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(71) Applicant: **Airbus Defence and Space SA**  
**28906 Getafe Madrid (ES)**

(72) Inventors:  
• **SÁNCHEZ QUIRÓS, Ramón Manuel**  
**28906 Getafe (ES)**

- **DÍAZ CRUZ, José Carlos**  
**28906 Getafe (ES)**
- **HÖTZ ORDOÑO, Josef Ignacio**  
**28906 Getafe (ES)**
- **NAVARRO PALMAR, Manuel**  
**28906 Getafe (ES)**
- **GARCÍA FERNÁNDEZ, Francisco José**  
**28906 Getafe (ES)**
- **TORRES MORENO, Juan**  
**28906 Getafe (ES)**
- **BARTHELEMY, Olivier**  
**28906 Getafe (ES)**

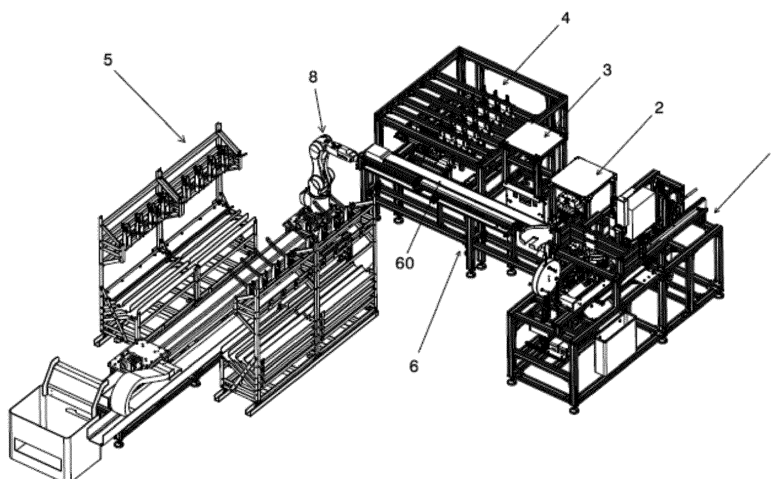
(74) Representative: **Elzaburu S.L.P.**  
**C/ Miguel Angel, 21**  
**28010 Madrid (ES)**

(54) **DEVICE AND METHOD FOR PROCESSING ELECTRICAL CABLES**

(57) An electric wire processing device comprising:

- a feed unit (1),
- a stripping unit (2) to strip the end of the wire to be processed,
- a crimping unit (4) to crimp a terminal onto the stripped end of the wire,
- a quality control unit (3),
- a storage unit (5),
- a transport unit (6) comprising:
  - a continuous platform (60),

- a tray (61) to hold the wire to be processed, the said tray (61) being slidable on continuous platform (60),
- a gripping clamp (62) attached to tray (61) to grip the end of the wire to be processed,
- means for moving gripping clamp (62) with respect to tray (61), so configured as to enable the end of the wire to be processed to be inserted into stripping unit (2), quality control unit (3), and crimping unit (4) for processing.



**Fig. 1**

## Description

### FIELD OF THE INVENTION

**[0001]** The invention relates to a device for and a method of automatic processing of electrical wiring for the aerospace industry. The device and method of the invention are intended to perform the operations of feeding, stripping, terminal crimping, quality control, and storage in continuous-flow production, all under the control of the plant's management system.

### BACKGROUND OF THE INVENTION

**[0002]** Electrical wiring processing systems employing a conveyor belt to carry the electrical wires from one wire processing station to another are known in the art. The said stations strip the insulation from the ends of the wires and then connect electrical terminals to the stripped ends.

**[0003]** Including a quality control device in the continuous-flow system to inspect the stripped ends and send a warning signal if specified tolerances are not met is also known. These quality control devices comprise an illuminated field in which the stripped end momentarily stops, an optical lens for providing an optical image of the stripped end, and a converter to convert the optical image into an electronic image signal

### DESCRIPTION OF THE INVENTION

**[0004]** The device and method of the invention for processing wire for the aerospace industry address a need to be able to perform all wire processing operations to specified quality standards automatically within a continuous-flow process manufacturing system managed by the plant's production control system. The plant's production control system is able to communicate through communications protocols established with the production control system of the device that controls the operations of each of the units.

**[0005]** The invention comprises a modular machine capable of performing all the wire processing operations to subsequently form the wiring to be mounted in an aircraft.

**[0006]** To that end, the device according to the invention performs the operations of labelling, wire winding, insulation stripping, terminal crimping, quality inspection and control, and storage according to a work order sent by the plant's production control system or from the device's own control station.

**[0007]** The device according to the invention is characterised in that it comprises:

- a unit for feeding the wire to be processed,
- a unit for stripping the end of the wire to be processed,
- a unit for crimping a terminal onto the stripped end

of the wire,

- a stripped wire end and crimped wire end quality control unit,
- a unit for storing processed and inspected wire,
- a transport unit for conveying the wire, comprising:

- a continuous platform with the feed, stripping, crimping, quality control, and storage units being located around and in communication with the continuous platform,
- a tray for holding the wire to be processed capable of moving along the continuous platform, the units being located in the direction of advance of the tray,
- a gripping clamp to hold the end of the wire to be processed, the said clamp being attached to the tray,
- means for moving the gripping clamp with respect to the tray, configured so as to enable the end of the wire to be processed to be inserted into the stripping, quality control, and crimping units for processing.

### Feed unit

**[0008]** This unit picks up the wire to be processed by the device. The wire is generally picked up from a laser marking and cutting machine that feeds wire into the device in predetermined lengths with predetermined markings.

**[0009]** The feed unit is configured to establish communication with the laser marking and cutting machine to obtain information on the type of wire to be processed and with the plant's production control to obtain additional information for complete wire processing.

**[0010]** The feed unit may be composed of various means performing a series of operations as described below:

- Wire pick-up: To pick up the wire this unit may be equipped with wire detection means at the unit's input end and with means for gripping the end of the wire.
- A system for gripping the end of the wire.
- Winding system: The wire may be wound for transport to the various modules making up the invention, so this module has a winding system.
- Fastening system: Optionally, it may be equipped with a cable tie system for the wire winding, where after the wire has been wound, the winder is placed in position for the cable tie applicator to be brought into position and place a cable tie to hold the wound wire in place.
- Labelling system: The machine may include a label-

ler for labelling the two ends of the wire with labels containing all details required for identification.

### Stripping unit

**[0011]** The stripping unit removes the insulation from the end of the wire to be processed, with stripping length depending on the wire type and the type of terminal to be attached, the lengths being taken from the regulations existing to that effect and being set by the device programming.

### Crimping unit

**[0012]** The crimping unit crimps the terminals onto the wire and may comprise several systems for preparing the terminal, positioning the wire, and crimping the terminal.

- Wire and terminal sensing. Before crimping it is necessary to detect the position of the wire for crimping.
- Terminal feeding system.
- Pick and place system. To pick up the terminal and place it in position in the different systems of the module, the machine may include a transporter for XY translation having electric actuators for movement through the unit.
- Centring system: The module may have a centring block with a range of gauges for inserting the wire into the terminal for wire crimping.

### Storage unit

**[0013]** This module performs the task of storing the processed wires.

### Quality control unit

**[0014]** This module performs quality control on the operations carried out on the wires. Quality control may be performed by machine vision, for which the unit may be equipped with a high sensitivity camera with an illumination dome. The camera takes images after the stripping and crimping operations and software compares them with predefined patterns that comply with the requisite regulations.

### Transport unit

**[0015]** The transport module transports the wire to the various units making up the device, where the transport unit winds the wire, the wound wire, with the end to be processed held by the said module.

**[0016]** In one embodiment, this unit comprises an electric sliding platform on which a tray is mounted, the tray

carrying the weight of the wound wire and a clamp that opens vertically to hold the end of the wire to be processed, the said clamp being placed on a second electric platform that moves in a direction transverse to that of the first electric platform that carries the end of the wire with high precision to the different units according to predetermined features of wire type and terminal type to be processed according to requirements.

**[0017]** The invention, therefore, affords the following advantages:

- Shortened times. Automatic performance of all the wire processing operations from the stage when the wires enter the machine from the laser marking and cutting system shortens transport and parking times, and the operation of storage of all wire types in a storage area is also performed.
- Independent processing. The machine makes it possible to perform only those processing steps necessary for a wire independently of the rest, hence all the wires leaving the marking and cutting system can be handled by the machine and the required processing performed, or the wires can merely be stored according to the corresponding work order.
- Modular concept. The machine's modular concept means that different configurations are possible to meet production needs and that it can be expanded and adapted to new types of wire or terminals for crimping.
- Integrated production control. The machine is integrated in the production control management system, and work orders can be managed in real time according to production needs without requiring prior preparation time. The machine can also be operated independently, controlled by an operator from the control station.
- Versatile storage. The machine's storage module allows grouping of different wire configurations, from a configuration made up of the same types of processed wires to complete cabling configurations.

## DESCRIPTION OF THE DRAWINGS

**[0018]** Figures are provided to complete the description and furnish a better understanding of the invention. The Figures are an integral part of the description and illustrate an example of one embodiment of the invention.

Figure 1 is a perspective view of an embodiment of the device for processing wires according to the invention.

Figure 2A is a perspective side view of an embodiment of the wire feed unit.

Figure 2B is a schematic side view of an embodiment of the wire winding drum.

Figure 3 is a perspective view of an embodiment of the wire stripping unit.

Figure 4 is a perspective and a plan view of an embodiment of the crimping unit.

Figure 5 is a perspective view of an embodiment of the processed wire storage unit.

Figure 6 is a perspective view of an embodiment of the transport unit.

Figure 7 is a plan view of an embodiment of the wire processing device according to

Figure 1.

Figure 8 is a side view of an embodiment of the quality control unit.

## DETAILED DESCRIPTION OF THE INVENTION

**[0019]** Figure 1 exemplifies an embodiment of the device according to the invention. The device comprises:

- feed unit (1) for feeding the wire to be processed,
- stripping unit (2) for stripping the end of the wire to be processed,
- crimping unit (4) for attaching a terminal to the end of the stripped wire,
- quality control unit (3) for inspecting the stripped wire end and the crimped wire end,
- storage unit (5) for storing the processed and inspected wire, and
- transport unit (6) in communication with feed unit (1), stripping unit (2), crimping unit (4), and quality control unit (3), such that it conveys the wire to be processed among the different units (1, 2, 3, 4) and positions the end of the said wire in stripping unit (2), quality control unit (3), and crimping unit (4) for processing.

**[0020]** Figures 1, 6, and 7 contain representations of an embodiment of transport unit (6). Transport unit (6) comprises:

- the continuous platform (60),
- the tray (61), which is moveable along continuous platform (60), to hold the wire to be processed,
- gripping clamp (62) to hold the end of the wire to be processed,
- a second platform (63) that moves gripping clamp (62) cross-wise to the direction of movement of tray (61).

**[0021]** The various units (1, 2, 3, 4, 5) are located

around continuous platform (60) along the direction of advance of tray (61).

**[0022]** In the embodiment, the transport unit (6) comprises a very long electrically sliding platform (60) on which the wire gripping assembly is mounted, formed by a series of members such as the tray (61), which holds the wound wire to be processed, the second electric platform (63) that moves a shorter distance and includes gripping clamp (62) having a vertical opening to hold the end of the wire. The continuous platform (60) performs lengthwise movements, transporting the assembly holding the wire to the various units of the device. When the assembly is located opposite the corresponding unit according to the sequence to be performed on the wire, second platform (63) effects a shorter transverse movement to bring the end of the wire held by gripping clamp (62) up to the corresponding unit for processing.

**[0023]** The embodiment of the feed unit (1) depicted in Figure 2 comprises:

- A laser barrier sensor (10).
- A pneumatic clamp (12) of parallel aperture. The clamp (12) is mounted on a sliding platform controlled by a servomechanism that moves clamp (12) at a constant rate along feed unit (1).
- A speed adjustment system (13) to compensate for any possible difference in speed between the laser cutting machine and feed unit (1), where the wire comes from the said modules. To that end it has a system of pulleys to adjust for possible differences. The pulley system comprises three pulleys, where the two pulleys on the ends are attached to linear actuators in a lower initial position so that the region the clamp holding the wire to be processed passes through is left free, the pulley located in the middle being mounted on and sliding along a shaft. In its initial position a linear actuator holds this pulley above the region the clamp holding the wire to be processed passes through. When the wire has passed through, the system starts up, the linear actuators raise the pulleys located at the ends, thereby putting tension the wire, and the linear actuator of the middle pulley moves downwards, thereby leaving the pulley free, with gravity pushing it down onto the wire, making it taut, whereby with the weight of the pulley on it the wire rises or descends along its path, therefore, taking up any possible difference in speed between the laser cutting machine and the processing device.

**[0024]** The pulley system is formed by three pulleys mounted on pneumatic sliding platforms, and when clamp (12) with the wire has passed by, it tightens the wire and by gravity the middle pulley drops onto the wire, taking up any possible difference in speed.

#### - Wire alignment system (14).

**[0025]** Optionally, when clamp (12) has passed through the pulley system, there are two sets of rollers to align the wire in feed unit (1) for subsequent pick-up by transport unit (6).

**[0026]** The system comprises pneumatic platforms on which the rollers are located, opening to free the path followed by the wire and closing to press on the wire when it has passed through. The system is equipped with a photoelectric cell and laser barrier sensor that signal the invention, telling it when to activate the different systems. The system comprises four pneumatic platforms, each carrying two rollers fastened to a belt. The belts are arranged in two groups, one belt above and one belt below, with a conical guide member that helps to guide the wire into the proper position. In the initial position each group of belts is open, leaving the region that the clamp holding the wire passes through free. There is a photoelectric cell between the two groups of belts to detect passage of the clamp holding the wire, and when passage of the clamp has been detected, the first group of belts is caused to close, compressing the wire against the belts and guiding it via the conical guide members. The second group of belts has a laser sensor that detects passage of the clamp and sends a signal causing the group to close, and it also detects the end of the wire and signals for subsequent processing.

#### - Wire clamping system

**[0027]** On the output side of the rollers the module has a system composed of a clamp that opens 180° mounted vertically on a pneumatic platform, the system being intended to grip the end of the wire to be processed; at the signal indicating that there is no wire sent by the laser sensor located at the rollers, the clamp closes completely, thereby clamping the end of the wire.

#### Winding system

**[0028]** The winding system comprises two separate drums (15) arranged vertically on pneumatic actuators, which when open allow the wire pick-up grip freedom of movement. When the platform controlled by the servo-mechanism reaches an exact position, the pneumatic actuators close, thereby pressing a pusher against the wire.

**[0029]** Lower drum (15) of the winder is attached to a revolving platform by means of a servomotor that causes drum (15) to rotate, thereby winding the wire.

**[0030]** The system consists of a winding positioning assembly formed by two pneumatically driven members holding the winding that has been formed while waiting for transport system (6) to allow the winding to fall for subsequent processing when in position.

#### Cable tie system

**[0031]** For placement of the cable tie, drum (15) has a series of openings through which the applicator can insert a tie, and when the rotating platform places drum (15) in the appropriate position, a position sensor sends a signal, causing the cable tie applicator on the platform to be moved into position and operated to put the tie in place.

#### 10 Labelling system

**[0032]** The labeller is placed on top of the wire end clamping system, and labels are attached in the form of flags.

15 **[0033]** The design includes a storage area for the cuttings produced by the laser cutting machine located at the head of the device, the said cuttings being produced when there is a change in the type of wire to be cut by the laser cutting machine.

#### 20 Stripping unit (3)

**[0034]** This unit comprises nine sets of blades (31) (18 in all) that strip wires from AWG 10 to 24 gauge in size, and in addition to stripping blades (31) the unit has a cutting blade to make a clean cut at the end of the wire before stripping. Blades (31) are mounted on aluminium blocks (32) mounted on pneumatic actuators that close blades (31) for stripping.

25 **[0035]** Blades (31) are located such that when the wire end located in gripping clamp (62) advances with second processing platform (63), the end of the wire is located opposite the corresponding blade (31).

30 **[0036]** This unit removes the insulation covering the wire, leaving the wire ready for subsequent operations. To remove the wire insulation, the unit has specific blades (31) to peel away the coating without harming the inner wire. Blades (31) mounted on the unit correspond to wire sections ranging in size from gauge AWG 10 to 24, each having its own specific design. In all, the unit is equipped with nine sets of blades (31), consisting of one blade (31) above and another below. Blades (31) are mounted on aluminium blocks (32) attached to two pneumatic linear actuators disposed so that there is one above and one below. In their initial position these actuators are open, so that transport system (6) can place the wire to be stripped between appropriate blades (31) depending on the cross-section. When the wire is in place, the pneumatic linear actuators are activated, closing blades (31) on the wire, leaving just the central core in the space between blades (31), such that when the unit withdraws the wire, the insulation is retained between blades (31) and the wire is stripped. The unit also has a pair of blades (31) that severs the wires completely; this cut is made before stripping the wire so that all the wires will have the same cut across the end.

#### Crimping unit (4)

**[0037]** This unit has been designed to crimp up to 15 different types of terminal. The modular nature of the invention allows the number of terminals to be expanded, including exchangeability for different terminal types according to need.

- Wire detection unit (41): this unit has a laser barrier sensor that detects the position of the tip of the wire as transport unit (6) moves it up to the sensor, such that it registers the advance until detection and then uses this information to bring the wire to the terminal later. This detection system is also used to detect the presence of the terminal and its position, the terminal pick-up jaws bringing the terminal up to the sensor so that it detects its presence.
- Feeding system (42): This system comprises 15 different types of feeders (one per terminal type) in which the terminals are arranged vertically, with a capacity for up to 300 terminals (likewise expandable); the terminals are to be loaded into feeders (42) by hand outside the module and the feeder then to be inserted into their final positions. Terminal dispensing is carried out by means of a pneumatic step-wise dispenser that places a terminal in position on demand.
- Pick and place system (43): To pick up the terminal and place it in the different systems of the module, the machine includes a transporter for XY translation having electrical actuators for movement through the module. Located above these actuators is the transporter carriage, on which three clamps are mounted, two four-finger clamps for crimping the terminal, one or the other being selected for use depending on terminal type, the difference between them being the crimping tool they carry, and the other clamp on the transporter carriage being a three-finger clamp used to pick up the terminal from the magazine, carry it through the module and place it in crimping position.

**[0038]** As previously mentioned, the module has two different crimping clamps, the crimping jaws of each adapted to the terminal crimping tools used according to standards MIL-C-22520-1 and MIL-C-22520-2.

- Centring system (44): To insert the wire into the terminal, the module has a centring block (44) for crimping of wire gauges from AWG 12 to 22. The housings in the centring block are conical in shape and should be mirror polished to facilitate entry of the wire into the terminal. Centring block (44) is mounted on two parallel clamps that open and close to free the wire after crimping.

**[0039]** To hold the terminal for wire entry and crimping,

the module has a pneumatic two-finger clamp, and the terminal is passed to it by the clamp on the transporter carriage. This two-finger clamp is mounted on an electric platform that places it in position on the centring block according to the gauge of the wire to be crimped.

#### Storage unit (5)

**[0040]** This module is intended for storing the processed wires, with a sort of rack having different positions for placement of the wires for storage. Depending on wire length, it may be wound, or storage may have to be lengthwise for smaller lengths that cannot be wound. Therefore, the racks have positions for hanging wire windings and positions for placing lengths of wire.

**[0041]** Each rack has eight positions for hanging wire windings and another eight positions for lengths of wire. The racks are equipped with wheels so that, if desired, they can be rolled away when loaded with processed wires, and they can also be set up so that the cables can be removed in the position in which they are stored in the machine.

**[0042]** To grip the processed wire the module has robotic means (8), specifically, a six-shaft robot equipped with a clamp designed to grip the wire. Robot (8) takes the wire from tray (61) on transport module (6) and places it on one of the positions on the rack for storage as previously programmed. To move robot (8) along storage unit (5), the embodiment exemplified here includes a conveyor unit on which robot (8) is mounted.

**[0043]** The module has an area for rejects in which wires processed by the invention are placed if they are rejected by the quality control.

#### Quality control unit (7)

**[0044]** The unit comprises:

- a hollow space in which the end of the wire to be inspected is placed;
- a camera (71) to take images of the wire to be inspected;
- lighting means (72) to illuminate the hollow space; and
- a gate (75), the hollow space and gate (75) being adapted for entry of gripping clamp (62) carrying the end of the wire and means for moving gripping clamp (62) along tray (61).

**[0045]** More specifically, the embodiment exemplified here comprises a camera obscura (71) for taking images, and inside, in addition to camera (71) and lighting means (72), there is an electric revolving actuator bearing a clamp that holds the wire from transport unit (6) so as to rotate the wire so that camera (71) can make images of the wire around its entire perimeter.

**[0046]** For entry and exit of the wire, the module has gate (75), which opens and closes for entrance and exit

of second platform (63), in this way reducing the entry of outside light that might adversely affect imaging.

### **Operating cycle of the machine**

**[0047]** This section describes the functioning of the processing machine during a complete working cycle, describing the different operations that may be performed according to wire type.

**[0048] Feed or pick-up unit (1)** The wire to be processed is picked up from the laser cutting machine located at the input side of the feed module; it is in this module where wires less than 1.5 m long are wound and tied and the two ends of the wire are labelled, and the wire is readied for reception by transport unit (6). The steps carried out by this unit are:

- The wire is detected by means of the laser sensor located at the head of the module, and a signal is sent for pick-up.
- The pick-up clamp is placed in position by the electric linear actuator, and when in position the clamp is closed to pick up the wire.
- Transfer of the wire; when the photoelectric cell located on the roller system detects passage of the clamp, a signal is sent to actuate the pulley system and the first set of rollers to press against the wire.
- As the clamp passes by the laser sensor located on the second set of rollers, the rollers close and a signal is sent for the clamp located on the output side of the rollers to be closed without exerting full pressure to grip the end of the wire.
- When the wire traction clamp is positioned behind the winder, a signal is sent to close the winding drums, and when they have closed the traction clamp opens, freeing the wire.
- When the wire is free of the traction clamp, winding begins, and winding continues as long as the laser sensor located on the output side of the roller system continues to detect wire; when the sensor no longer detects wire, winding is halted and the wire end gripping clamp closes completely, thereby holding fast the end of the wire to be processed.
- When the wire has been wound, the winding unit makes a reverse revolution, releasing tension on the wire until the next position for insertion into the crimping unit.
- When proper positioning of the winding unit is detected, the cable tie is placed to fasten the wound wire, and the cable tie applicator advances to fasten the tie and then moves back after fastening.
- When the cable tie applicator is in its initial position, the two members located on pneumatic platforms are actuated and are positioned below the winding.
- When the members are in position, drums (15) in the winding unit open, allowing the winding to fall onto the members.
- For wires not long enough for winding, the traction

clamp holding the first end of the wire will stop when the laser sensor on the output side of the rollers no longer detects wire, and the wire end clamp closes.

**[0049] Transport unit (6):** The transport module takes the wire when feeder unit (1) signals that it has completed its operations. The steps carried out by this module are:

- The transport carriage is positioned; the carriage carries tray (61) on which the winding is placed and electric platform (63) that carries gripping clamp (62) to grip the wire to be processed. The transport carriage is located on an electric actuator that positions the carriage along the length of the machine. It is first positioned in the feed module next to wire gripping clamp (62).
- When the carriage is positioned in the feed unit with gripping clamp (62) in the open position, the clamp closes around the wire, and feed unit (1) holding clamp opens and the members holding the winding also open, allowing it to fall onto tray (61).
- The transport carriage is positioned in the different units making up the invention, first in stripping unit (2), and when finished it is positioned in quality control unit (3), then in crimping unit (4), and when finished it returns to quality control unit (3) for inspection of the operations performed; following quality control it is positioned so that storage unit (5) robot (8) can pick up and store the wire, whereupon transport unit (6) returns to begin a new cycle.

**[0050] Stripping unit (2):** The steps carried out by this module are stripping away from the wire a length of insulation set by the production control unit, and depending on the terminal to be applied, the following steps are performed:

- Cutting of the end to be processed: The transport carriage places the tip of the wire to be processed in position where it will come into contact with cutting blade (31) and advances a set amount to control wire tip position 0.
- When the wire tip is in position, the pneumatic actuators close, severing the tip of the wire, after which the actuators open again.
- The transport carriage places the wire opposite blade (31) corresponding to the cross-section size of the wire (this information will have previously been sent by the production control unit).
- The wire is advanced towards blade (31) a distance specified by the production control unit.
- When the length of wire is in place, the pneumatic actuators close, and when they have closed the transport carriage draws back, taking with it the clamped wire, and the insulation remains in blade (31).
- With the wire back in its initial position on the transport carriage, the pneumatic actuators open and the

module is ready for a new cycle.

**[0051] Quality control unit (3):** This module carries out two steps, once after stripping and once after crimping. The following steps are carried out after stripping:

- The transport carriage is positioned in quality control unit (3), and the clamp is advanced a predetermined distance.
- With the wire in place, the clamp located on the revolving actuator closes.
- Transport carriage clamp (62) releases the wire and the carriage draws back.
- Quality control unit (3) gate (75) closes.
- Images of the stripped wire are taken as the revolving actuator rotates the wire, first in one direction, then in the other, so that images are taken around the entire perimeter.
- Quality control unit (3) software compares the images taken to patterns previously defined as valid according to standards, and the comparison yields a signal of either pass or fail sent to the invention's production control unit.
- When imaging is complete, gate (75) opens, and a signal is sent from the pneumatic actuator indicating that it has returned to its initial position.
- The transport carriage advances a pre-set distance towards the module and gripping clamp (62) closes around the wire.
- On receipt of the signal that the transporter clamp has closed, the revolving actuator releases the wire, and the transporter carriage moves back to its initial position, leaving the quality control unit ready for another cycle.

**[0052] Crimping unit (4):** The crimping unit performs the preparatory and crimping operations on the terminal specified by production control for the wire to be processed. This module performs two different operations, preparation of the terminal and crimping.

**[0053]** The module may commence terminal preparation on receipt of the information specifying the terminal to be attached, that is, while the machine is carrying out any previous operation in any of the preceding modules, so that when the wire is ready for crimping, the terminal will already be in crimping position. The terminal preparation steps are:

- The pneumatic stepwise dispenser of magazine (42) containing the terminal for crimping releases a terminal to the park position.
- The x-y translation actuators position the clamp carriage opposite magazine (42) holding the terminal for crimping.
- The clamp carriage advances and the three-finger clamp closes around the terminal.
- The clamp carriage moves back and the carriage moves into the laser barrier sensor position.

- The clamp carriage advances until the laser sensor detects the tip of the terminal, and the distance advanced by the carriage until detection is stored in memory.
- The clamp on centring block (44) mounted on an electric sliding platform places the platform in position opposite the opening in centring block (44) for the gauge of the wire to be crimped.
- The clamp carriage moves into position where centring block (44) clamp is located.
- The clamp carriage advances, and when the centring block clamp closes around the terminal and the three-finger clamp opens, releasing it, the clamp carriage moves back.
- The carriage places the programmed crimping clamp in the crimping position.

**[0054]** The operations carried out when the terminal is in position and the transport carriage with the wire to be processed has left quality control unit (3) following inspection of the stripping operation are:

- The transport carriage places the wire in position for the laser barrier sensor, advancing the wire until the tip of the wire has been detected, and production control stores the distance advanced until detection in memory.
- Upon detection of the wire the transport carriage positions the wire opposite the selected gauge aperture in centring block (44).
- The clamps where centring block (44) is positioned are closed, and the transport carriage advances to insert the stripped end of the wire into the terminal.
- When the wire has been inserted into the terminal, the crimping clamp closes and attaches the terminal by crimping.
- Centring block (44) and the terminal holding clamp open, the transport carriage with the crimped wire moves back, and the module is ready for a new cycle.

**[0055] Quality control unit (3) [crimping]:** The steps performed for quality control of crimping are the same as described for quality control of stripping, the sole difference being that the software compares the images taken with patterns chosen for crimping.

**[0056] Storage unit (5):** Both finished processed wires that have passed all the quality control operations and wires that have failed quality control are stored, the latter in an area for rejects. The steps carried out by this module are:

- When all the operations in the other modules have been completed, tray (61) moves to a set position in transport unit (6).
- Robot (8) picks up the wire, the location for this will vary depending on whether the wire has been wound or not, information that has already been processed by production control. If the wire has been wound,



robot (8) positions itself next to the aperture in transport tray (61) to pick up the wire winding; if the wire has not been wound, robot (8) positions the pick-up clamp next to the end of the processed wire.

- With robot (8) in position, the clamp closes, picking up the wire, and robot (8) places the wire in a pre-determined storage position on the rack, either a hook for wound wire or a horizontal box for straight wires.
- Robot (8) deposits rejected wires in the rejection area, and the module returns to the initial position ready for a new cycle.

## Claims

1. An electric wire processing device, **characterised in that** it comprises:

- a feed unit (1) for the wire to be processed,
- a stripping unit (2) to strip the end of the wire to be processed,
- a crimping unit (4) to crimp a terminal onto the stripped end of the wire,
- a quality control unit (3) to inspect the end of the wire after stripping and the end of the wire after crimping,
- a storage unit (5) for the processed and inspected wire,
- a transport unit (6) to transport the wire, which comprises:

- a continuous platform (60), feed unit (1), stripping unit (2), crimping unit (4), quality control unit (3), and storage unit (5) all being located around and in communication with the said continuous platform (60),
- a tray (61) to hold the wire to be processed, the said tray (61) being slidable on continuous platform (60), such that the units (1, 2, 3, 4, 5) are located in the direction of advance of tray (61),
- a gripping clamp (62) to grip the end of the wire to be processed, the said gripping clamp (62) being attached to tray (61),
- means for moving gripping clamp (62) with respect to tray (61), so configured as to enable the end of the wire to be processed to be inserted into stripping unit (2), quality control unit (3), and crimping unit (4) for processing.

2. An electric wire processing device according to claim 1, **characterised in that** the means for moving gripping clamp (62) are configured to move clamp (62) in a direction transverse to the direction of advance of tray (61).

3. An electric wire processing device according to either claim 1 or claim 2, **characterised in that** feed unit (1) comprises means for winding the wire.

4. An electric wire processing device according to any of the preceding claims, **characterised in that** the means for winding the wire comprise:

- two opposing drums (15) that are movable axially,
- a revolving platform attached to one of drums (15) having a motor adapted so as to rotate drum (15) and, therefore, wind the wire.

5. An electric wire processing device according to any of the preceding claims, **characterised in that** storage unit (5) comprises robotic means (8) for gripping the wire from transport unit (6) and moving it within storage unit (5).

6. An electric wire processing device according to any of the preceding claims, **characterised in that** quality control unit (7) comprises:

- a hollow space in which the end of the wire to be inspected is placed;
- a camera (71) to make images of the wire to be inspected;
- lighting means (72) to illuminate the hollow space; and
- a gate (75), the hollow space and gate (75) being adapted so that gripping clamp (62) with the end of the wire and the means for moving gripping clamp (62) may enter.

7. An electric wire processing device according to claim 6, **characterised in that** quality control unit (7) further comprises a clamp for holding the wire, the said clamp being capable of rotating the wire so that images may be made and configured to take the wire from gripping clamp (62).

8. A method of processing electric wires, **characterised in that** it comprises the following steps:

- wire is fed into feed unit (1) for the wire to be processed,
- the wire, therefore, fed in is transferred to a transport unit (6),
- the end of the wire to be processed is held by a gripping clamp (62) attached to a tray (61) slidable along a continuous platform (60) of transport unit (6),
- the wire is moved by transport unit (6) to a stripping unit (2),
- means for moving gripping clamp (62) with respect to tray (61), configured so as to enable the end of the wire to be processed to be inserted

into stripping unit (2), are actuated,

- the wire is stripped,

- the stripped wire is transferred by transport unit (6) to a quality control unit (3) for inspecting the stripped end of the wire,

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- means for moving gripping clamp (62) so as to enable the end of the wire to be processed to be inserted into quality control unit (3) are actuated,

- quality control is performed on the wire,

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- the wire is conveyed by transport unit (6) to a crimping unit (4),

- means for moving gripping clamp (62) so as to enable the end of the wire to be processed to be inserted into crimping unit (4) are actuated,

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- a terminal is crimped onto the end of the stripped wire,

- the crimped wire is conveyed by transport unit (6) to quality control unit (3) for inspection of the crimped end of the wire,

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- means for moving gripping clamp (62) so as to enable the end of the wire to be processed to be inserted into quality control unit (3) are actuated,

- quality control is performed on the wire,

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- the wire is conveyed by transport unit (6) to a storage unit (6),

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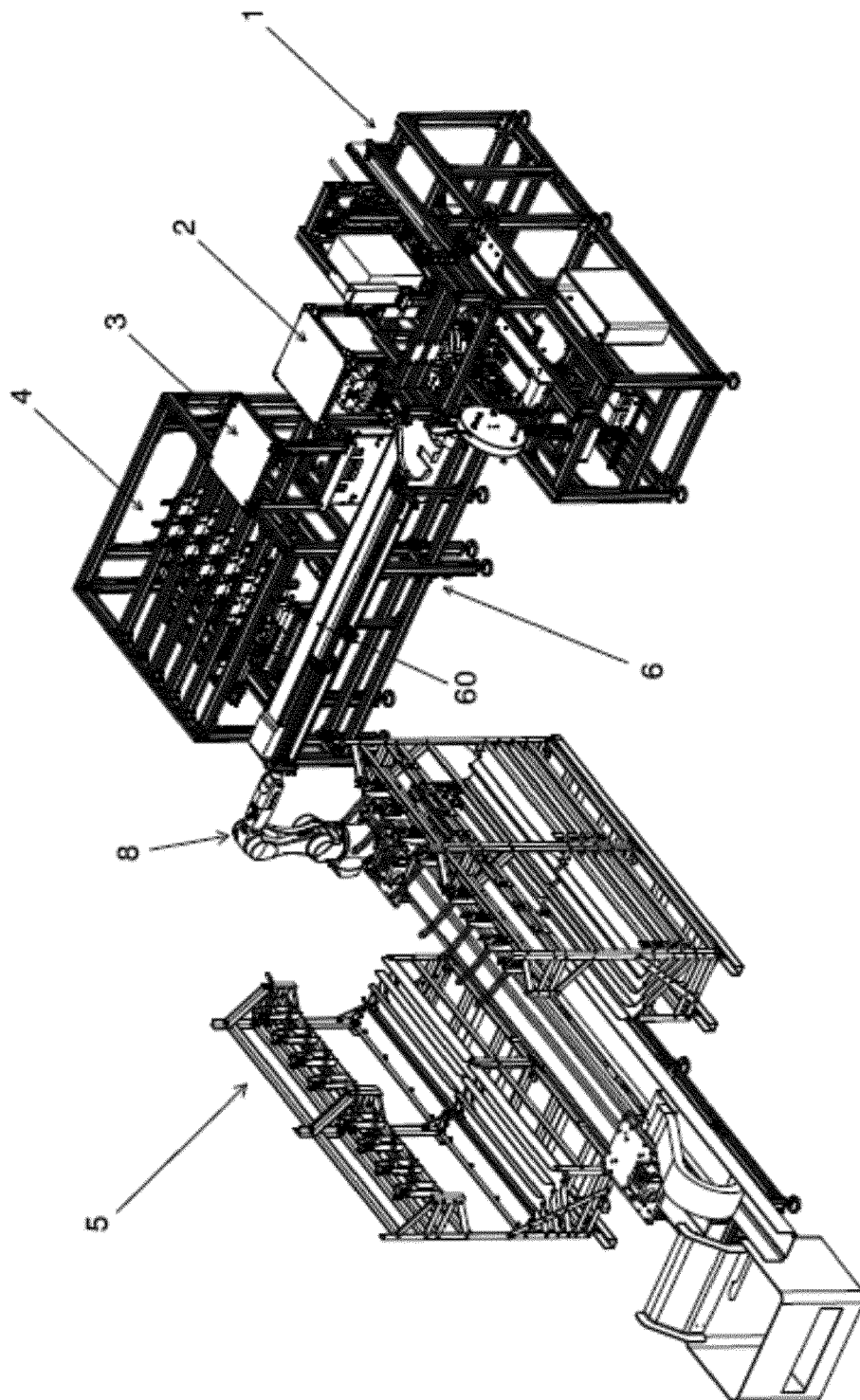


Fig. 1

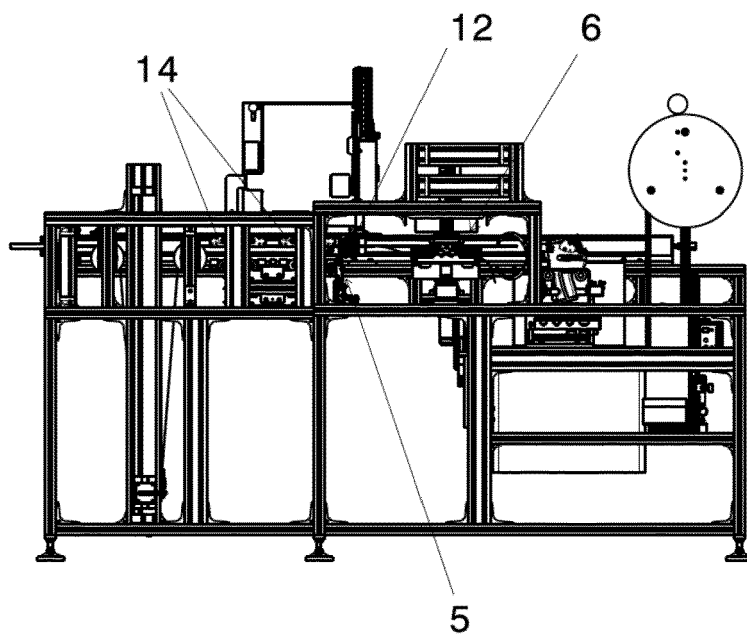
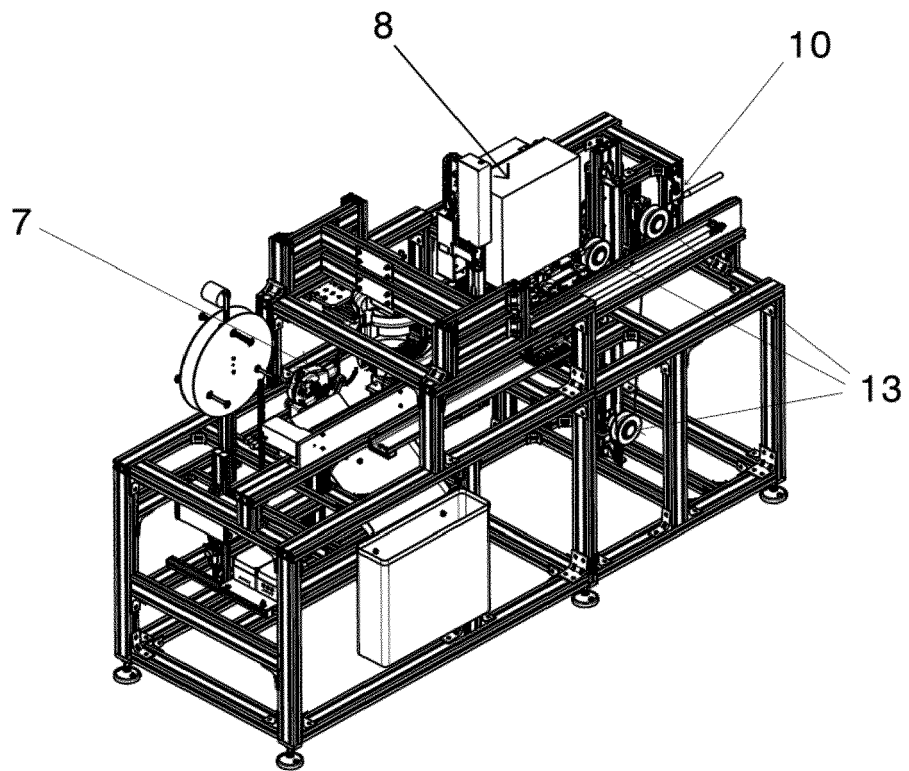


Fig. 2A

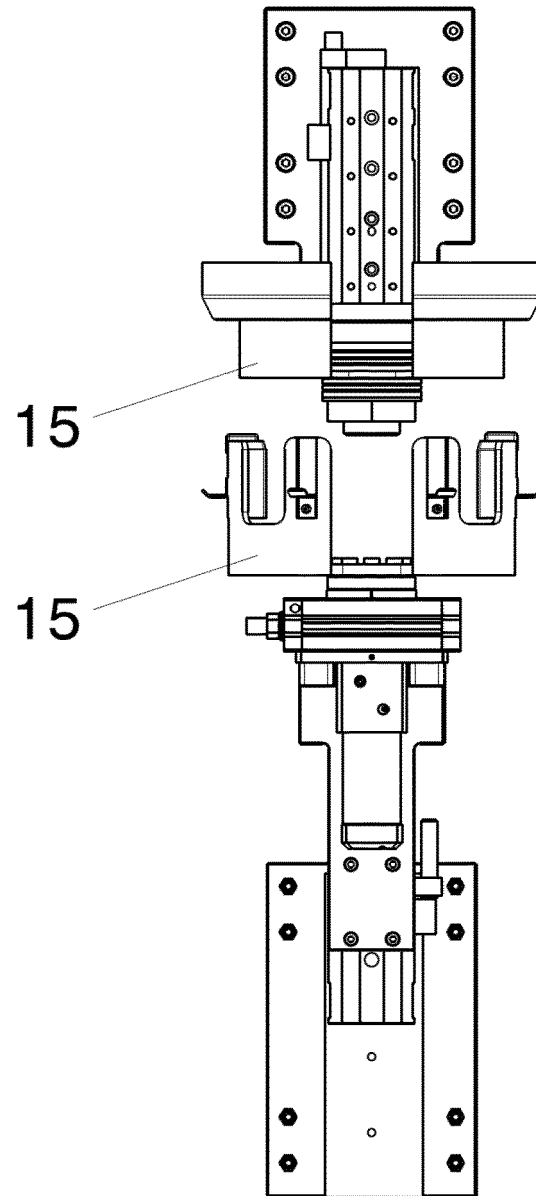


Fig. 2B

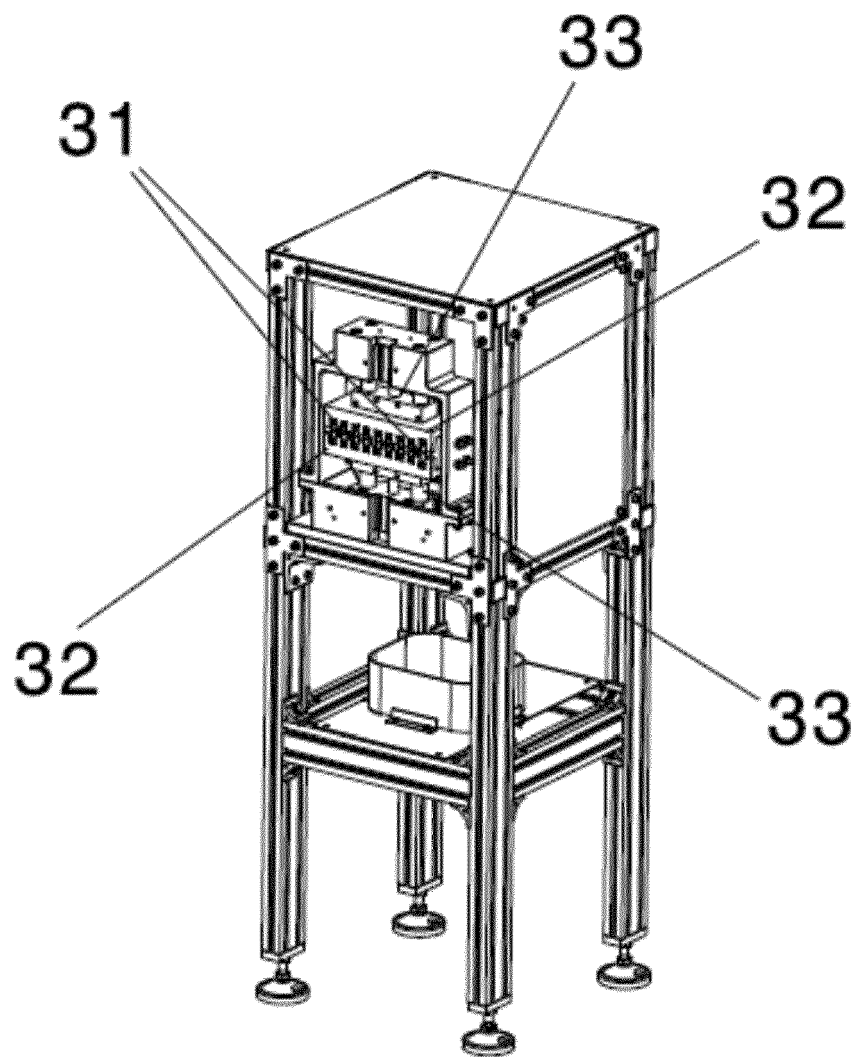


Fig. 3

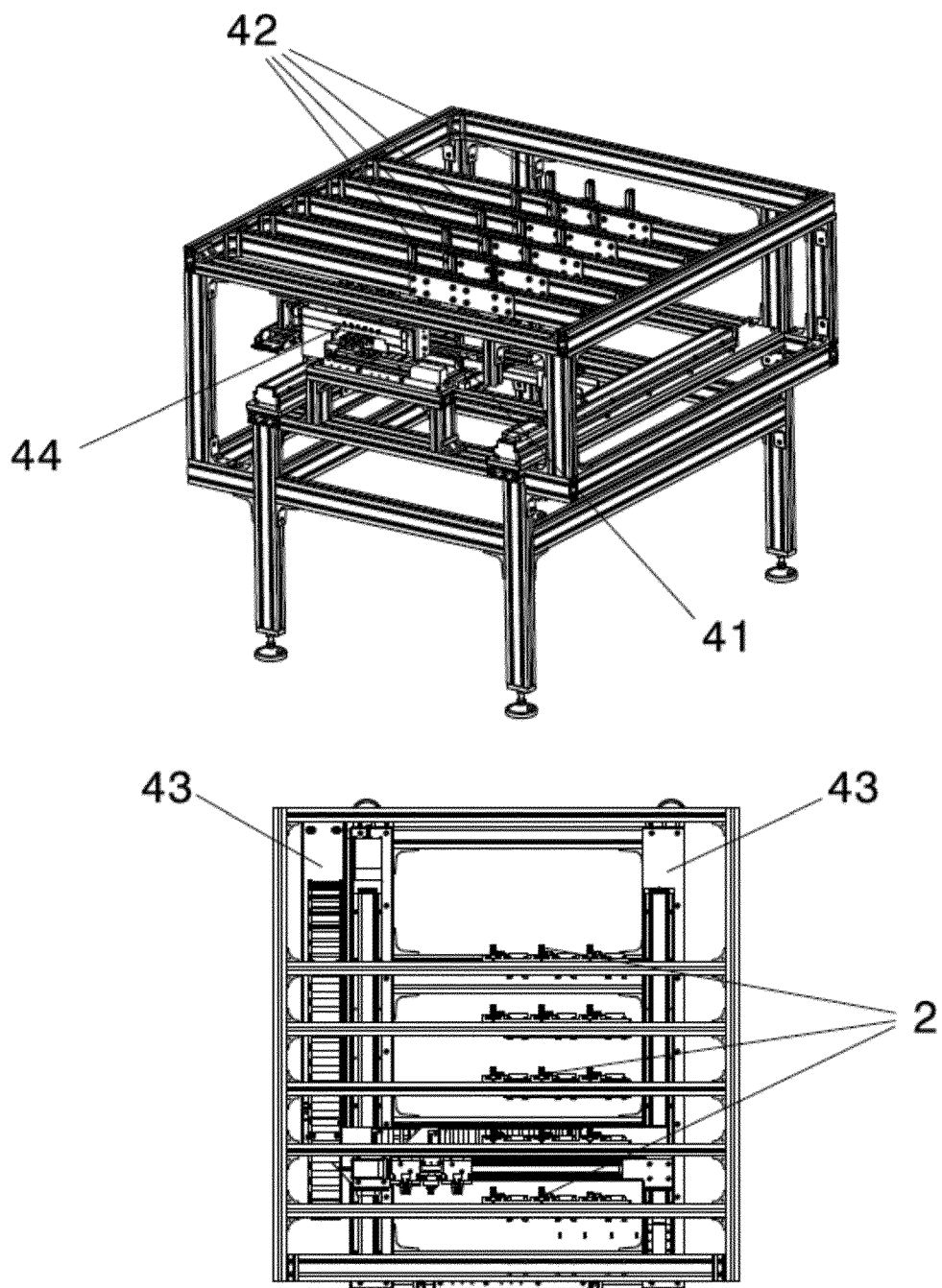


Fig. 4

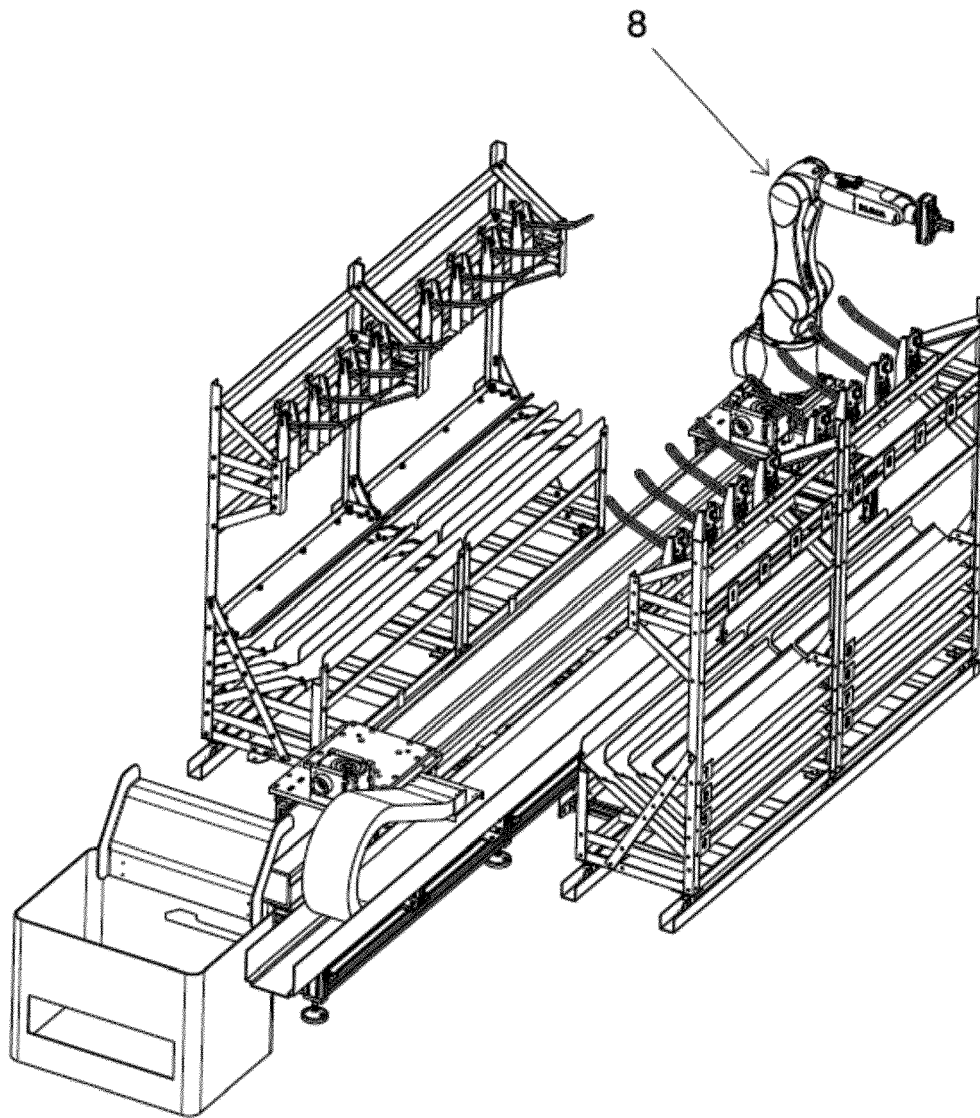


Fig. 5



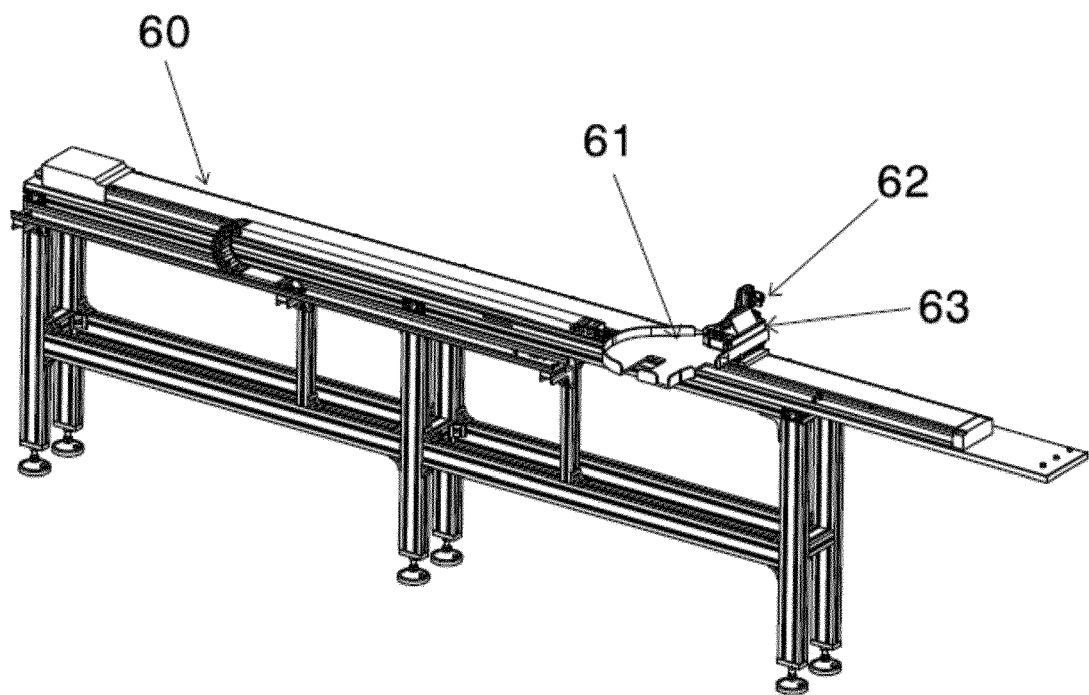


Fig. 6

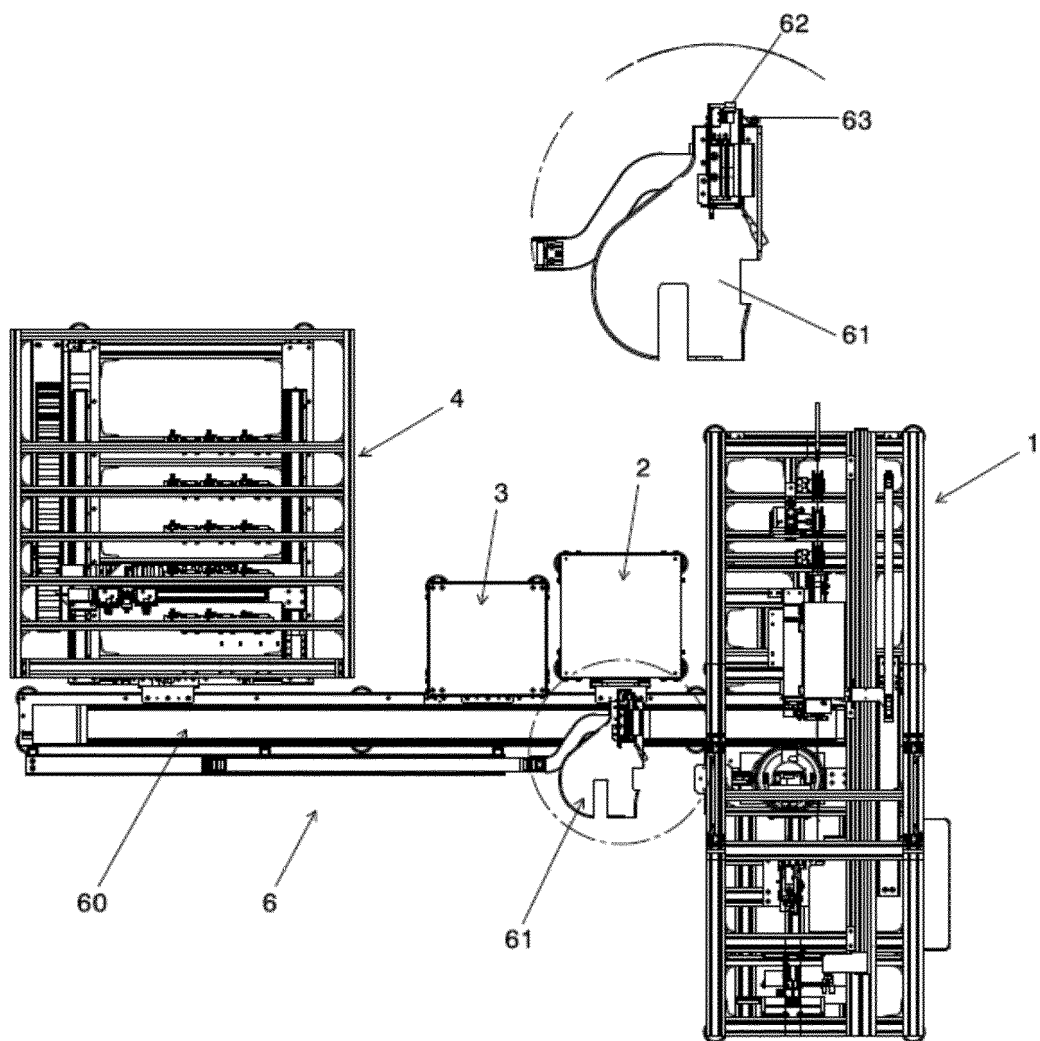


Fig. 7

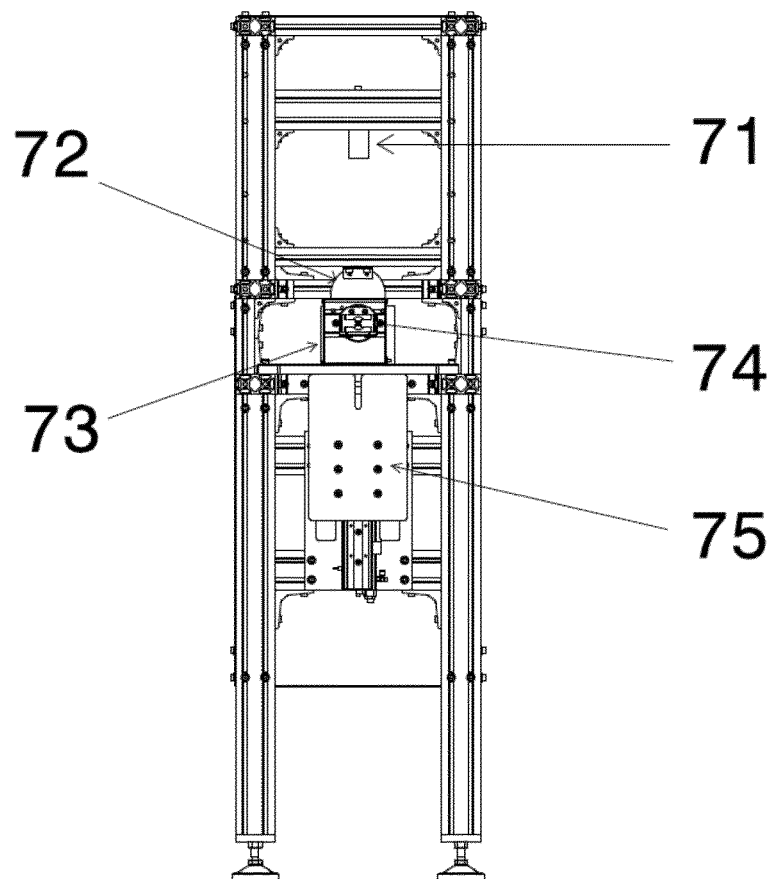


Fig. 8



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Place of search The Hague		Date of completion of the search 28 April 2017	Examiner Georgiadis, Ioannis
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The members are as contained in the European Patent Office EDP file on  
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