures are provided on the clip board, and multiple holes are formed on the wiring board, the position of the plurality of holes are corresponding to the mounting positions of clip fixtures on the clip board.
- 10 3. The split-type harness operation station of clause 2, wherein when the wiring board moves to a position above the clip board and the clip board is lifted up, the clip fixtures will pass through the plurality of holes and reach to a point above the surface of the wiring board.
- 15 4. The split-type harness operation station of clause 1, further comprising control apparatus to control the movements of the translating mechanism and the lifting mechanism.
- 20 5. The split-type harness operation station of clause 3, further comprising a sensor, the control apparatus is to detect if the wiring board has moved a position above the clip board based on the inputs from the sensor.
- 25 6. An automatic clip loading apparatus to be mounted onto a robotic arm, said automatic clip loading apparatus comprises:
a turntable which can be attached to end of robotic arm through connection part;
a plurality of clip holders disposed along circumference of the turntable,
said robotic arm can drive the turntable to rotate, and each of the plurality of clip holders can be used to suck and release a clip.

7. The automatic clip loading apparatus of clause 6, further comprising indication lights corresponding to the clip holders, when a clip holder is sucking a clip, the corresponding indication light will be on

- 5 8. The automatic clip loading apparatus of clause 6, further comprising control apparatus to control the robotic arm to perform the following operations: move the automatic clip loading apparatus to a pickup position, rotate the turntable to pick up clip by suction successively, move the automatic clip loading apparatus to assembling position, rotate the turntable to release clip successively.

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CLAIMS

1. An assembly line for assembling a wiring harness, the assembly line comprising:
a plurality of assembly boards, each assembly board comprising a plurality of
5 wiring supports for holding the wires of a wiring harness in position on the assembly
board, and a plurality of body clip holders;
a series of assembly stations located along the assembly line; and
a conveyor for moving the assembly boards along the assembly line to each
assembly station;
10 wherein at least one of the assembly stations comprises at least one robot
operative to automatically complete an assembly operation.
2. The assembly line according to claim 1, wherein the robot is operable to move
along the assembly line between a start position and a finish position at a speed
15 corresponding to the speed of the conveyor such that the robot remains stationary
relative to moving assembly boards during the assembly operation.
3. The assembly line according to any preceding claim, being configured such that
the assembly boards move along the conveyor from a first end to a second end, a wiring
20 harness removal station is located proximate the second end, and the assembly line
comprises a second conveyor for returning the assembly boards from the second end
following the wiring harness removal station.
4. The assembly line according to claim 3, wherein the second conveyor is located
25 beneath the first conveyor and the assembly line further comprises a lowering apparatus
located at the first end that is arranged to lower the assembly boards to the second
conveyor and a lifting apparatus located at the first end arranged to lift the assembly
boards to the first conveyor.
- 30 5. The assembly line according to any preceding claim, wherein the robot is
operative to complete an assembly operation comprising one or more of (i) inserting body

clips into the body clip holders; (ii) applying tape to wires supported on the wiring supports; and (iii) applying fasteners to secure the body clips supported in the body clip holders and to the wires supported on the wiring supports.

5 6. The assembly line according to claim 5, wherein the body clip holders are movable between a raised position and a lowered position and the assembly line comprises a controller operative to move the body clip holders to a predetermined raised or lowered position at one or more of the assembly stations.

10 7. The assembly line according to claim 6, wherein one of the series of assembly stations comprises a body clip application station including a robot operative to insert body clips into the body clip holders, and the controller is operative to move the body clip holders to the raised position at the body clip application station to improve access to the body clip holders by the robot.

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8. The assembly line according to claim 6 or 7, wherein one of the series of assembly stations comprises a tape application station including a robot operative to apply tape to wires supported on the wiring supports, and the controller is operative to position the body clip holders at the lowered position at the tape application station to prevent interference between the robot and the body clip holders.

20

9. The assembly line according to any one of claims 6 to 8, wherein one of the series of assembly stations comprises a fastener station including a robot operative to apply fasteners to secure the body clips supported in the body clip holders to the wires supported on the wiring supports, and the controller is operative to position the body clip holders at the raised position at the fastener station to bring the body clips close to the wires to which they are to be fastened.

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10. The assembly line according to any one of claims 6 to 9, wherein one of the series of assembly stations comprises a routing station configured for the manual routing

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of wires on the wiring supports of the assembly board, and the controller is operative to position the body clip holders at the lowered position at the routing station.

11. The assembly line according to any one of claims 6 to 10, wherein one of the series of assembly stations comprises a harness removal station configured for the manual removal of the wiring harness from the assembly board, and the controller is operative to position the body clip holders at the lowered position at the harness removal station.

12. The assembly line according to any one of claims 6 to 11, wherein the assembly boards comprise an upper wiring board having the wiring supports mounted thereon and a lower body clip board having the body clip holders mounted thereon, wherein the upper wiring board includes a plurality of apertures through which the body clip holders extend and the upper wiring board and lower body clip board are able to translate vertically relative to each other between a raised configuration in which the body clip holders are held at a raised first position above the upper wiring board and a lowered configuration in which the body clip holders are held at a second position that is lower relative to the upper wiring board than the raised first position.

13. The assembly line according to claim 12, wherein the upper wiring board is supported on the conveyor in a horizontal orientation and the lower body clip board is moved vertically to reconfigure the assembly board between the raised and lowered configurations.

14. The assembly line according to claim 13, comprising one or more actuators located along the assembly line arranged to engage the lower body clip board to raise the lower body clip board to the raised configuration.

15. The assembly line according to claim 14, wherein the conveyor has a horizontal direction of travel and the one or more actuators are configured to move in the direction

of travel of the conveyor when engaged with the lower body clip board and move in an opposing return direction when they disengage from the lower body clip board.

16. The assembly line according to any preceding claim, wherein each body clip
5 holder comprises a sensor configured to generate a signal indicating the presence of a body clip in the body clip holder and communicating that signal to a processor.

17. The assembly line according to claim 16, wherein one of the series of assembly
10 stations comprises a harness removal station configured for the manual removal of the wiring harness from the assembly board, and wherein when the assembly board is at the harness removal station the processor is operative to provide a signal to the operator based on the signals from the body clip holders indicating whether all of the body clips are present.

15 18. The assembly line according to claim 17, wherein the controller is operative to position the body clip holders at the lowered position at the harness removal station.

19. The assembly line according to claim 7, wherein the robot of the body clip
20 application station includes a dispensing head arranged to dispense body clips to the body clip holders and one or more storage containers configured to automatically supply body clips to the dispensing head.

20. The assembly line according to claim 19, wherein the one or more storage
25 containers comprise a plurality of cassettes and the robot further comprises indexing means operative to selectively move the cassettes respectively into registration with the dispensing head.

21. A wiring harness assembly board comprising:
an upper wiring board having a plurality of wiring supports mounted
30 thereon;

a lower body clip board arranged below the upper wiring board and having a plurality of body clip holders upwardly extending from the surface of the lower body clip board;

wherein the upper wiring board includes a plurality of apertures
5 corresponding in location to the position of the body clip holders of the lower body clip board, the upper wiring board and lower body clip board being arranged parallel to each other and having a vertical axis defined perpendicular to a planar upper surface of the upper wiring board, the upper wiring board and lower body clip board are configured to move vertically relative to each other between a raised configuration in which the body
10 clip holders extend through the apertures to a raised first position above the upper surface of the upper wiring board and a lowered configuration in which the body clip holders are held at second lowered position that is lower than the raised first position relative to the upper surface of the upper wiring board.

15 22. The wiring harness assembly board according to claim 21, wherein the lower body clip board comprises a plurality of elongate support members extending vertically therefrom, the body clip holders are mounted on the elongate support members and the elongate support members extend through the corresponding apertures of the upper wiring board and are arranged to vertically translate within said apertures as the upper
20 wiring board and lower body clip are reconfigured between the raised configuration and the lowered configuration.

23. The wiring harness assembly board according to claim 21 or 22, wherein in the lowered configuration the lower wiring board is vertically spaced from the upper wiring
25 board by a first distance and in the raised configuration the lower wiring board is vertically spaced from the upper wiring board by a second distance that is less than the first distance.

24. The wiring harness assembly board according to any one of claims 21 to 23,
30 wherein the lower board is moved to a raised position and a lowered position to

reconfigure the assembly board in the raised configuration and the lowered configuration respectively.

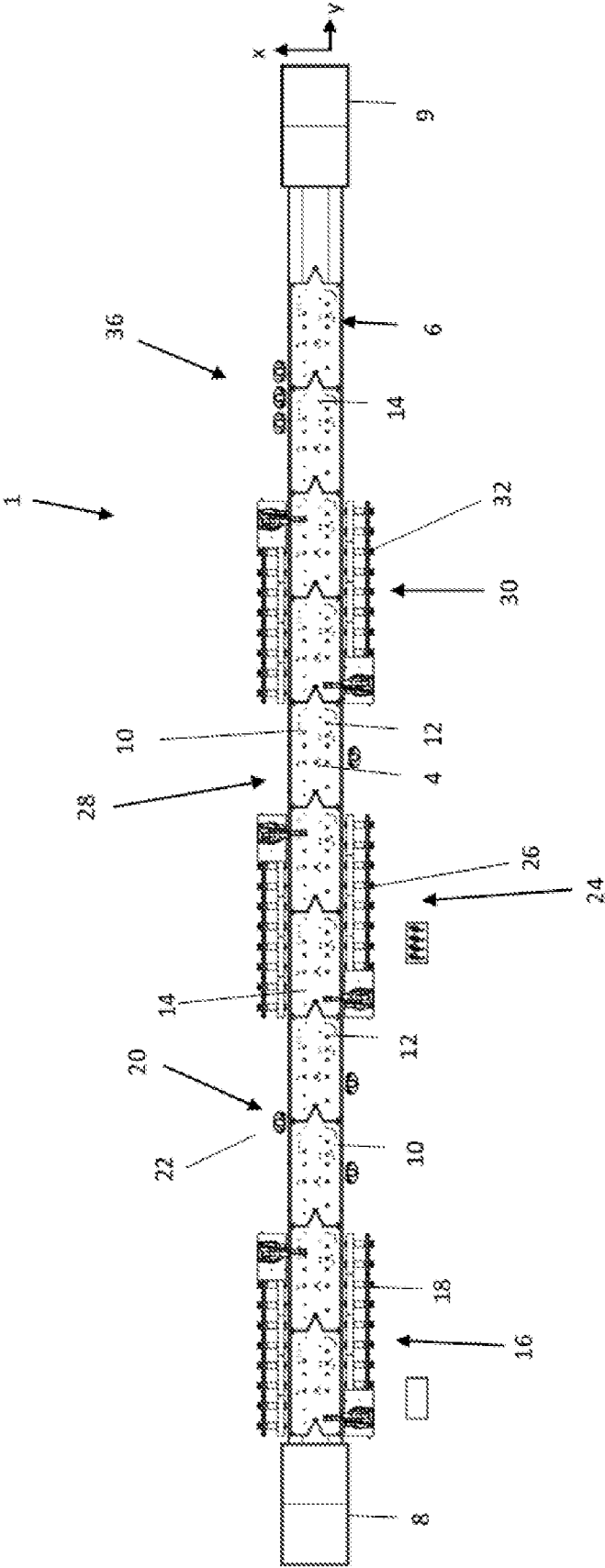


FIG. 1

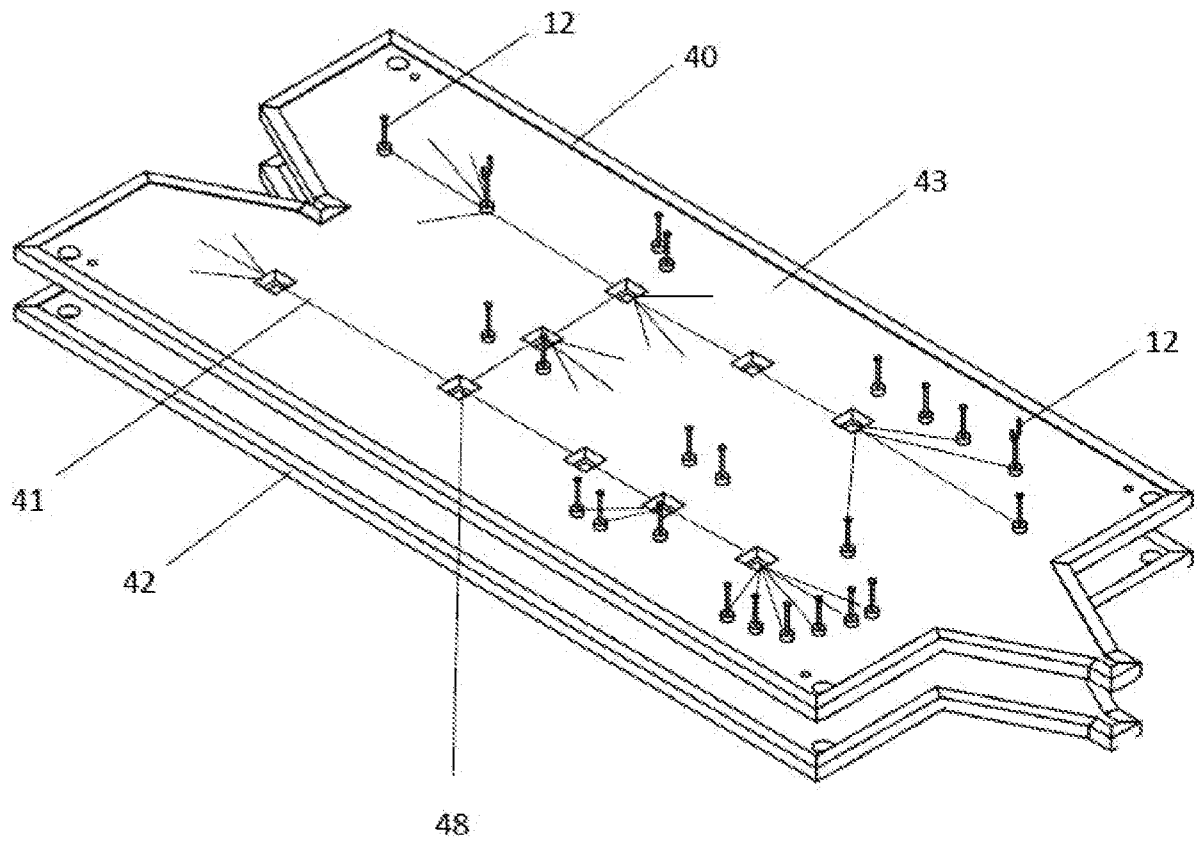


FIG. 2

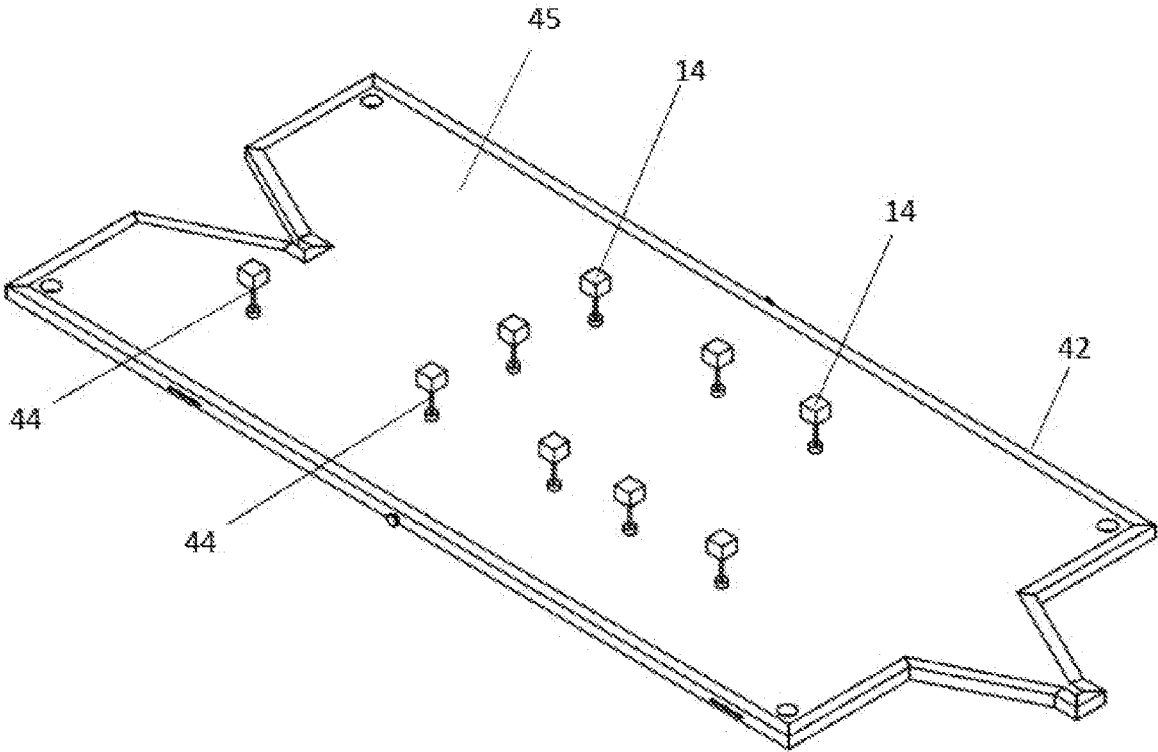


FIG. 3

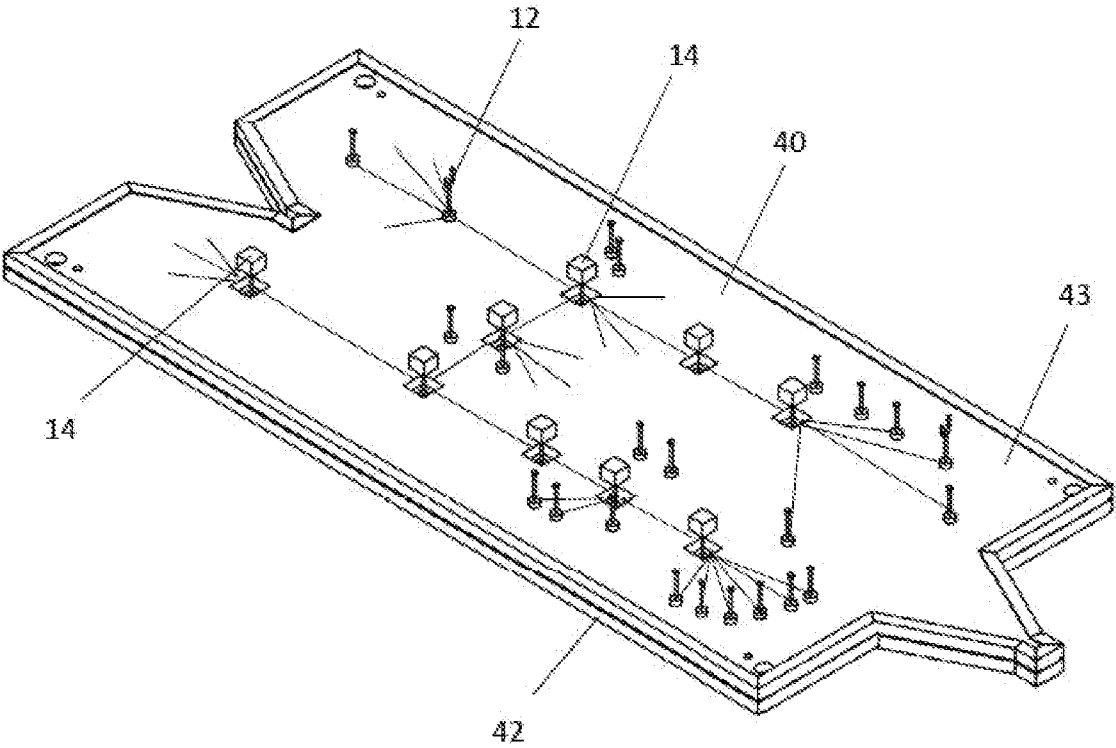


FIG. 4

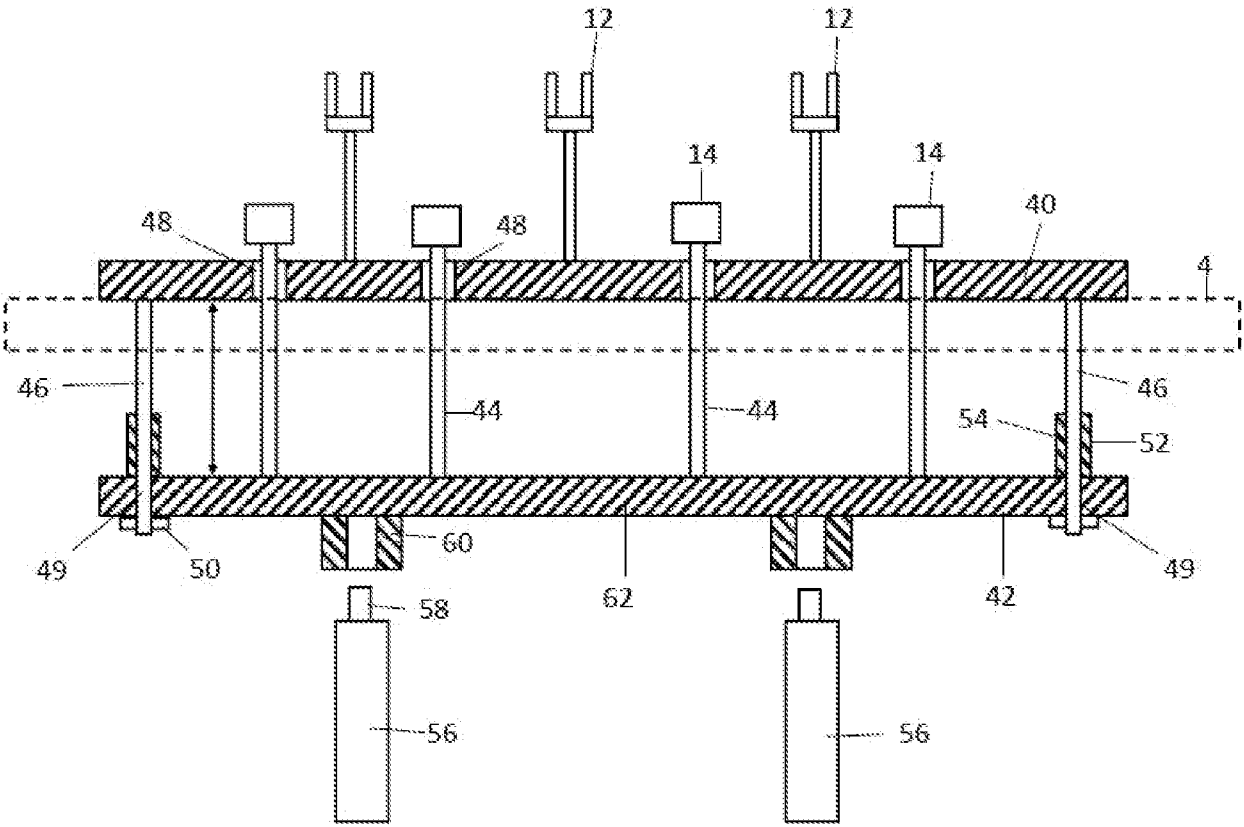


FIG. 5

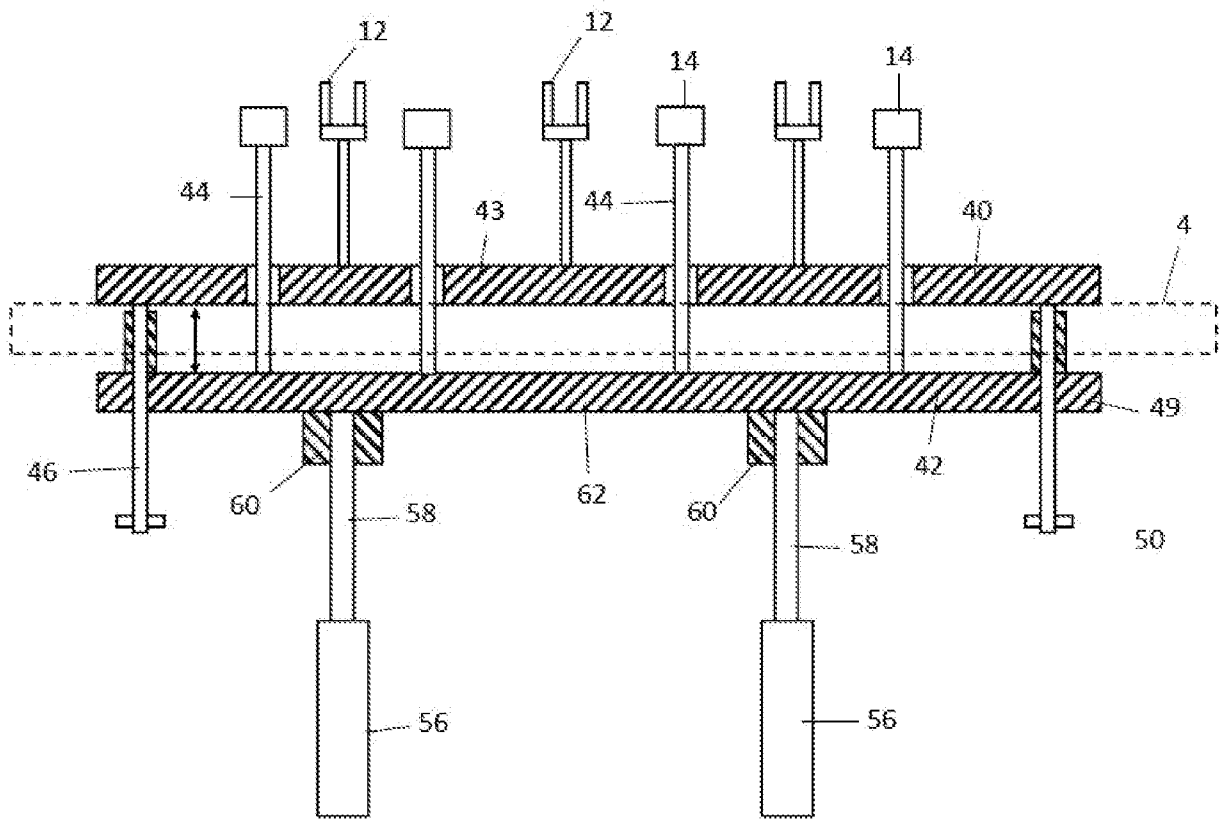


FIG. 6

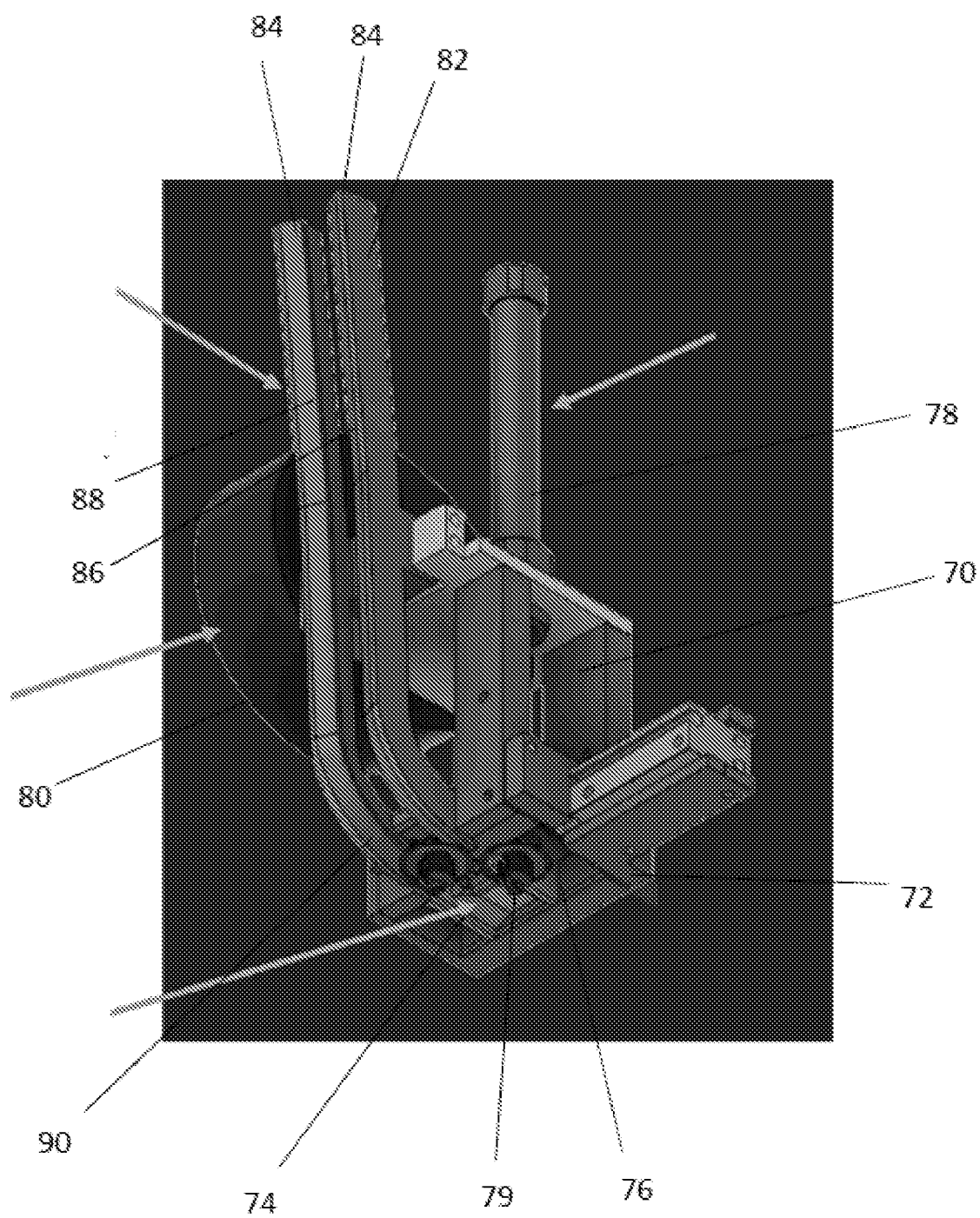


FIG. 7

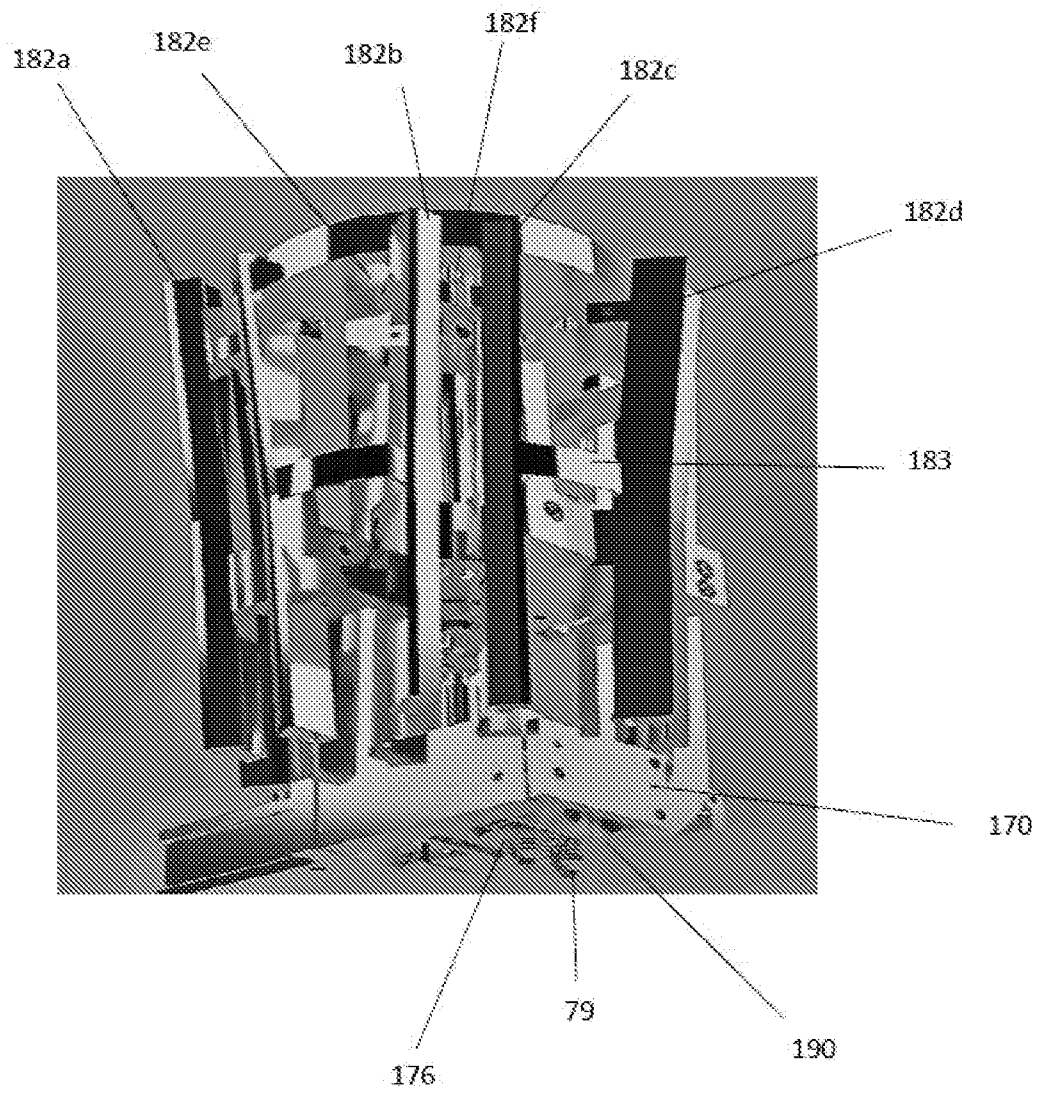


FIG. 8

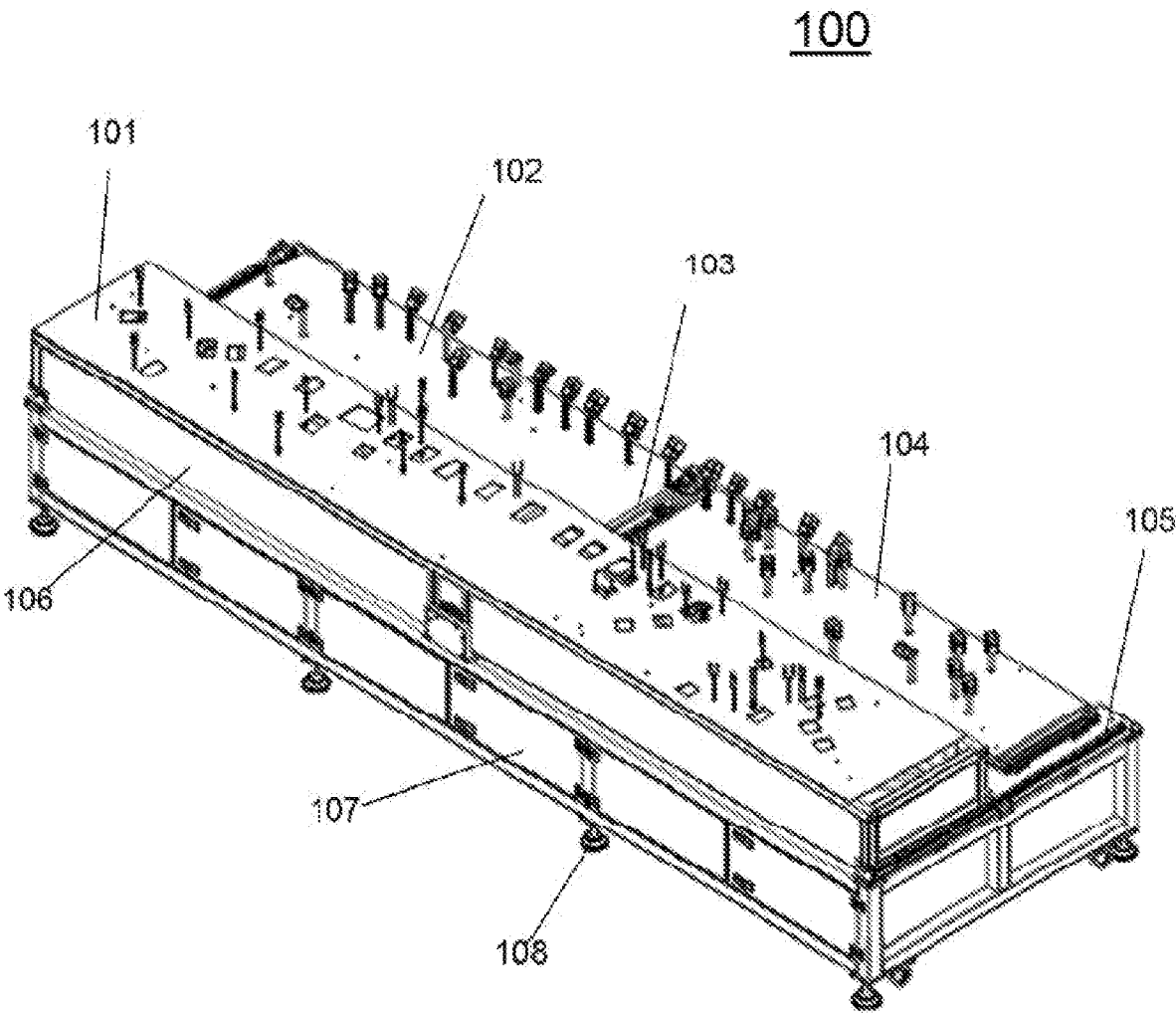


FIG. 9

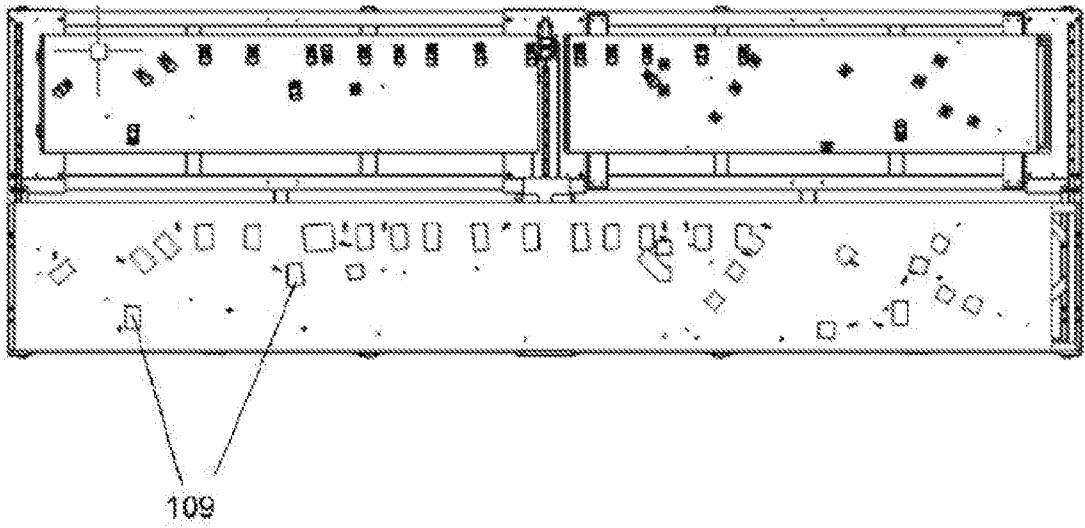


FIG. 10A

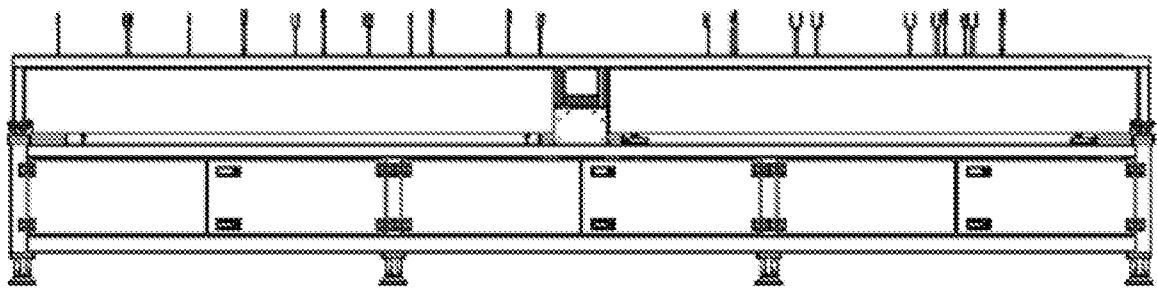


FIG. 10B

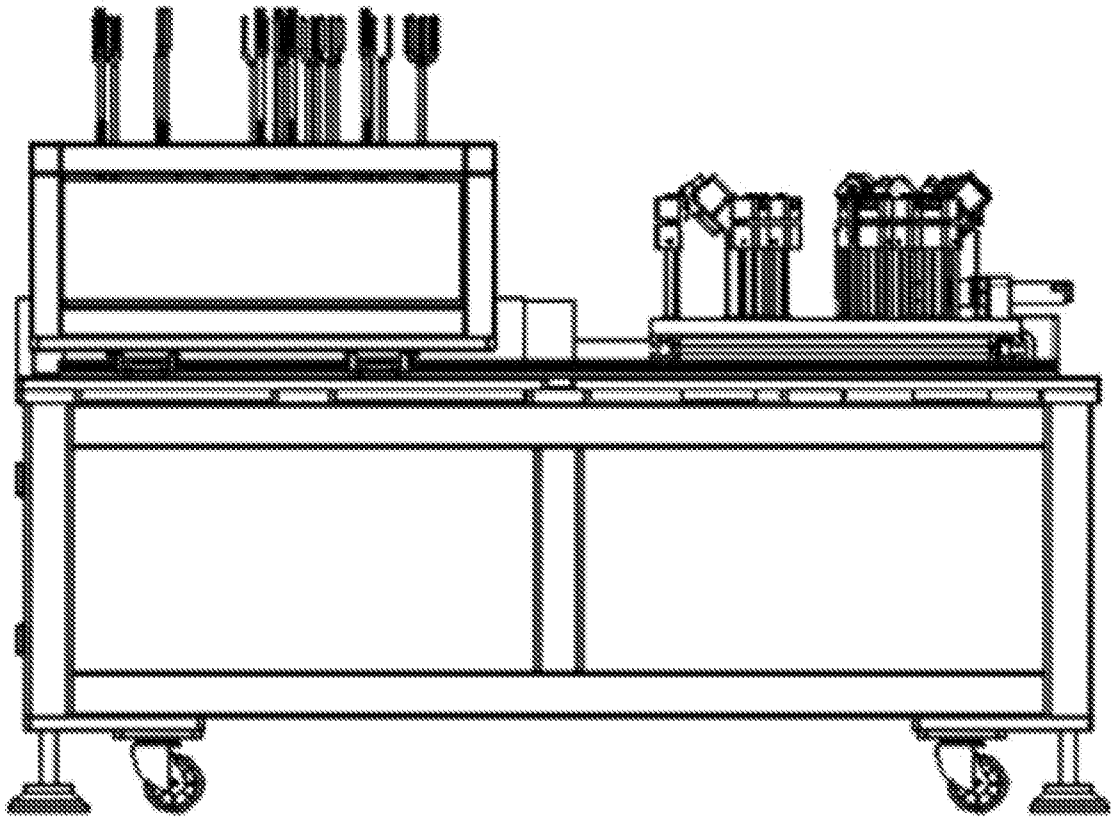


FIG. 11

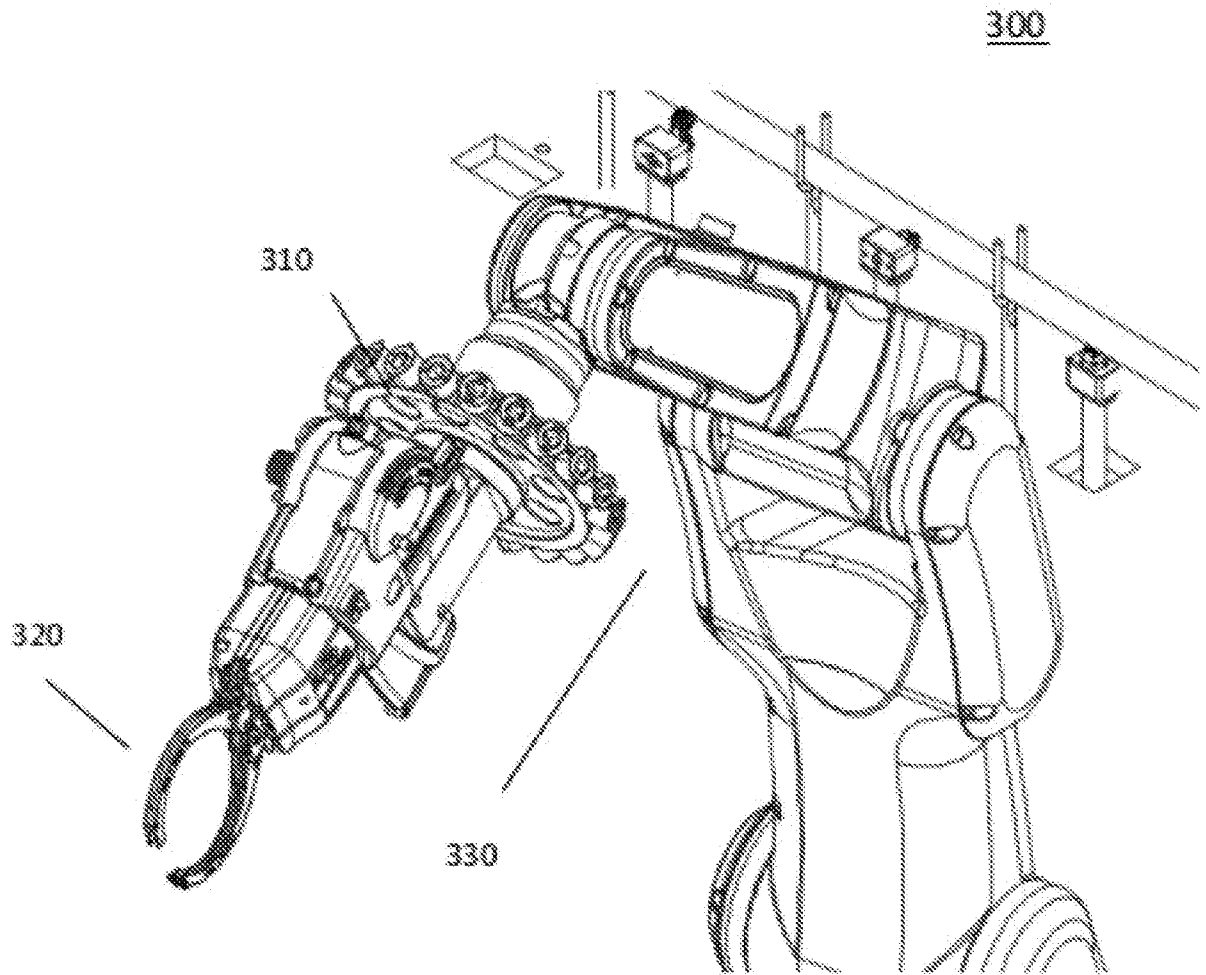


FIG. 12

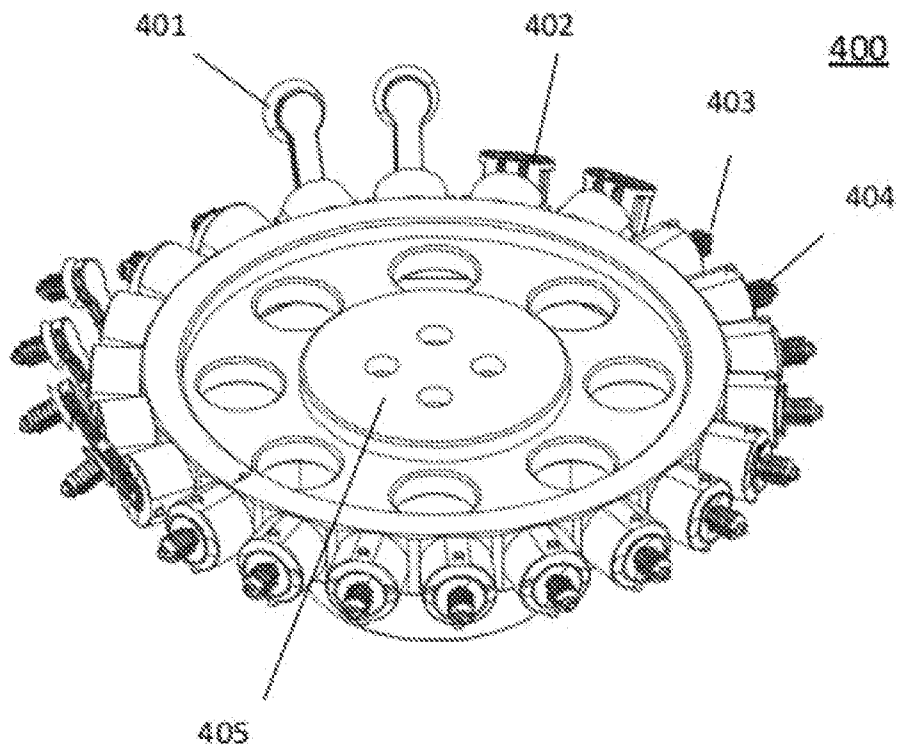


FIG. 13A

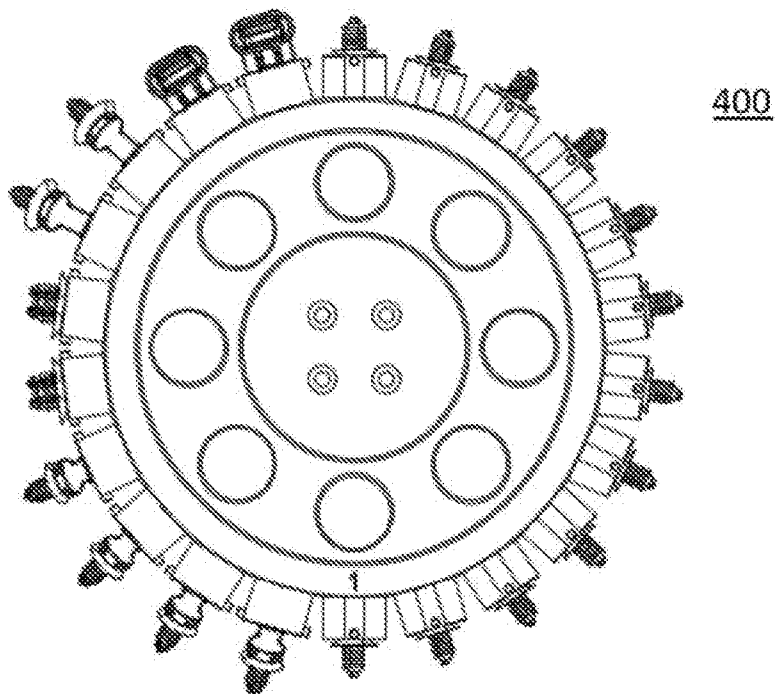


FIG. 13B

400

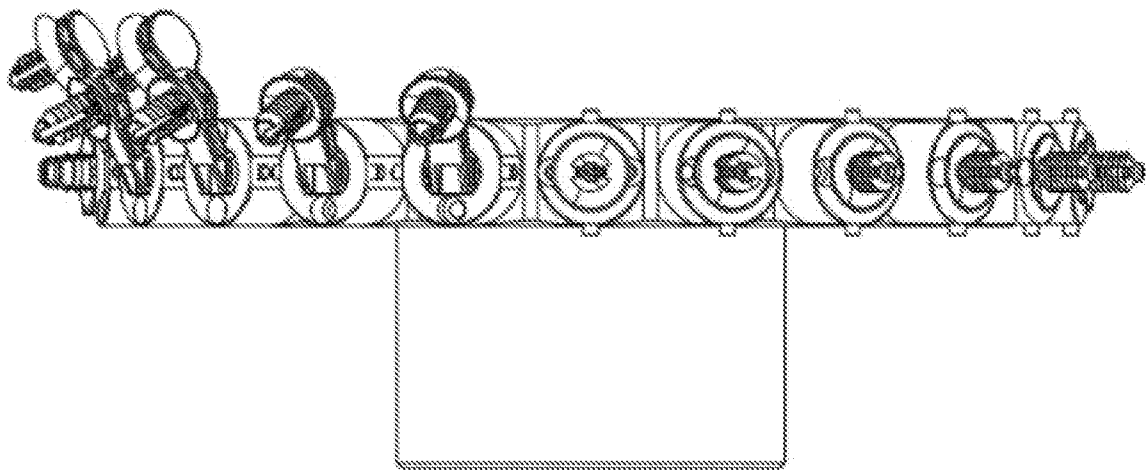


FIG. 13C

400

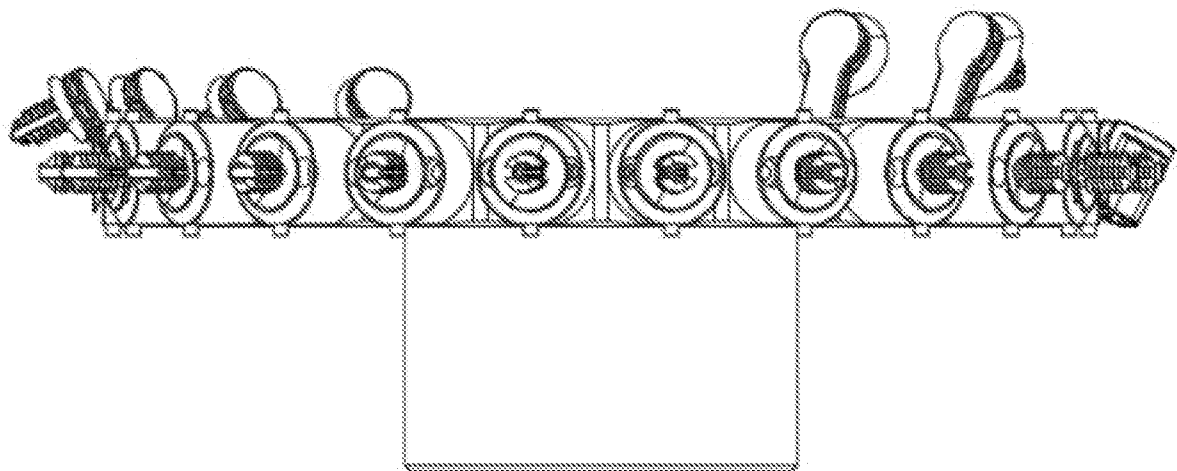


FIG. 13D

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/071775

A. CLASSIFICATION OF SUBJECT MATTER

H01B 13/012(2006.01)i; H02G 3/30(2006.01)i

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)

H01B;; H02G;; H01R

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI; EPODOC; CNKI; CNPAT: wir+, harness, manipulate+, robot, assembl+, line, support?, convey+, hold+, up, down, YAZA, auto, clip

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2019219361 A (FURUKAWA AUTOMOTIVE SYSTEMS INC. et al.) 26 December 2019 (2019-12-26) description, paragraphs [0018]-[0097], and figures 1-10	1-3, 5, 16-18
Y	JP 2019219361 A (FURUKAWA AUTOMOTIVE SYSTEMS INC. et al.) 26 December 2019 (2019-12-26) description, paragraphs [0018]-[0097], and figures 1-10	4, 6-15, 19-20
X	JP 2016207550 A (YAZAKI CORP.) 08 December 2016 (2016-12-08) description, paragraphs [0010]-[0117], and figures 1-12	21-24
Y	JP 2016207550 A (YAZAKI CORP.) 08 December 2016 (2016-12-08) description, paragraphs [0010]-[0117], and figures 1-12	4, 6-15, 19-20
A	CN 101981632 A (SUMITOMO DENSO KK) 23 February 2011 (2011-02-23) the whole document	1-24
A	JP 2012217226 A (FURUKAWA AUTOMOTIVE SYSTEMS INC. et al.) 08 November 2012 (2012-11-08) the whole document	1-24
A	JP H08257880 A (YAZAKI CORP.) 08 October 1996 (1996-10-08) the whole document	1-24



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“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)

“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

“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

“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

“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

“&” document member of the same patent family

Date of the actual completion of the international search

09 March 2022

Date of mailing of the international search report

28 March 2022

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/071775

Patent document cited in search report				Publication date (day/month/year)			Patent family member(s)	Publication date (day/month/year)		
JP	2019219361	A	26 December 2019	JP	6738864	B2		12 August 2020		
JP	2016207550	A	08 December 2016	JP	6558936	B2		14 August 2019		
CN	101981632	A	23 February 2011	CN	101981632	B		28 November 2012		
				WO	2009128177	A1		22 October 2009		
				JP	2009259480	A		05 November 2009		
				JP	5169418	B2		27 March 2013		
JP	2012217226	A	08 November 2012	None						
JP	H08257880	A	08 October 1996	None						