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(54) **METHOD AND DEVICE FOR THE PRODUCTION OF A FINISHED WIRE OR CABLE HARNESS**

(57) The invention relates to a method and a device (12) for finishing a wire or cable harness (1) made from prepared (processed) wires or cables (2) bearing cable end pieces or housings (3) or the like wherein the cable end pieces/housings (3) or the like and with them the processed wires or cables (2) are temporarily mounted in a transport pallet (5) which transport pallet (5) is used in a wired wire harness preparation machine or wire or cable inserting machine to provide cable end pieces or housings (3) for the inserting process. In the invention such transport pallet (5) is new further used to hold sequences of prepared wires or cables (2) in relation to a new wire or cable harness bundling machine (12) such that said wire or cable bundling machine tapes wires or cables (2) to branches (7) from said sequence.

The advantage is that the new device avoids large wiring boards and needs has hence a small floor space but still allows for full automated finished wire or cable harness production.

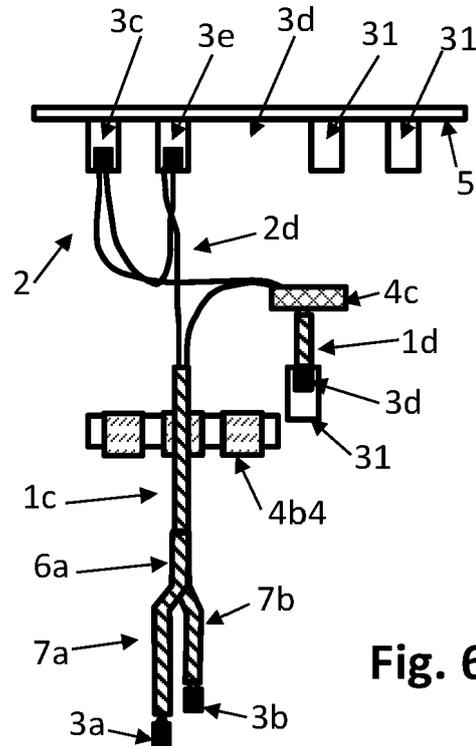


Fig. 6k

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Description

[0001] The invention relates to a method and a device for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece or housing (3) or the like.

[0002] Wherein the cable end piece (3) or the like and with them the prepared wires or cables (2) are temporarily mounted in a transport pallet (5) which transport pallet (5) is used in a wired wire harness preparation machine or wire or cable inserting machine to provide cable end pieces or housings (3) for the insertion process.

[0003] The term "prepared wires or cables" refer to a semifinished wire harness product which includes wires or cables which with at least some of the wire or cable ends inserted in cable end pieces. Such, end pieces are typically connectors (housings), sensor devices (also in the form of housings) or the like. FURUKAWA also uses in the same sense the term "wire harness semifinished product" in the English computer translation of FURUKAWAS patent JP5583064B2 <https://worldwide.espacenet.com/patent/search?q=pn%3DJP5583064B2> (see more below). Such product is often also named as "wired wire harness". A "wired wire harness" in the sense of this application is a semifinished product consisting of a variety of wires or cables at least partly inserted in connectors (often referred to as "housings"). Such wired wire harness contains typically all wires or cables which are used together for one device (e.g. a car or a machine). Before those are used in such car or machine they are partly bundled together and eventually connected with further elements which is a finishing process. The finishing process turns the semifinished product into a finished wire or cable harness ("Kabelbaum" in German language). The term processed wire or cable refer to a wire or cable which is cut and strip or the like so that it can be used together with end pieces.

[0004] The machine which produces such wired wire harnesses (semifinished products) is often called wire inserting machine or wire processing machines or wired wire harness preparation machine (in this application preferred).

[0005] The technology of producing finished wire or cable harnesses is not an old technology. It was developed over the time, when production of cars was disrupted in the sense that companies did not produce complete cars themselves but had parts prepared by suppliers - among those who produced finished wire or cable harnesses which are then inserted into hollow spaces of a car body. The production of a finished wire or cable harness is traditionally a manual work done on a wiring board. Recent articles call for improvements in this technology:

Download from the internet 20.7.2023 by Paul Rosenich: In an article of the electronic Journal: www.elektroniknet.de/automotive/software «Die automatisierte Bordnetzproduktion der Zukunft» of 9. November 2022, 13:30 Uhr published with the link: <https://www.elektroniknet.de/>

[automotive/software-tools/die-automatisierte-bordnetz-produktion-der-zukunft.200329.html](https://www.goo.gl/automotive/software-tools/die-automatisierte-bordnetz-produktion-der-zukunft.200329.html)<https://www.goo.gl/automotive/software-tools/die-automatisierte-bordnetz-produktion-der-zukunft.200329.html> shown as: "Standardisiert, robotisiert, verlagert: Die automatisierte Bordnetzproduktion der Zukunft - Software + Tools - Elektroniknet».

[0006] It is explained that at least until November 2022 the cable harness bundling branch focusses on wiring harnesses to be produced on a laying board/wiring board also named as assembly board by the support of these wiring activities with a robot. They article calls it: "Die automatisierte Bordnetzproduktion der Zukunft». Translated: "the automated board net production of the future."

[0007] Thereby one has to acknowledge that such wiring boards extend often up to 1-2m high and 2-4m long or longer. A robot who would work on such a large wiring board has a very large area to cover which is technically difficult. It is further a problem that in case the wiring of the wired harness on a wiring board is often need at angles smaller than 90° between two branches is very difficult often a robot can't work between such branches (in such small areas). On top of all the wiring board hinders also free movement of robots or the like. Another article of 2.June 2020 of another online journal www.automobilproduktion.de with the link: <https://www.automobilproduktion.de/management/komplexe-bordnetze-erfordern-eine-automatisierte-produktion-129.html>; Title: "Im Interview: Bernd Jost, Geschäftsführer der DiIT GmbH" explains where the problems of the automatization lies: flexibility/slackness of the wires and cables and special parts which should be mounted on a cable harness. Download 20.7.2023 by Paul Rosenich.

[0008] Also the following article of the homepage of the company diit.GmbH discusses the further development of cable harness bundling link: <https://www.diit.de/wiring-harness-production-how-the-future-could-look/> named: "Wiring harness bundling: how the future could look" - DiIT GmbH downloaded by Paul Rosenich 20.7.2023 deals with the future of cable harness bundling, and states:

Krailling, November 24, 2022 - Wiring harness manufacturers must thoroughly automate their production, otherwise face a loss of competitiveness. DiIT describes how this could be achieved.

[0009] In contrast to many other wire processing sectors, many manual processes are still used in wiring harness bundling. Although wire cutting is highly-automated, wiring harnesses are then generally pre-assembled manually and their final assembly is even performed completely by hand - mostly in best-cost countries.

[0010] These manual processes are preventing the digitalization of the sector that is urgently required. They are also impeding the continuous collection and processing of data without which wiring harness manufacturers cannot meet the increasing requirements of automotive groups for product quality and traceability.

[0011] This means that manufacturers have no alter-

native but to increase automation. DiIT, a specialist for integrated software systems used in wiring harness bundling, explains what the future could look like for wiring harness bundling:

1. **Standards.** One of the main reasons for the low level of automation is the lack of standardization in the wiring harness sector. Therefore, it absolutely has to find a way to define which components can be automated. These standards must drastically reduce the variance in components such as wires, contact parts and connectors and completely exclude use of those components such as shrink tubing or seals which cannot be automated.

2. **Robots.** Using these standards as a basis, wiring harness manufacturers can then convert their process chains piece by piece to full automation of production. One particularly big challenge in this regard is the final assembly of wiring harnesses on the assembly board. One obvious way of automating this process step is to use robots.

3. **Relocation.** To date it has not been commercially viable to use robots for the final assembly of wiring harnesses. However, rising wages in best-cost countries could change the calculation. Added to this are geopolitical distortions and the increasing risk of failure of suppliers there. Robotized final assembly in the immediate vicinity of automotive manufacturers could in future be more cost-effective and more secure than current practice.

[0012] "The cornerstone for wiring harness bundling is standardization. Wiring harnesses must be designed to enable their automated production," explains Bernd Jost, Managing Director of DiIT. "However, the industry can only accomplish this challenge together because it goes against the previous competitive principles of wiring harness manufacturers. Companies must come together and jointly develop fit-for-purpose automation standards."

[0013] To put all of these prior art articles together it can be stated that the use of robots for taking over the work from human harness maker is highly suggested. Thereby it is suggested that the robots - like humans - work on a layering board or assembly board (wiring board), where the finished wire or cable harness is built.

[0014] The applicant supported harness bundling in layering boards/assembly boards by providing machines to produce preprepared wires and cables (inserted wires or cables or wired wire harnesses) connected with connectors and the like. Such machines are produced e.g. under the well-known brand Omega. The wired wire preparation machine Omega type 8x0 delivers wires or cables with cable end pieces (connectors) for finished wire or cable harness bundling, whereby the connectors and their housings respectively are held in housing

holders which are mounted on a transport pallet. The function of this transport pallet is to receive the housings and transport them inside the wired wire preparation machine, where the wires or cable are inserted. After that production step the transport pallet moves back again, so that the wired wire harness can be removed. After removal from said transport pallet the wired wire harness is typically transported on simple carriers to a wiring board for completing the finished wire or cable harness.

[0015] While Omega connects wires with connectors (connector housings) it does also temporarily fix those in housing holders of the transport pallet. Said transport pallet is then used inside the wired wire preparation machine to temporarily transport the produced sequence of mounted/inserted wires/cables (wired wire harness) in the direction of a wiring board where the harness is finally assembled on a wiring board either by humans or eventually by robots. As mentioned above typically the transport to the wiring board is performed by removing the wired wire harness from the transport pallet and depositing it on a carriage which is then moved to the wiring board.

[0016] Such a transport pallet in the sense of the invention is a plate with a variety of holes (interfaces) in array/matrix form consisting of lines and columns said interfaces are adapted to receive cable end piece holders (housings holders) or cable end pieces (housings), which cable end piece holders are adapted to receive cable end pieces from processed wires or cables. Such transport pallets are standard elements of KOMAX[®]-wire processing and typically used in the KOMAX[®] Omega transfer line machines 740-755. These wire/cable inserting machines (wired wire harness preparation machines) prepare the wires by stripping the ends of wires and cables cutting them into proper lengths and providing them with cable end pieces which are then inserted in said cable end piece holders one by one as the machine delivers the prepared wires or cables.

[0017] The purpose of these transport pallets in the prior art were to have all prepared wires or cables in a proper transport means (transport pallet). Said transport pallets are typically used to hold the cable end piece holders and to transport the cable end pieces (sometimes they are named housings) together with the connected cables or wires within those machines (inserting machines), where the cable endpieces have been fixed to the ends of the cables or wires and to a position at said machines where the wired wire harness can be removed from the transport pallet. After removal the prepared (inserted) cables or wires are typically further transported to wiring boards in order to allow wiring personnel or robots to take the prepared wires or cables off the carriage and position them properly onto the wiring board. Such transport pallets and wired wire harness preparation machines are disclosed also in US2002144395A1 with the title: Method and apparatus for equipping plug housings with fitted-out cable ends of a cable. Such

transport pallets per se are hence well known in the art.

[0018] Sumitomo disclosed rags (carriages) for holding cable end pieces: see WO 2017090435 A1, WO 2017038477 A1 and WO 2016158339 A1. However, these do not substitute transport pallets and cables or wires are not being automatically assembled by inserting machines.

[0019] The prior art US4593452A discloses a robotic harness maker with a wiring board (named harness board, see Fig. 1). There an apparatus for manufacturing wiring harnesses employs a robot mounted above a harness wiring board with storage areas for jigs, connectors, wire dispensers, and insertion tooling about the periphery thereof for easy pickup by robotic gripper, which positions jigs and connectors and laces wire from a wire dispensing assembly through the jigs before terminating and severing wire. Dispensing assembly comprises a dispenser which gripper picks up from a bracket in a holder to draw wire from endless source to lace the harness. The holder has wire feed wheels and a severing mechanism therein which may be used with a choice of dispensers in order to use different color or size wire. After termination and severing, pivoted platforms on wire jigs eject wire scraps from around lacing posts fixed on the jigs. Such a device does not utilize the output of automatized complex wire inserting apparatuses like OMEGA but basically substitutes manual work with robotic activity at the wiring board.

[0020] In another prior art document with the title WIRE HARNESS MANUFACTURING METHOD, WO2018105375A1 of Sumitomo a wire harness assembling device is used to perform processing such as bundling processing on the wiring member extending from a connector (terminal portion). The banding process is a process of binding the wiring member extending from the connector at a position away from the connector as it is typical for all common binding processes. The wire harness assembling device includes an electric wire holding jig, a support member that supports the electric wire holding jig, and a drawing board 60 shown in Fig. 13 and 14 of this prior Art. Here, the wire harness assembling apparatus includes a first robot as a wire drawing mechanism, a second robot as a binding mechanism, an imaging unit as a state information acquiring unit, and a processing control unit. However, these rather complex and highly automated apparatus needs to be filled with new inserted cables/wires with their housings one by one and an integration/close relation with wire inserting apparatuses is not suggested. In other words: This prior art device substitutes on one hand manual work by robots, which wire harnesses on a wiring board, as humans would do on the other hand a further integration with wire inserting machines is not provided or suggested.

[0021] The US7024760B2 of the applicant KOMAX[®] discloses a wire inserting apparatus (like OMEGA) where an equipping unit (inserting unit) takes over the cable ends (wire ends) in succession and positionally correct at the second transfer station and introduces the cable ends

into the corresponding plug housings/terminal portions. The plug housings/terminal portions are arranged each in a housing holder of a transport pallet. The transport pallet collects - so to say -the final product of such wire inserting machine and finally executes a movement, wherein the stocking of the pallet with the housings and the removal of the cable equipped housings can be carried out manually or automatically as described above.

[0022] A further different use of such a pallet with inserted housings of terminal portions of cables/wires out of the wire inserting apparatus is not suggested.

[0023] As another prior art a well-known KOMAX[®] process exists performed at a machine called: KTL 10 of Komax Taping GmbH & Co. KG, where a taping machine on which a cable end piece connected to wires or cables can be inserted in a movable holding jig whereby the other end of said wires and cables are to be held by hand of an operator. In between the taping mechanism can tape the wires or cables respectively. By doing so it is possible for humans to create wired harnesses with knots and branches. The holding jig is moveable in axial direction of the wires or cables. By doing so the length of the taping on the wires or cables can be controlled by the taping machine. This machine does not give any hint as to how to utilize a transport pallet of a wired wire harness preparation machine in the process of wire harness bundling.

[0024] Another type of wire harness bundling utilizing holding jigs is shown in the WO2020255508A1 (Sumitomo). Here the holding jig is fixed but the taping mechanism is moveable opposite the above-mentioned KTL 10 - process of KOMAX[®]. Both known systems do not need wiring boards which are normal standard for wiring/assembling of harnesses - as explained above. These known systems work for inserted cables/wires (wired wire harnesses) which are fed into the devices manually.

[0025] Sumitomo further disclosed in the WO2020255508A1 a MANUFACTURING METHOD AND MANUFACTURING DEVICE FOR WIRE HARNESS. The wire harness manufacturing process is there roughly divided into two process steps, for example, a circuit forming process (wire inserting process) and an assembly process (harness wiring). The circuit forming step is a step of forming a circuit by connecting the ends of a plurality of electric wires having a predetermined length to a predetermined connector (terminal portion). The assembly process is a process in which the wiring body on which the circuit is formed is assembled into a shape to be mounted on a vehicle or the like. Such wiring bodies comprise basically wires and terminal portions. In the assembly process, for example, a plurality of electric wires are bundled, a branch is formed in a wiring body, and an exterior member is attached. This reflects standard procedure of any known wiring board techniques for harness bundling. The purpose of that SUMITOMO disclosure is to provide a technology capable of automating, with a simple device, at least a portion of a step for assembling a wire harness.

[0026] This manufacturing method for a wire harness is a method for manufacturing a finished wire harness by bundling a wiring body before forming branch in the wire harness, the method comprising a step for moving, in a predetermined extraction direction, a terminal holding part by means of a holding part moving part in a size adjustment mechanism while the one terminal part in the size adjustment mechanism is held on the terminal holding part, and performing size measurement a region from the one terminal part to the position of one branch place. A tape winding mechanism is provided to tape wires together which are held hanging from a holding jig into which the wires have been brought by taking them out of a terminal holding jig. The terminal holding jig includes a plurality of holding portions. The plurality of holding portions are provided side by side in a line. Each holding unit can hold a terminal unit which is e.g. a connector/housing or the like. As a result, the terminal holding jig holds the plurality of terminal portions in a lined state and the wires are hanging down from there. In the example shown in FIG. 2 of said publication, the holding portion is configured to hold the electric wire 12 extending from the connector/terminal portion.

[0027] Someone needs to fill in these holding positions so that all wires and terminal positions are hanging there in a line. From there they are then removed in order to be held in a holding jig separated from the terminal holding jig. This process can be automated. Compared to more conventional harness wiring procedures where the wires are lying down in a wiring board (assembly board) here the wires are hanging and the terminal portions and their connected wires are taken from one jig to another jig, whereafter a taping mechanism may automatically tape the respective wires hanging down from the jig and terminal portion respectively.

[0028] This prior art suggests that a robot should be substituted by a more simple device so that at least a part of the harness bundling process can be automated. By doing so this prior art focuses on the manipulation of wires with terminal portions which have been delivered to the device and manually inserted into the terminal holding jig from where it can be taken out later in order to be then held by another holding jig.

[0029] The closest prior Art (OMEGA of KOMAX[®]) however uses a particular pallet which on the one hand delivers end pieces into an automatic cable processing and terminating machine (wired wire harness preparation machine) and on the other hand delivers the processed and terminated cables together with its endpieces (wired wire harness) to a place of said cable processing and terminating machine where it can be removed and transported further to be finished elsewhere. From there conventional wiring boards are used to wire the wired harness. Sumitomo does not show such transport pallets and such functionality and could not use such transport pallets in their racks in the same manner, as these racks do not belong to automatic cable processing and terminating machines.

[0030] The task of the invention is to find an integrated and more efficient way of producing wire harnesses with wires and terminal portions as they are produced and put together to a wired wire harness in an automatic wire inserting machine. A possibility for a direct integrated combination of wire inserting machines and finished wire harness preparation machines is sought.

[0031] As already mentioned, well known in the art are automatic inserting machines (wire assembly machines or wired wire harness preparation machines) from the applicant, where wires are connected with terminal portions (terminal housings). KOMAX[®] specifies on its homepage:

"The fully automatic inserting of single leads and unshielded twisted-pair wires with innovative solutions from KOMAX[®] is an essential step on the way to automatic wire harness bundling and seamless traceability."

[0032] As a result, wires and housings are connected and the housings are stored in housing holders of a transport pallet as also disclosed in the above mentioned US7024760B2, which - as a first inventive step of this invention - allows to transport a batch of wires with housings (a wired wire harness) away from an automatic inserting machine (wired wire harness preparation machine).

[0033] m FURUKAWA has disclosed in the JP5583064B2 titled: MANUFACTURING METHOD OF WIRE HARNESS a manufacturing method of manufacturing a finished wire or cable harness having a branch part without an assembly operation bench (wiring board) with an electric wire holder. A wire harness semifinished product is prepared which has connectors previously connected to one another by an electric wire (electric wire bundle), and two connectors among the connectors constituting the semifinished product are held at a position where the electric wire bundle connecting the connectors to each other is tensed linearly. Further, a connector other than the connectors is held at a predetermined position. A movable slide clip fitted to the electric wire bundle at a position nearby the connector is slid along a length of the electric wire bundle to be moved up to a place (branch part) where the electric wire bundle branches off toward the connector, and then a slide clip is fixed not to move. Consequently, the branch part of the wire harness is formed. By doing so FURUKAWA avoids using a wiring board and utilized automatically controlled grippers - like fingers of a human to lay the bundles "in the air" because the bundle of wires are held between two grippers and taped in between etc. The connectors - before they are taken by the grippers are hold in a store line similar to the devices of SUMITOMO.

[0034] It is the task of the invention to provide a new and simple efficient process for harness bundling.

[0035] The main inventive step of the invention is thereby to utilize and integrate the transport pallet in/into the harness bundling process and not only use it as a transportation means with respect to the wired wire harness preparation machine (like OMEGA). That reduces the

need of extra holding jigs for holding the terminal portions and wires as suggested by Sumitomo. In other words: The transport pallet of KOMAX[®] gets a second task independent from the existing task as transport means within the wired wire harness preparation machine and it becomes part of the harness bundling machine (finished wire harness production machine).

[0036] This allows for the inventive method which is much more efficient than known methods.

[0037] The task of the invention is solved by a method for manufacturing a finished wire or cable harness from prepared wires or cables bearing cable end pieces (terminal portions) or the like (wired wire harnesses)

[0038] Wherein the cable end piece or the like and with them the processed wires (cut and strip e.g.) or cables are - as a first step - temporarily mounted in a transport pallet which transport pallet is temporarily held in a take-over position. In a second step and continuously using such pallets.

[0039] One cable end piece or the like after the other are removed from the transport pallet together with the related wires or cables, whereas the other end piece of the same string of wires/cables remains in the pallet.

[0040] Thereby straightening/combing said related wires or cables and thereafter bundling said related wires or cables and temporarily fixing them in intermediate clamps.

[0041] In other words, the transport pallet is used as a jig for holding housings and cables/wires at one end, while the other end of said cables or wires are held by different grippers or the like and removed from said transport pallet.

[0042] It can be noted that the transport pallet most preferably would be assembled by an inserting machine, like OMEGA, but certainly the invention may also be performed in the way of manually feeding a pallet with housings of connectors and inserted wires or by inserting such housings with wires or cables by a robot into a transport pallet.

whereafter those bundled related wires or cables which should be bundled together with other bundled related wires or cables or other related wires or cables are taken off the clamps and straightened/combed again together with the other bundled related wires or cables or other related wires or cables and bundling them together thereby building desired knots and branches of the harness one by one as long as the desired finished wire or cable harness is completed.

[0043] At the end - of course - also the remaining housings held in the transport pallet will be removed from that transport pallet in the course of finishing the wired harness.

[0044] Whereafter the finished wire or cable harness is deposited in a finished wire or cable harness deposit tray.

[0045] Whereafter the transport pallet is returned from the take-over position **and without** utilizing a wiring board/assembly board or the like.

[0046] Which final step is very important, as this saves

a lot of space. For that reason, an inventive device has a small floor space compared to known wiring boards or the like.

[0047] Further the new method and system allows for integration of wire harness bundling with wire inserting methods and devices.

[0048] Further the invention avoids distributing the whole wired harness in two dimensions over a large area. That reduces floor space in the workshop and reduces manipulation costs.

[0049] A further advantage is that (compared to wiring board) the cable end pieces and their wires can be moved in the room by grippers but this also allows for more space for following bundling operations.

[0050] Due to the invention, it is also possible to tightly tape knots without manual taping activity.

[0051] An improved method for manufacturing a finished wire or cable harness from prepared wires or cables bearing cable end piece or the like wherein the cable end piece or the like are held in cable end piece holders which are temporarily held in housing interfaces of said transport pallet - provides that when one cable end piece or the like after the other are removed from the transport pallet together with the related wires or cables, they are removed by temporarily removing the cable end piece holders together with the cable end piece and

[0052] Whereby after bundling said related wires or cables and temporarily fixing them in intermediate clamps said cable end piece holders are returned into their original interface within said transport pallet. This allows for an efficient use of the housing holders and completes the transport pallet for a new cycle of being filled with housings of prepared end pieces/end portions.

[0053] A very good integration of devices is ensured, when the transport pallet is automatically delivered from a wire/cable inserting machine (wire inserting machine or wired wire harness preparation machine) to a wire or cable harness bundling machine (or finished wire or cable harness production machine) and

wherein after delivery of the finished wire or cable harness to the finished wire or cable harness deposit tray the transport pallet is automatically returned to said wire/cable inserting machine.

[0054] A useful variant of the invention suggests the removal and returning of one cable end piece after the other from the transport pallet together with the related wires or cables and/or together with the related cable end piece holder is performed by a first automatic gripper device of a first linear drive or of a first robot.

[0055] In order to smoothen the wiring bodies (bundles of wires or cables) according to a further modification of the invention a straightening/combing said related wires or cables is performed by said first automatic gripper device according to claim 5 or by a second automatic gripper device of another linear drive or of another robot, in which alternative case the second automatic gripper device cooperates with the first automatic gripper device of the first linear drive or of the first robot in order to

straighten/comb said related wires or cables.

[0056] It is efficient when the temporarily fixing is performed within automatically controlled mechanical intermediate clamps or within self-clamping clamps.

[0057] In an improved variant of the invention the bundling of the related wires or cables and/or bundling in order to build desired knots and/or branches is performed by an automatically controlled bundling module especially an automatically controlled taping module or by an automatically controlled binding (taping) module.

[0058] For easy access to the finally finished wired and taped wire harness the finished wire or cable harness is deposited in a finished wire or cable harness deposit tray by gravitation force. Hence the deposit tray may be used as a collector.

[0059] In addition or alternatively the finished wire or cable harness is weighed by a scale as a quality control measure. This allows to instantly detect certain failures in the overall process. E.g. when housings got lost or when taping was incomplete or the like. This weighting step of ready produced wired harnesses is an independent invention as such. It can be further developed by providing an intelligent Software - eventually supported by AI which diagnoses and indicates automatically which failure happened, so that a repair could be easily performed. In addition to a scale also optical pattern recognition systems (known per se) may be provided in connection with the finished wire or cable harness deposit tray for quality control of the wired harnesses.

[0060] Typically, the transport pallet is in a vertical position and the housing holders and housing/connectors/end pieces are held in a horizontal position. Of course, the wires/cables are hanging down because of and according to their flexibility whereby the wires or cables are hanging from the transport pallet and whereby the linear drives or robots are straightening/combining in a horizontal plane.

[0061] In Fig. 6 such vertical plane is shown symbolic with 19 (instead of 18). In that case the transport pallet 5 would be in a vertical plane and the wires 2 would be hanging downwards from it but the operation with the wires would be in a horizontal plane - like parallel to the drawing plane.

[0062] In a variant of the invention the pallet is temporarily positioned in a horizontal position.

[0063] Whereby the wires or cables are hanging down from the transport pallet and whereby the linear drives or robots are straightening/combining in a vertical plane. In Fig.6 such vertical plane is shown symbolic with 18. In that case the pallet 5 would be hanging up and the wires 2 would be hanging downwards from it. So Fig. 6 has two ways of interpretation. Depending on the spatial orientation of the transport pallet in the room.

[0064] It is convenient and assists efficiency when at least three and preferably at least four automatic gripper devices of linear drives or robots are provided for temporarily holding said cable end piece or said wires or cables in order to define the desired knots and/or length

of bundling actions of the branches.

[0065] A safe way of connecting and disconnecting housings from housing holders of transport pallets is suggested when a transport pallet is employed wherein the transport pallet contains interfaces to receive cable end piece holders which interfaces are adapted to receive cable end piece holders at a certain lower insertion force (23) and to release cable end piece holders at a certain higher release force and wherein the certain release force is chosen at least 110% or preferably at least 150% of the certain insertion force which is necessary to properly insert cable end piece holders into said interfaces .

[0066] The invention covers also a wire or cable harness bundling machine for utilizing the method for manufacturing a finished wire or cable harness from prepared wires or cables bearing cable end piece or housing.

[0067] Wherein the cable end pieces and with them the processed wires or cables are temporarily mounted in a transport pallet which transport pallet is temporarily held in a take-over position and wherein a pallet receptor for temporarily holding a pallet is provided and spatially fixed with regard to automatic grippers of linear drives or of robots and a respective controller for controlling said automatic grippers.

[0068] Such that said automatic grippers may automatically detach cable end pieces and/or cable end piece holders from the transport pallet together with the related wires or cables in order to thereby straightening/combining said related wires or cables and allowing for bundling especially taping or binding.

[0069] A further developed wire or cable harness bundling machine provides an automatic bundling module which is controlled by the controller such that it is also in a defined spatial relationship to said transport pallet and can be positioned along the wires in order to tape them.

[0070] The wire or cable harness bundling machine may also have a controller which contains a length adjustment module which controls the movement of the automatic grippers in order to leave proper space for the bundling module to bundle the wires or cables or harness branches built from them.

[0071] A very good result in terms of small floor space and a system with short transportation ways is reached when the wire or cable harness bundling machine is build side by side or integrated with a wired wire harness preparation machine.

[0072] Preferably the pallet receptor is thereby connected with a rail with said wired wire harness preparation machine, so that a transport pallet can move on said rail from said wired wire harness preparation machine to said wire or cable harness bundling machine and back on the same rail or on another rail as the case may be.

[0073] The invention covers also a transport pallet and cable end piece holders for a wire or cable harness bundling machine as disclosed above wherein the transport pallet contains interfaces for temporarily receiving

cable end piece holders, which cable end piece holders are temporarily removable from said interfaces together with plugs/housings inserted in said cable end piece holders, wherein the cable end piece holders have a particular outside geometry adapted to be hold by particular automatic grippers of said linear drives or of said robots.

[0074] Said transport pallet is further developed when said interfaces are adapted to receive cable end piece holders at a certain low insertion force and to release cable end piece holders at a certain higher release force. Further the interfaces might have a defined spatial relationship to said pallet receptor when the pallet is received by said pallet receptor. This in turn ensures that the grippers or robots easily get grip on the holders.

[0075] Energy efficiency and a safe holding is given when the certain release force is at least 110% or preferably at least 150% of the certain insertion force.

[0076] The invention claims also a set of transport pallet and housing holders for cable end pieces or housings respectively to be used in a wire inserting machine for receiving different housings of different prepared wires or cables wherein said housing holders have different proper interfaces for respective different housings to be inserted into said housing holders and for being usable in one of the above described methods wherein all housing holders have a particular common outside geometry adapted to be held by particular automatic grippers of linear drives or of robots so that these grippers may take any and all of those housing holders in the same manner and for that reason in a defined spatial relationship.

[0077] These inventive measures ease the need for computer control of the grippers and allows to concentrate on fast touching and removing and returning of housing holders from and to transport pallets - independent of the sizes of the housings.

[0078] The reference numerals and the technical content of the claims as well as of the figures are part of the disclosure of this application. The figures are described together and interrelated to each other. Same reference numerals refer to the same construction elements. Reference numerals with different indices refer to construction elements with the same or similar function or to similar construction elements.

The figures show:

[0079]

Fig. 1a an overview of a first example of the invention without certain carrier elements and without most of the drives, in order to allow a better view on more important parts of the device;

Fig. 1b the same example however with completed carrier elements and additional the

most relevant drives;

- 5 Fig. 1c the most important parts of the same example in a top view - disclosing that the whole device is basically very small compared to a wiring board which would be at least double in size for the same type of finished wire or cable harness;
- 10 Fig. 1d a detail view on a Y-double portal with two gripper means of a novel harness bundling machine - particularity of the same example;
- 15 Fig. 1e a detail view on a second Y-double portal of the same bundling machine with two gripper means;
- 20 Fig. 2a a cable end piece housing in a cable end piece housing holder;
- 25 Fig. 2b a transport pallet with two arrays of cable end piece housing holders, which are by chance shown with only one size of housings - which in reality could be different - however with a uniform outer dimension of the housing holders;
- 30 Fig. 3 a detail of intermediate clamps and moveable pins for wires, cables and branches of the same example;
- 35 Fig. 4a a detail of a straightening unit/combing unit with opened jaws/rollers;
- 40 Fig. 4b the same straightening unit/combing unit but with closed jaws/rollers;
- 45 Fig. 5 a holding unit with grippers of the same example; ...
- 50 Fig. 6a-6l a symbolic bundling process for a finished wire or cable harness;
- 55 Fig. 7 one set of wires or cables straightened - by holding the housing holder at one end and with a straightener module combing the wires or cable on their other end and prepared for taping by a taping module of the same example;
- Fig. 8 the same set of wires straightened but now already taped (bundled) with a taping module of the same example and with handling grippers holding the wires/cables instead of the straightener unit on the other side;
- Fig. 9 the same set of wires and another set of wires of the same harness straightened

and taped (forming a branch) but hanging down with their end pieces - instead of being laid out in x-y direction on a wiring board - as known from prior art.

Examples of the invention as shown in the figures:

[0080] The finished wire or cable harness is produced on a wire or cable harness finishing machine or wire or cable harness bundling machine 12 by the use of a transport pallet 5 on which housing holders 31 are fixed. Each housing 3 (terminal end piece) has its own housing holder 31.

[0081] The housing holders 31 may be exchanged in the transport pallet 5 according to the particular shape of the respective housing 3. The housing holders 31 however have in a preferred embodiment generally always the same outer shape (independent from the shape of the housings 3), which is adapted to be easily gripped by automated handling grippers 4e.

[0082] The transport pallet 5 allows a flexible position of the housing holders 31 as it contains an array of holes 11 to fix the detachable housing holders 31. However also other means of fixation on the transport pallet 5 are possible. Holes however are standard for such transport pallets.

[0083] The housing holder 31 has an internal interface 17 for temporarily and stable holding the housing 3 and an external interface which fits to the holes 11 in the pallet 5 or in an interface 22 for temporarily and stable holding the housing holders 31 in/on the transport pallet 5. (see fig. 2a and 2b) This guarantees a stable and repeatable position of the housing 3 relative to the transport pallet 5. Additionally, the housing holder 31 contains an additional interface 26 on which it can be taken and picked up and connected and disconnected from the holes 11 or the interface 22 of the transport pallet 5. Preferably also a locking mechanism 34 is provided to fix the housing holders 31 in the holes 11 or in the interface 22 of the transport pallet 5. Said mechanism 34 can be preferably released or locked by a lock 36 in order to allow removal of the housing holders 31 or fixing the housing holders 31 in the holes 11 or in the interface 22 of the transport pallet 5.

[0084] Likewise, the housing holder 31 contains an internal mechanism to lock or release (eject) the housing 3 from the housing holder 31, as was already provided in the prior Art of KOMAX® (OMEGA and transport pallet).

[0085] The transport pallet 5 can be built such, that the housing holders 31 are held on the surface of the pallet 5 with respective housing holder fixation means (11, 22, 34) (as shown in Fig. 2b e.g.). However, it is also possible to have relatively thicker pallets, which bear holes of the size of housing holders 31, so that the housing holders 31 may be completely inserted into these holes of such a modified transport pallet. Such housing holders would have also releasable locking means so that they can be temporarily fixed in and released from said holes of said

modified pallets.

[0086] Alternatively, a further developed variant lies within this invention, where the housings 3 are releasably inserted in respectively sized holes of the pallet 5 and the outer shape of these housings fit with the gripper means. This would avoid the use of housing holders 31 but would still allow for preparing finished wire or cable harnesses 1 by the assistance of a transport pallet 5 and by an inventive herein described wire or cable harness bundling machine 12

[0087] The transport pallet 5 is held in a fixed spatial position 9 (Fig. 1c) within the wire or cable harness bundling machine 12. Preferably a pallet receptor 38 is provided on which the pallet 5 is temporarily fixed. (Fig. 1b, 1c, 2b).

[0088] The wired wire harness preparation machine or inserting machine is inserting the single wires or cables 2 into the housings 3.

[0089] The fixation is typically achieved using a primary and often an additional secondary lock inside the housings 3. The contact or the housing 3 have a locking lug, which locks into place during the assembly process in the inserting machine (e.g. OMEGA from KOMAX®). This avoids an unwanted slip out of the single wires 2 of their housings 3.

[0090] Once the wires including their end pieces (housings 3) are finished on the wire inserting machine by having all single wires or cables 2 connected to their respective housings 3 and those in the housing holders 31, the transport pallet 5 is moving or brought to the new wire or cable harness bundling machine 12. This can be done manually or preferred automatically along rails along a transfer mechanism or through any kind of robot arms or the like.

[0091] The wire or cable harness bundling machine 12 employs several modules such as taping modules 16, straightener modules 4c (comb modules and a similar module 4a on the bundling see Fig. 1e) and another module 4a, 4c, handling grippers 4a, d-f and holding modules 4b. Some of those have different functions they may hold/grip and/or straighten/comb e.g. modules 4a and 4c. It has also a receiving station (pallet receptor) 38 for receiving and holding a transport pallet 5 in a spatially fixed position relative to the wire or cable harness bundling machine 12 and its modules.

[0092] The taping module's 16 function is to create and fix the form of the final finished wire or cable harness (to bundle the single wires or cables 2 into branches 7 of the wire or cable harness 1). This can be achieved - as already known - by spot tapes, spiral tapes or cable ties or other similar fixation means for cables or wires which are wound or clipped around a selected bundle of single wires 2.

[0093] The straightener module's 4c function is to collect single wires 2 to a wire branch 7 and straighten the single wires 2 and the branch 7 respectively to a certain position and to pull them so that the respective single wires 2 lie in parallel as much as possible and as wanted.

[0094] Handling grippers 4e can pick up housing holders 31 or collect wire branches 7 and position them spatially within the machine 12.

[0095] In principle, it is one embodiment of the invention that the handling grippers 4, particularly 4e could grip and remove housings 3 from the pallet 5. That means they are adapted to grip the housings 3 directly. However, since there is often a very large variety of different housings 3a, 3b, 3c, 3d, 3e, 3f, 3g it is a preferred embodiment that the handling gripper 4 is adapted to remove housing holders 31 only. In this case the outer appearance of said housing holders 31 is the same, so that the grippers 4, particularly 4e could grip them safely. However, with the necessary flexibility of certain gripping elements on the grippers 4 also a combination is possible, namely that housing holders 31 or housings 3 may be gripped and removed from the pallet. However as mentioned above to generally undock only the housing holder 31 from the pallet 5, always the same interface can be used at the grippers 4, which is easier to master. Of course, as soon as the branch of the wired wire harness 1 on its course to a finished wire or cable harness 1 is ready made, the housing holder 31 can be removed from the housing 3 and put back to the pallet 5.

[0096] The invention covers also a system wherein the handling grippers 3 may temporarily remove housing holders 31 from the transport pallet 5 and insert them in different positions at the transport pallet 5. This allows to have the housings 3 in different positions for forming of harnesses 1 compared to filling the pallet 5 with housings 3 and wires 2 respectively in an earlier process. By doing so the bundling of the wired wire harness 1 may be easier as the case may be. Of course, after such bundling with relocated housing holders 31 and after the removal of the housings 3 from their respective housing holders 31 the removed housing holders 31 would need to be put back to its original position, so as to keep the pallet 5 fit for use in the harness preparation machine/wire inserting machine. This can be done by the same handling grippers 4.

[0097] In one example, e.g. shown in Fig. 5 each handling gripper 4d, 4e has at least two sets of clamps/interfaces 35d, 35e, one 35e for the housing holder 31 and eventually also for the cable bundle (combination clamps) and one 35d for the cable bundle eventually also a separate clamp/interface for the housing holders 31. The difference in those clamps/interfaces 35d, 35e is their interface/shape which is adapted to be connected with the good to be gripped and held properly.

[0098] A pneumatic cylinder 20 with a gear is provided on top of the grippers 4d and 4e in order to allow a rotation of about 180 degrees, so that the spatial position of the grippers 4d and 4e can be switched, in order to either take and hold a housing holder 31 or to hold wires or cables 2 or branches 7 etc.

[0099] The holding module 4b of Fig.3 can store semi-finished branches 1 and put two or more branches 1 together for an additional taping by the taping module 16 in order to create a new thicker branch 1 see e.g. 1c in

Fig. 1k.

[0100] The handling gripper 4a is picking up a detachable housing holder 31 from the holes of the transport pallet 5 or from the housing holder fixation position respectively (see e.g. Fig. 6e). The handling gripper 4a has a detaching mechanism to interact with the locking mechanism of the housing holder 31 in order to release the housing holder from the holes 11 of the transport pallet 5. The handling gripper 4a is moving afterwards to a predefined position so that the housing holder 31 is held in a spatial relationship with the bundling/taping module 16 and the wire or cable harness bundling machine 12 respectively.

[0101] A straightening unit/combing unit 4a, 4b, 4c is collecting the single wires 2 close to their housing 3 and straightens (combs) them in order to create a wire branch 1 of several single wires 2 and/or twisted wires. Straightening means 4a, 4b, 4c are pulling the wires 2 along their axes so that the single wires 2 lie in parallel as much as possible and wanted. This is done for a following bundling and taping process.

[0102] The other side of those single wires 2 of a housing 3a typically are connected to other housings 3e (in Fig.6k e.g.). In most of the cases the whole distance from one housing 3 to the other housing 3 on the same single wires 2a will not be bundled/taped completely. This is done only for "Jumper" connection cables. However, for such Jumper connection cables straightening (combing) may be even unnecessary, as they would be held anyway straight when one housing holder 31 is taken by a handling gripper 4e (Fig.7 e.g.) and stretched away from the pallet 5 and the other housing holder 31 respectively. It is possible that jumper cables might be hold by handling grippers 4 on both ends at the housings 3 or housing holders 31 respectively.

[0103] After straightening, preferably an additional handling gripper is taking over the wire branch 2a and keep the tension and position of the wire branch 2a until the bundling is finished.

[0104] Typically, the handling gripper 4e holds only one end of the single wire(s) 2a (the housing and/or housing holder) while the other end of the wire(s) 2a is(are) still held by another housing holder 31 in the pallet 5 as mentioned above. However, the other end might also be held by another handling gripper 4e, eventually also in its branch point. In the branchpoint the single wires are typically held by a cable holder 4b as shown in Fig. 3 e.g.

[0105] The straightened cable branch 2a is processed by the taping module 16 by wrapping a tape around the length of the branch 2a from one end to the other or about parts of the length - depending on the needs.

[0106] Once the bundling process is finished the secured branch (secured by spot or spiral taping or the like) is placed into the holding module 4b. There the holding gripper 4e triggers the internal release mechanism of the housing holder 31 to eject or release the housing 3. The handling gripper 4e returns the empty housing holder 31 to the transport pallet 5 and stores the housing holder 31

in its original position on the pallet 5 or at any other position (defined by the respective holes 11) of said pallet 5 which is useful for the following wired wire harness preparation process. For such the electronic controller 21 of the wire or cable harness bundling machine 12 is connected with the electronic control device of the wired wire harness preparation/wire inserting machine. The handling gripper 4e is then ready again to either detach a new housing 3 or a new housing holder 31 from the transport pallet 5 or to pick up finished branches from the holding module 4b. It is possible that more than one branch 1 is held by the handling gripper 4d, so that these can be bundled together from their branch point 6a (e.g. Fig. 6j and Fig. 8 and 9).

[0107] Regarding the controller 21 it is mentioned that in the drawings it is shown behind a metal sheet housing. However, the controller 21 can be placed anywhere, eventually also outside the wire or cable harness bundling machine 12. Eventually it could be even the controller of the wired wire or cable harness preparation machine (Wire inserting machine) which is taking over the controller function for the wire or cable harness bundling machine - especially in case they are integrated.

[0108] Alternatively, a ready bundled branch 1b can be put into the collection tray 8 in order to move them out from the bundling-operation area, see e.g. Fig. 9.

[0109] A second branch is formed in the similar way as described above.

[0110] As soon as all necessary branches 7a, 7b for the first branch point 6a are processed (Fig.6h-6l), the first branch point 6a is formed. A branch point 6 is a point in the wired wire harness (or in the finished wire or cable harness respectively) from which at least two taped branches 7 stand out. The branches 7 are thereby pushed together with two movable pins 4f of the holding module 4b. The 1st handling gripper 4e takes the branches with its 2nd set of clamps 35e and moves to a starting point. Again, the straightening unit 4c catches the wires 2 and the section of the wire harness stretched and straightened to its desired length. To keep the wires straight the 2nd handling gripper 4e takes the wires from the straightening unit 4c. Now the taping unit 16 can set the spot tapes and / or cover the section of several branches with tape. The combined branch 1c is put back to the holding module 4b3 for setting the next branch point 6a.

[0111] Fig. 4a shows a gripping module 4a, as it might be mounted on a taping module 16 as seen in Fig. 1e. This gripping module 4a is moveable relative to the taping module 16 and may hold wires or cables 2 during the process of taping close to the tape. Of course, if needed this gripping module may also be used as a straightening module before taping is performed. That way the taping module 16 (and its gripper 4a) is of flexible useability.

[0112] The same or a similar gripper 4c is mounted on the other side of the taping module 16 (see Fig. 1e) and on a separate linear drive 13c. The characteristic of such gripper 4a or 4c is that they have four rollers 35c shown

when open in Fig. 4a and when closed - to grip wires or cables 2 shown in Fig. 4b.

[0113] The holding mechanism is of advantage for a good guiding of clamped wires or cables 2 and it reduces friction by rolling movements of the rollers 35.

[0114] The wire or cable harness bundling machine 12 prepares the next branches 1 and combines them with the existing structure to gradually process the entire finished wire or cable harness 1.

[0115] As already mentioned, the inventive wire or cable harness bundling machine may have further modules for applying spot tapes, spiral tapes or cable ties, cable clips, or other similar fixation means for cables or wires which are wound or clipped around a selected bundle of single wires or cables 2. It may further include modules to fix further devices to the finished wire or cable harness like sensors, markings, tags, RFID-chips or the like.

[0116] After the last combination the finished wire harness 1 is - preferably by one of the grippers 4 - put in a wire or cable harness deposit tray 8 below for an operator or for an out take device to take out for delivery.

[0117] In an alternative execution, some parts of the wire or cable harness 1 are held by the holding module 4b (Fig.6d-6h) in order to reduce tension in the wires 2 during processing and to reduce the workload of the holding grippers 4 and to assist combing/straightening etc.

[0118] In a further alternative execution, the bundling/-taping module 12 is also able to alternatively to tapes affix mounting clamps or set cable ties or the like onto the wires or cables 2. Also it would be possible to have in addition to a taping module separately provided alternative modules/units e.g. cable tie module or a mounting element installation module. Such modules can be mounted and used as the taping module 16 is shown in the drawings e.g. Fig. 1e.

Reference list

[0119]

- 1 Finished wire or cable harness (**1a-1d**) indices refer to branches (parts) of the finished wire or cable harness
- 2 wires or cables (**2, 2a-2d**) indices refer to selected groups of wires/cables which are typically transferred into branches 1x
- 3 cable end piece/housing (**3, 3a-3g**) this could be terminals, plugs, connectors, sensors, any kind of devices which are connected to the ends of the cables or wires. The latter are inserted into said end pieces. Often they are referred to as housings.
- 4 Intermediate clamp (**4a-4f**) could also be grippers or the like. Some are referred also to (**4a**) holding unit (**4b**) wire/cable holder or holding unit with sub holders (**4b1-4b4**)

(4c) straightening/comb unit
 (4d) gripper for cables
 (4e) gripper for end pieces/housings 3 or endpiece holders 31
 (4f) centering gripper 5
 5 transport pallet (5) could be also named terminal holding jig, as this is its function within the wire or cable harness bundling machine (12)
 6 knots (6a, 6b)
 7 branches (7a-7d) 10
 8 wired harness deposit tray (8)
 9 take-over position (9)
 11 array of holes (11)
 12 wire or cable harness bundling machine (12)
 13 linear drive (13a-13d) 15
 14 double portal (14a-14b)
 15 automatic gripper device (15a-15b) refers un-specifically to automatic grippers 4. An automated gripper device may have one or more automated grippers 4 according to this invention. 20
 16 automatically controlled taping module/unit (16)
 17 internal interface in housing holder 31 for temporarily and stable holding the housing (17)
 18 vertical plane (18)
 19 horizontal plane (19) 25
 20 pneumatic cylinder for rotation of grippers 4d and 4e (20)
 21 controller (21)
 22 interface (22)
 23 inserting force (23) 30
 24 release force (24)
 25 scale (25)
 26 additional interface (26)
 31 cable end piece/housing holder (31)
 34 locking mechanism (34) 35
 35 gripper interface (35c-e), 35c rollers 35b interface on the outer surface of the locking mechanism 34
 36 lock (36)
 37 unlocking mechanism (37)
 38 pallet carrier, receiving station, pallet receptor (38) 40

Claims

1. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) or the like wherein the cable end piece (3) or the like and with them the processed wires or cables (2) are temporarily mounted in a transport pallet (5) **characterized in that** 45
 the transport pallet (5) is temporarily brought into a take-over position (9) of a wire or cable harness bundling machine (12) one cable end piece (3a etc.) or the like after the other (3b, etc.) are removed from the transport pallet (5) together with the related wires or cables (2a, 2b etc.), thereby straightening/combing said related wires or cables (2a, 2b etc.) and 55

thereafter bundling said related wires or cables (2a, 2b etc.) and temporarily fixing them in intermediate clamps (4a etc.) and whereafter those bundled related wires or cables (2a, 2b etc.) which should be bundled together with other bundled related wires or cables (2c, 2d etc.) or other related wires or cables (2e, 2f etc.) are taken off the clamps (4a etc.) and straightened/combed again together with the other bundled related wires or cables (2c, 2d etc.) or other related wires or cables (2e, 2f etc.) and bundling them together thereby building desired knots (6) and branches (7) one by one as long as the desired finished wire or cable harness (1) is completed
 whereafter the finished wire or cable harness (1) is deposited in a finished wire or cable harness deposit tray (8)
 whereafter the transport pallet (5) is returned from the takeover position (9)
and without utilizing a wiring board or the like.

2. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) or the like according to claim 1

wherein the cable end piece (3) or the like are held in cable end piece holders (31) which are temporarily held in interfaces (22) of said transport pallet (5)

characterized in that

when one cable end piece (3a) or the like after the other (3b etc.) are removed from the transport pallet (5) together with the related wires or cables (2), they are removed by temporarily removing the cable end piece holders (31) together with the cable end piece (3) and whereby after bundling said related wires or cables (2) and temporarily fixing them in intermediate clamps (4a etc.) said cable end piece holders (31) are returned into their original interface (22) within said transport pallet (5).

3. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to claim 1 or 2

characterized in that

the transport pallet (5) is automatically delivered from a wire/cable inserting machine to a wire or cable harness bundling machine (12) and wherein after delivery of the finished wire or cable harness (1) to the finished wire or cable harness deposit tray (8) the transport pallet (5) is automatically returned to said wire or cable inserting machine.

4. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the

preceding claims **characterized in that** the removal and returning of one cable end piece (3) after the other from the transport pallet (5) together with the related wires or cables (2) and/or together with the related cable end piece holder (31) is performed by a first automatic gripper device (4; 15a) of a first linear drive (13a) or of a first robot.

5. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims
characterized in that

straightening/combing said related wires or cables (2) is performed by said first automatic gripper device (4; 15a) according to claim 5 or by a second automatic gripper device (15b) of another linear drive (13b) or of another robot in which alternative case the second automatic gripper device (15b) cooperates with the first automatic gripper device (15a) of the first linear drive (13a) or of the first robot in order to straighten/comb said related wires or cables (2).

6. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims
characterized in that
the temporarily fixing is performed within automatically controlled mechanical intermediate clamps (4a) or within self-clamping clamps (4b).

7. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims
characterized in that
bundling of the related wires or cables (2) and/or bundling in order to build desired knots (6) and/or branches (7) is performed by an automatically controlled bundling module especially an automatically controlled taping module (16) or by an automatically controlled binding module.

8. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims **characterized in that**

the finished wire or cable harness (1) is deposited in a finished wire or cable harness deposit tray (8) by gravitation force
and/or

that the finished wire or cable harness (1) is weight by a scale (25) as a quality control measure.

9. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims

characterized in that

the transport pallet (5) is temporarily positioned in a horizontal position whereby the wires or pallet cables (2) are hanging down from the transport pallet (5) and whereby the linear drives (13) or robots are straightening/combing in a vertical plane (18)

or in that the transport pallet (5) is temporarily positioned in a vertical position

whereby the wires or cables (2) are hanging from the transport pallet (5) and whereby the linear drives (13) or robots are straightening/combing in a horizontal plane (19).

10. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims

characterized in that

at least three and preferably at least four automatic gripper devices (4, 15) of linear drives (13) or robots are provided for temporarily holding said cable end piece (3) or said wires or cables (2) in order to define the desired knots (6) and/or length of bundling actions of the branches (7).

11. A method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3) according to any of the preceding claims

characterized in that

a transport pallet (5) is selected wherein the transport pallet (5) contains interfaces (22) to receive cable end piece holders (31) which interfaces (22) are adapted to receive cable end piece holders (31) at a certain lower insertion force (23) and to release cable end piece holders (31) at a certain higher release force (24) **and wherein** the certain release force (24) is chosen at least 110% or preferably at least 150% of the certain insertion force (23) which is necessary to properly insert cable end piece holders (31) into said interfaces (22).

12. A wire or cable harness bundling machine (12) for utilizing the method for manufacturing a finished wire or cable harness (1) from prepared wires or cables (2) bearing cable end piece (3)

wherein the cable end piece (3) and with them the processed wires or cables (2) are temporarily mounted in a transport pallet (5) **characterized in that**

a pallet receptor (38) for temporarily holding a

transport pallet (5) is provided and spatially fixed with regard to automatic gripper devices (4a, 15) of linear drives (13) or of robots and a respective controller (21)

such that said automatic gripper devices (4, 15) may automatically detach cable end piece (3) and/or cable end piece holders (31) from the transport pallet (5) together with the related wires or cables (2) in order to thereby straightening/combining said related wires or cables (2) and allowing for bundling especially taping or binding.

13. A wire or cable harness bundling machine (12) of claim 12 **characterized in that** an automatic taping module (16) is provided and controlled by the controller (21) such that it is also in a defined spatial relationship to said transport pallet (5).

14. A wire or cable harness bundling machine (12) of claim 12 or 13, **characterized in that** the controller (21) contains a length adjustment module which controls the automatic gripper devices (4, 15) in order to leave proper space for the taping module (16) to bundle the wires or cables (2) or branches (7).

15. A wire or cable harness bundling machine (12) of claim 12 or 13, **characterized in that** it is build side by side or integrated with a wired wire harness preparation machine **and that** preferably the pallet receptor is connected with a rail with said wired wire harness preparation machine, so that a transport pallet (5) can move on said rail from said wired wire harness preparation machine to said wire or cable harness bundling machine (12).

16. A transport pallet (5) and cable end piece holders (31) for a wire or cable harness bundling machine (12) of claim 12 or 13 **wherein** the transport pallet (5) contains interfaces (22) for temporarily receiving cable end piece holders (31), which cable end piece holders (31) are temporarily removable from said interfaces (22) together with plugs/casings inserted in said cable end piece holders (31), **characterized in that** the cable end piece holders (31) have a particular outside geometry adapted to be hold by particular automatic gripper devices (4, 15) of said linear drives (13) or of robots.

17. A transport pallet (5) of claim 15 **wherein** said interfaces (22) are adapted to receive cable end piece holders (31) at a certain insertion force (23) and to release cable end piece holders (31) at a certain release force (24)

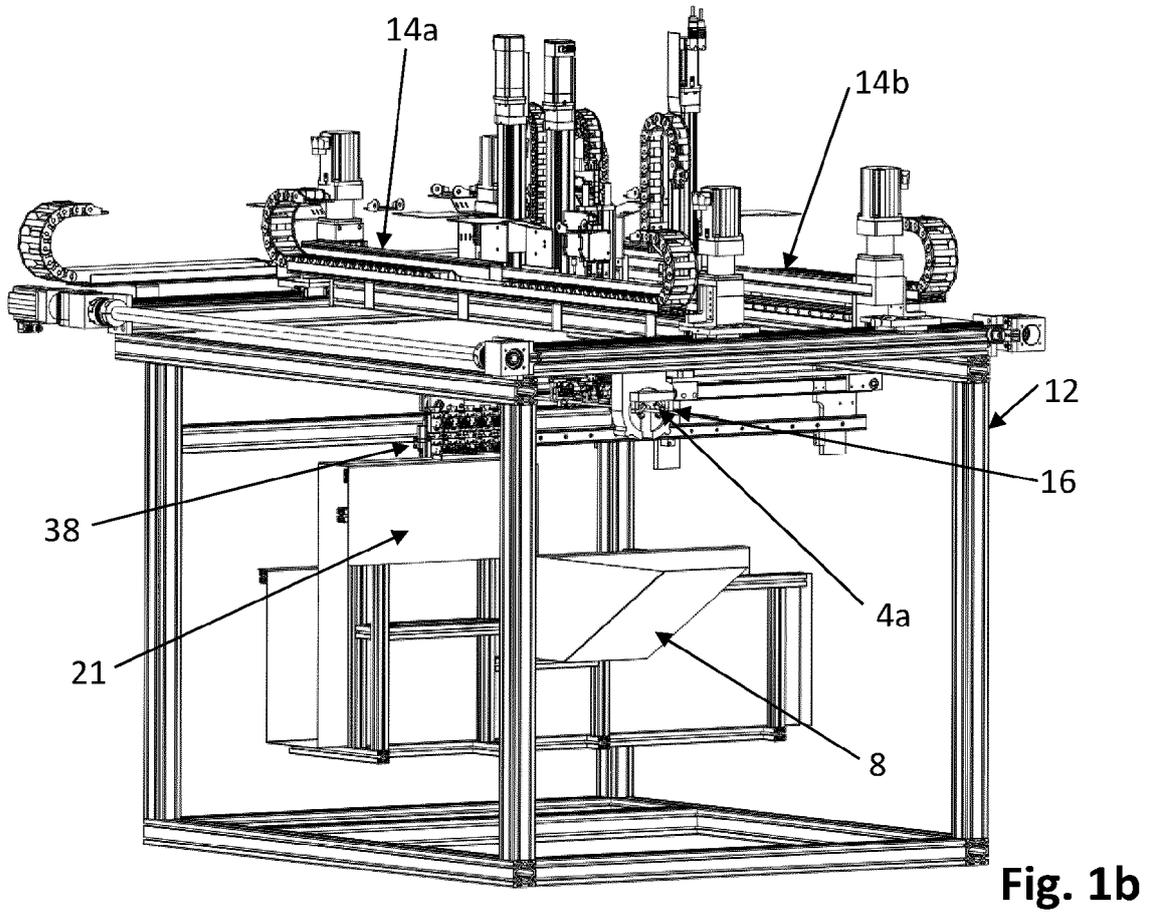
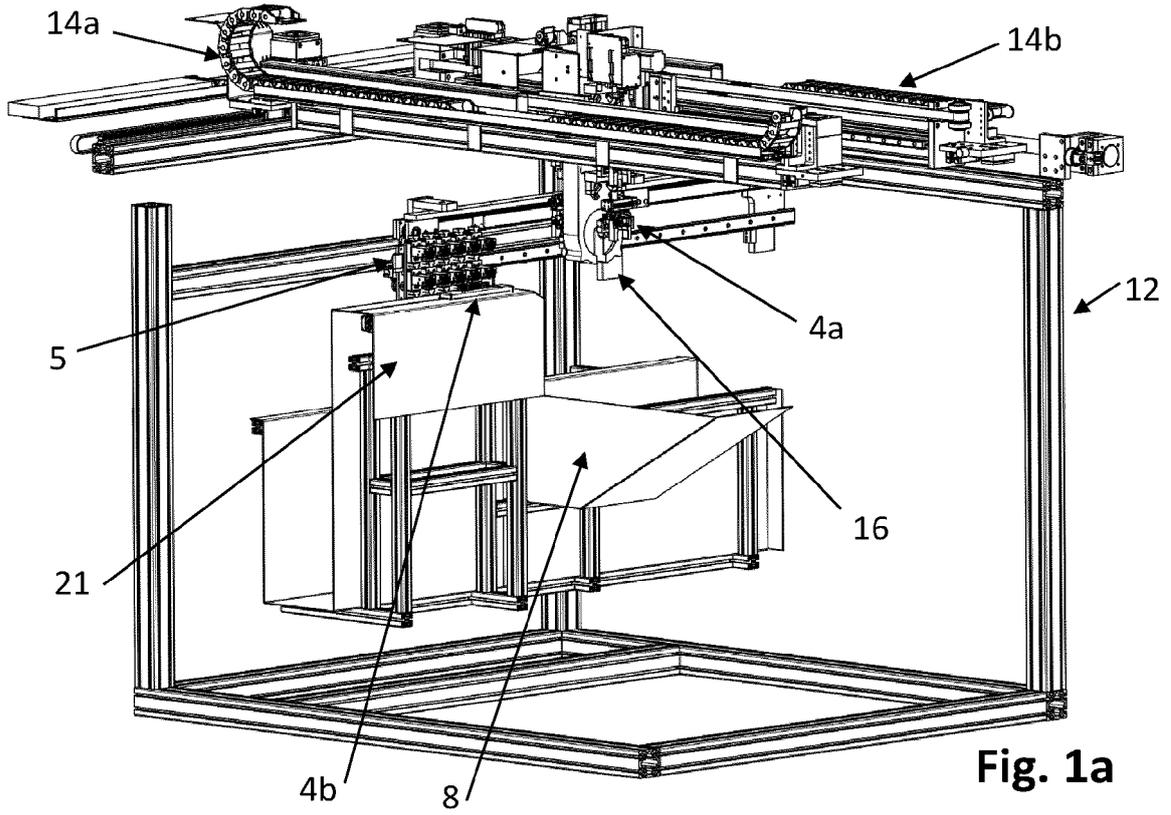
and wherein the interfaces (22) have a defined spatial relationship to said pallet receptor (38) when the transport pallet (5) is receipt by said

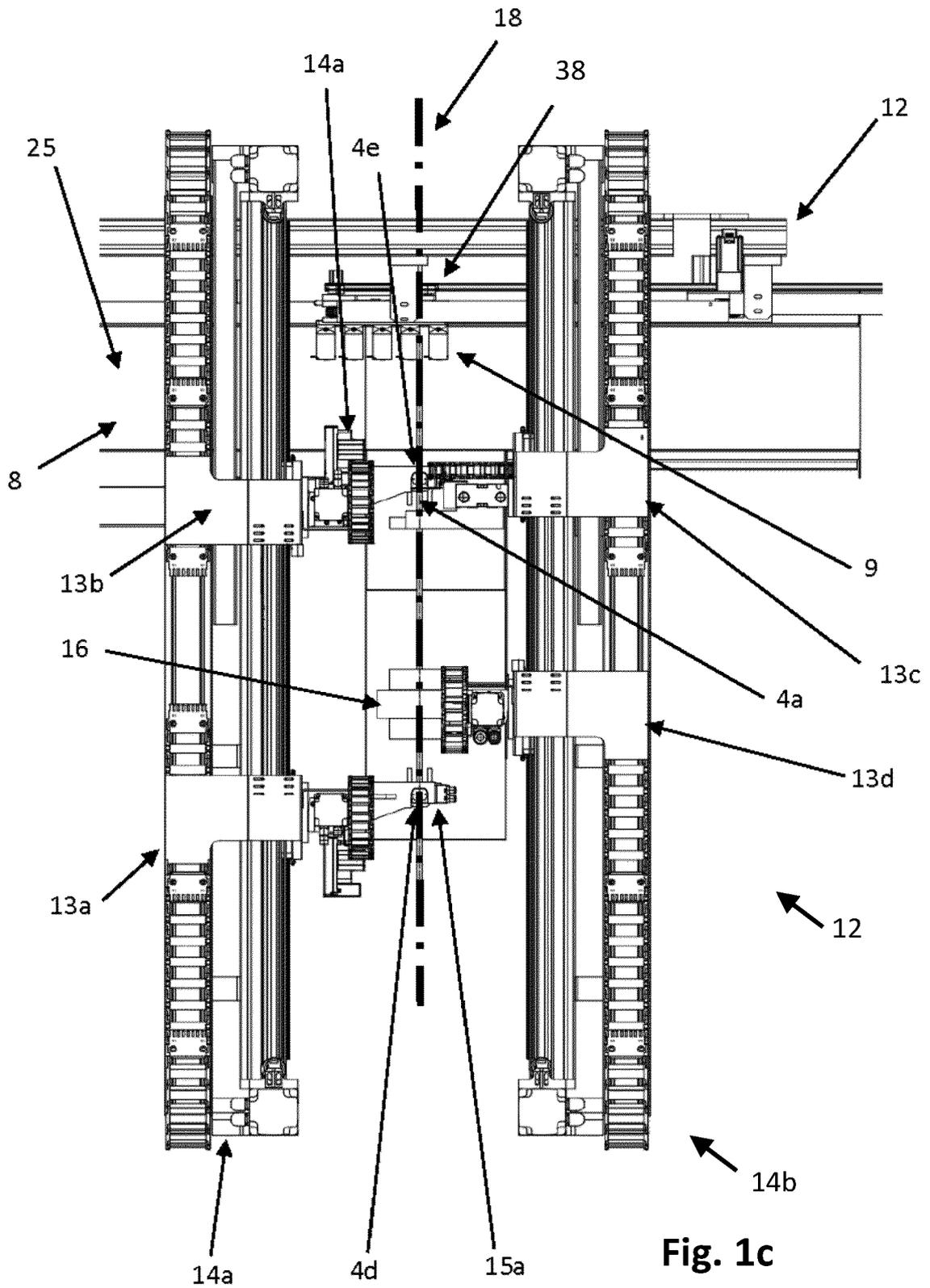
pallet receptor (38)

characterized in that the certain release force (24) is at least 110% or preferably at least 150% of the certain insertion force (23).

18. A set of transport pallet (5) and housing holders (31) for cable end pieces or housings respectively to be used in a wire inserting machine for receiving different housings of different prepared wires or cables wherein said

housing holders have different proper interfaces for respective different housings to be inserted into said housing holders and for being usable in one of the methods according to claims 1 to 11 **characterized in that** all housing holders (31) have a particular common outside geometry adapted to be held by particular automatic grippers (15) of linear drives (13) or of robots so that these grippers (4; 15) may take any and all of those housing holders in the same manner and for that reason in a defined spatial relationship.





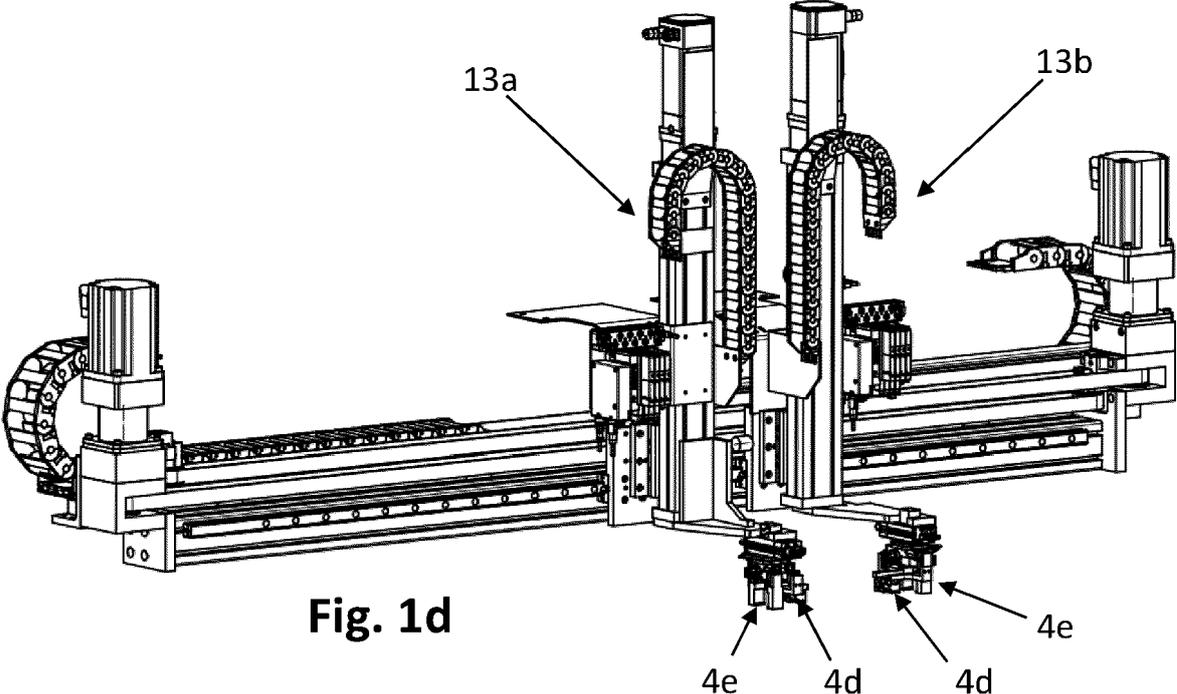


Fig. 1d

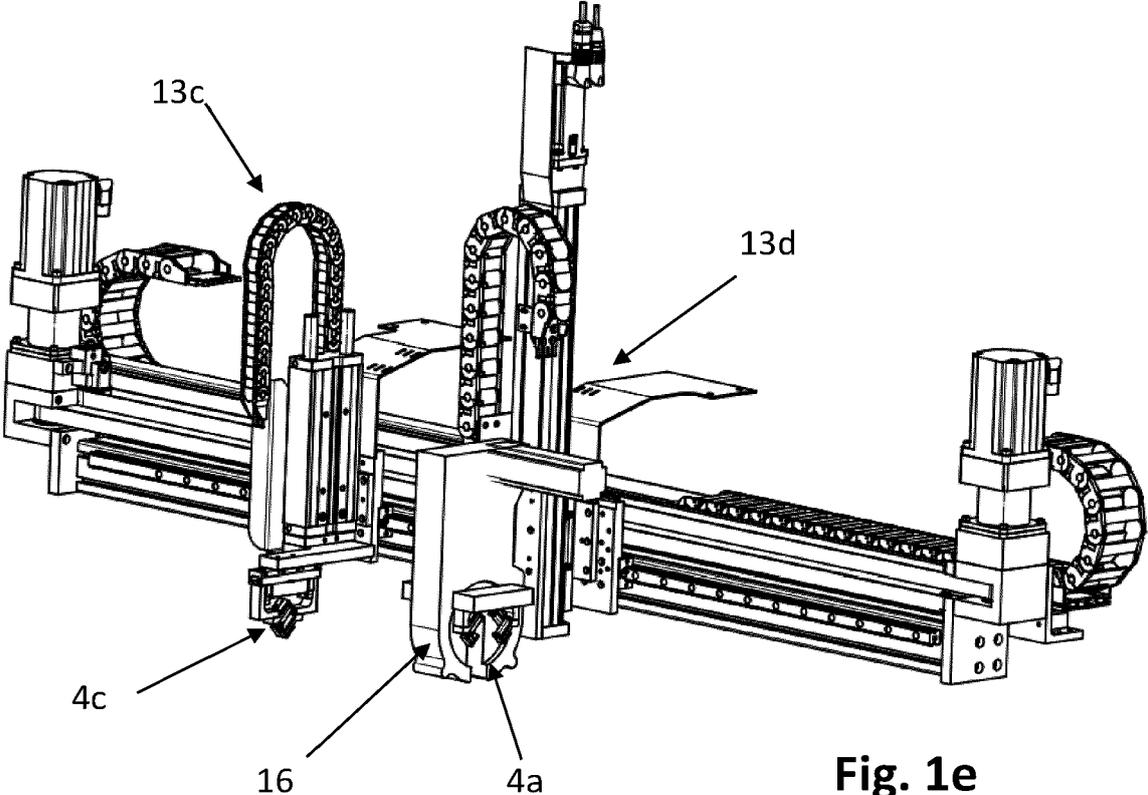
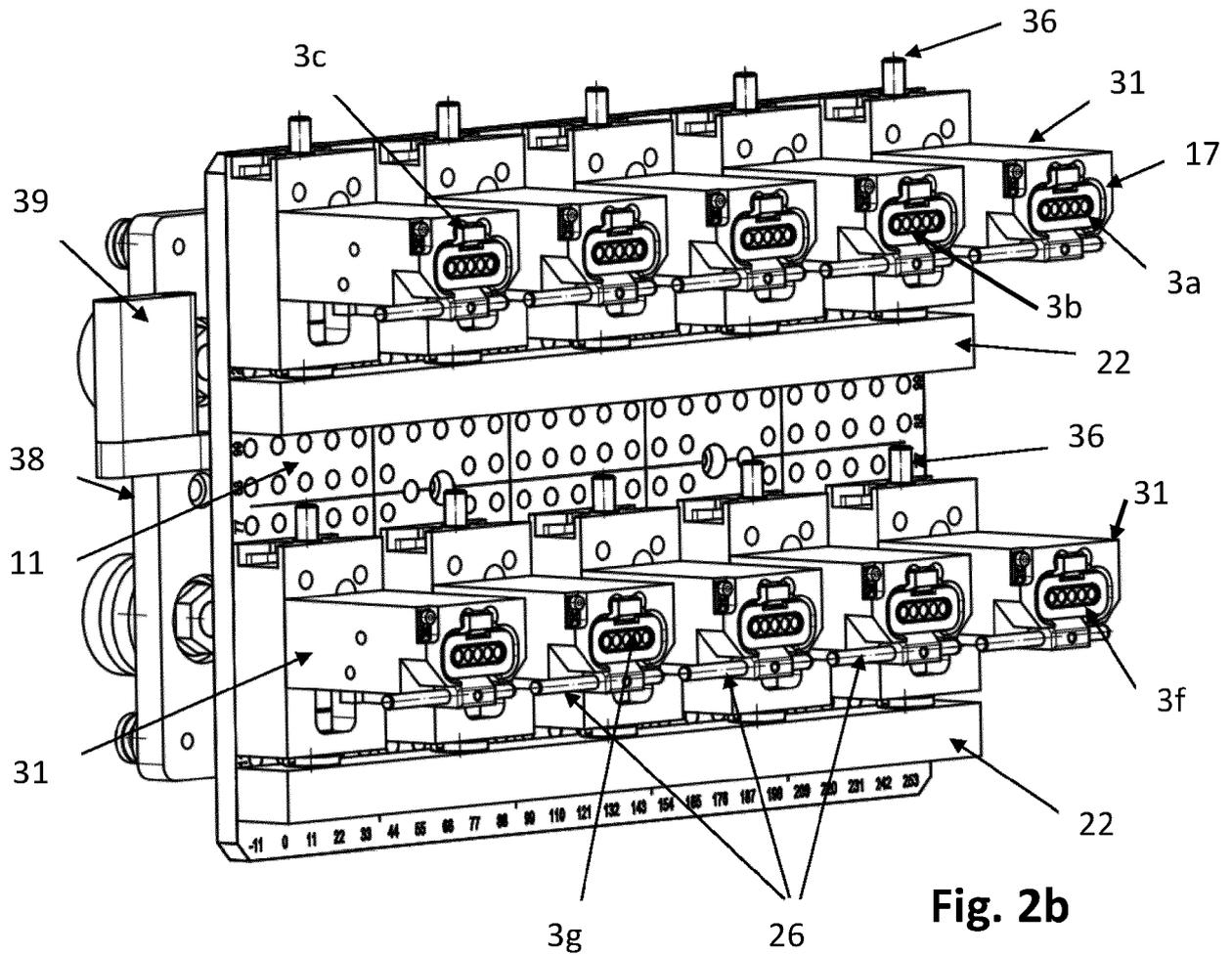
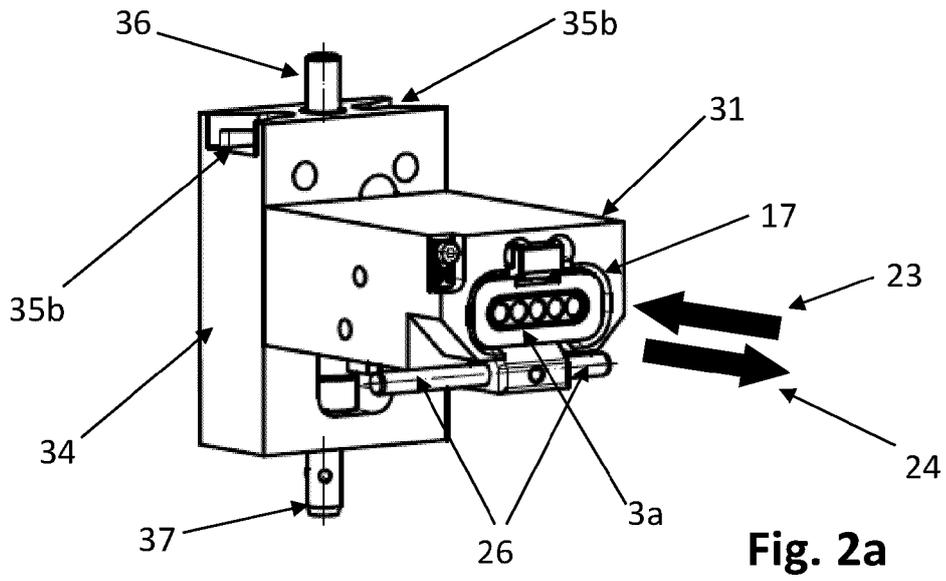
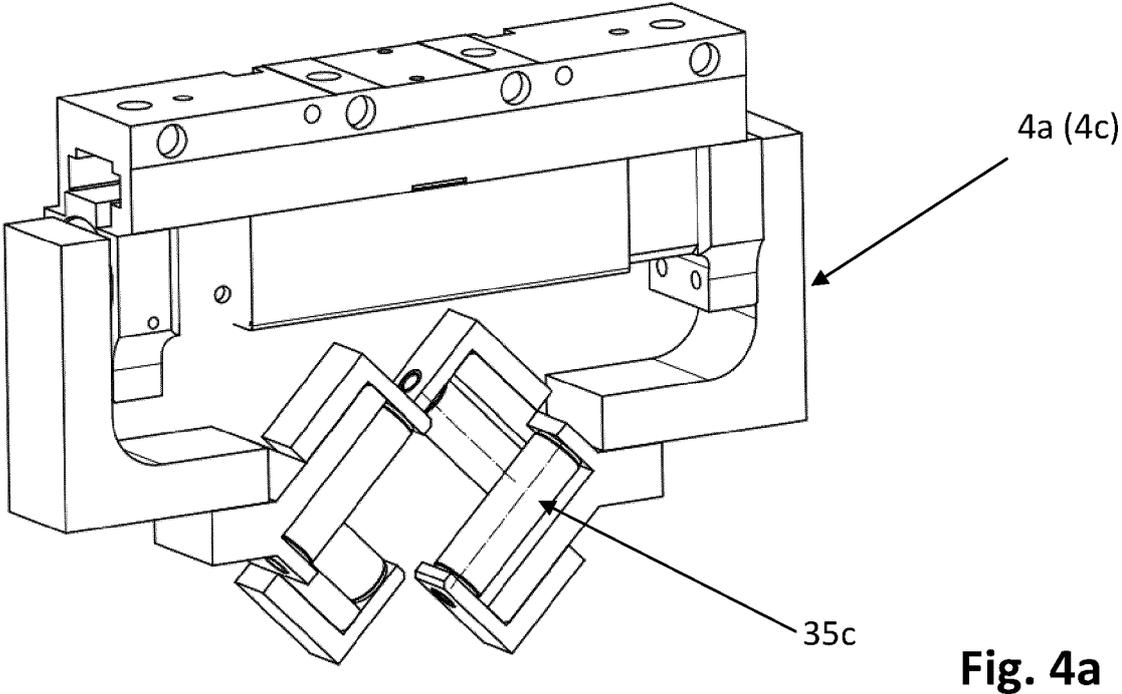
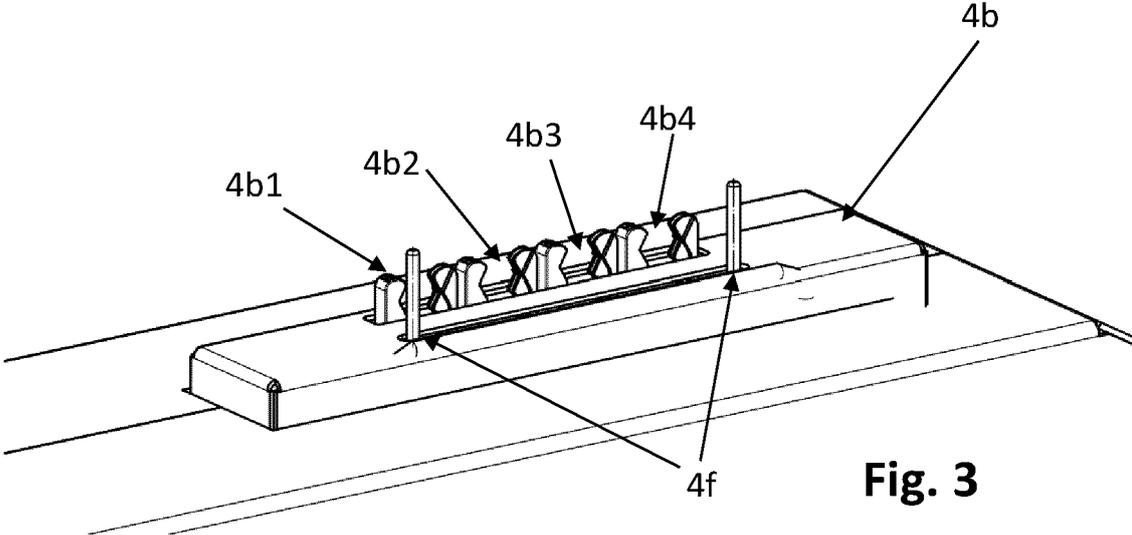
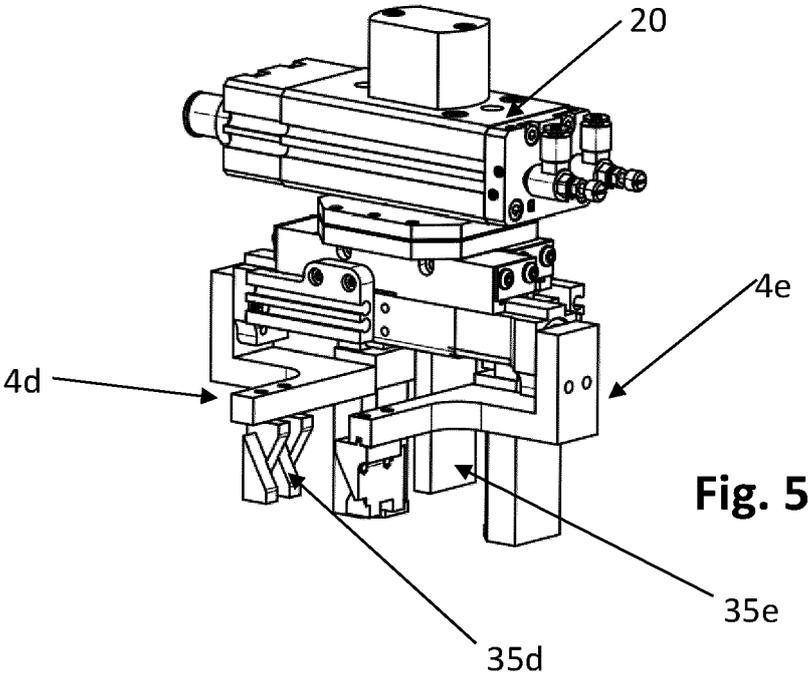
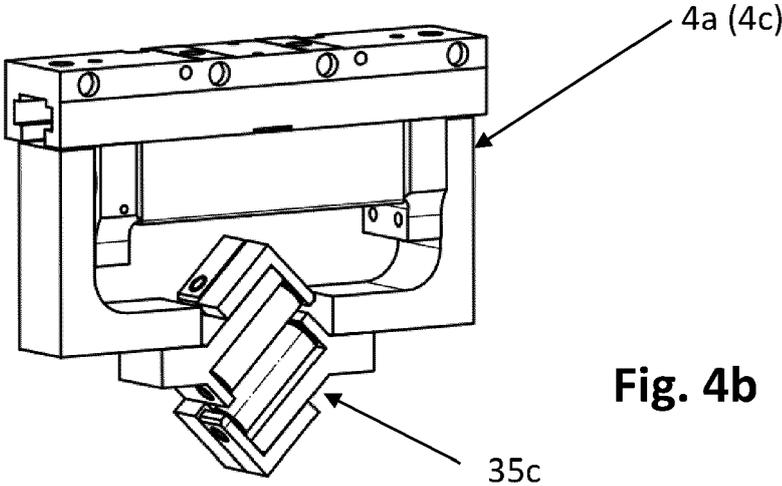


Fig. 1e







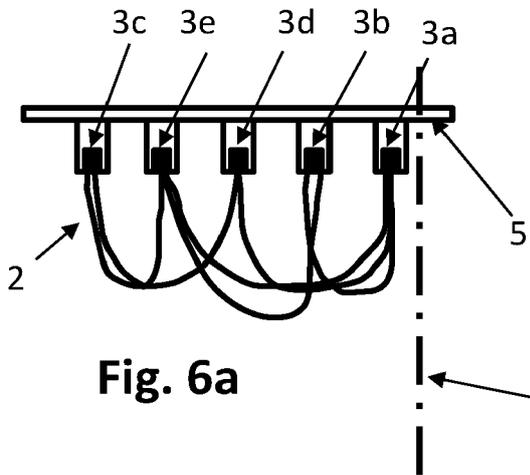


Fig. 6a

Symbols in Fig. 6a to Fig. 6l

-  –straightener module combing 4c
-  –handling gripper 4d
-  –moveable centering pins 4f
-  –clamps of holding module 4b

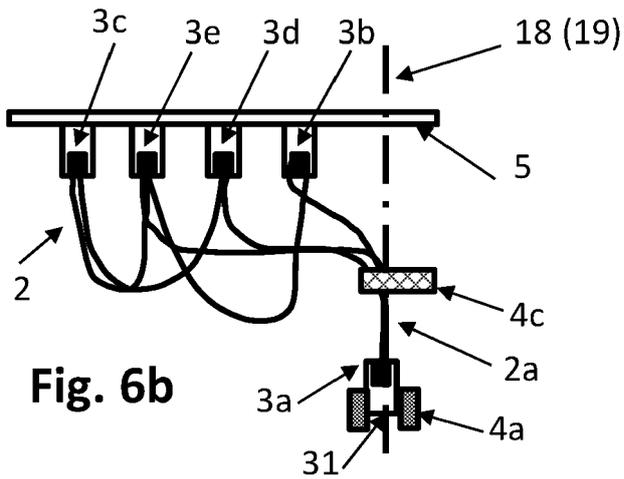


Fig. 6b

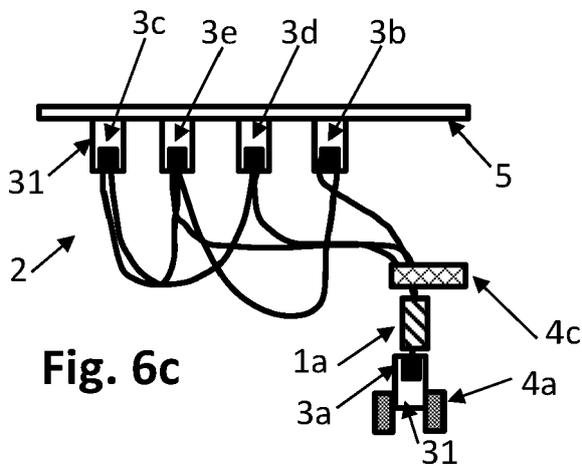
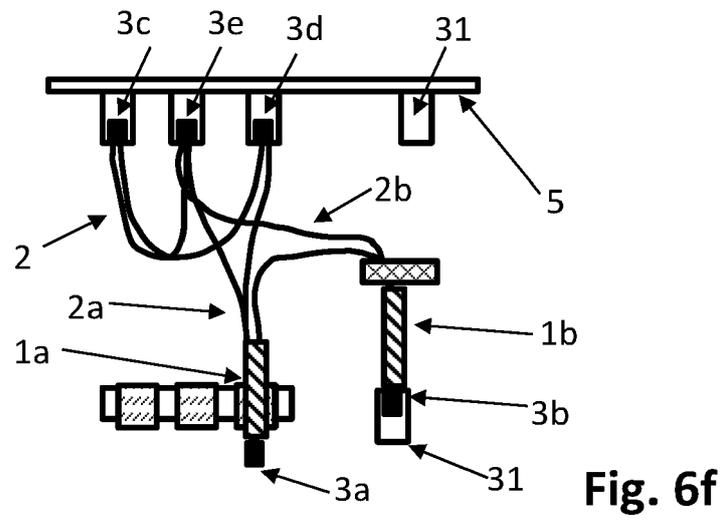
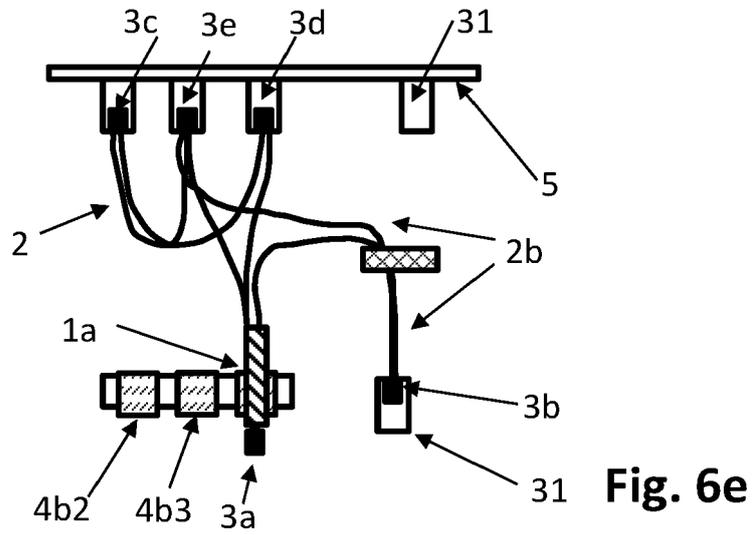
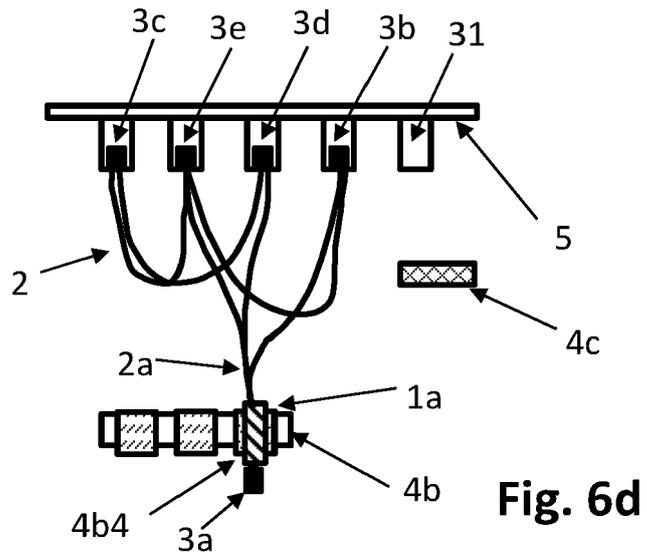
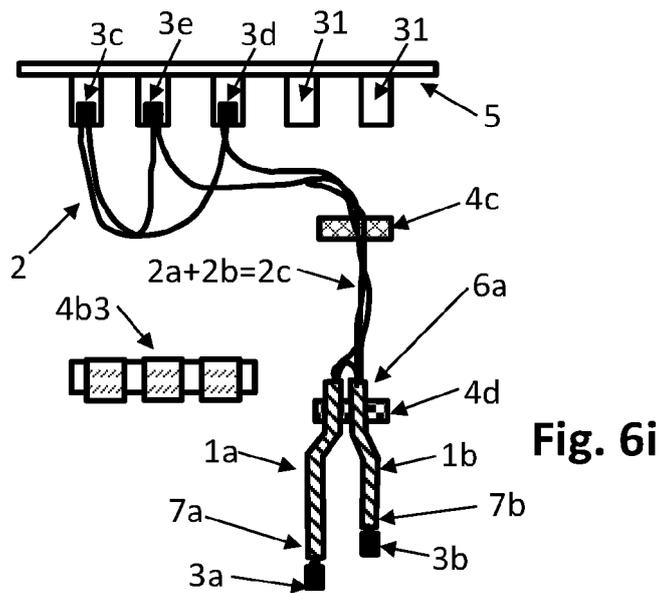
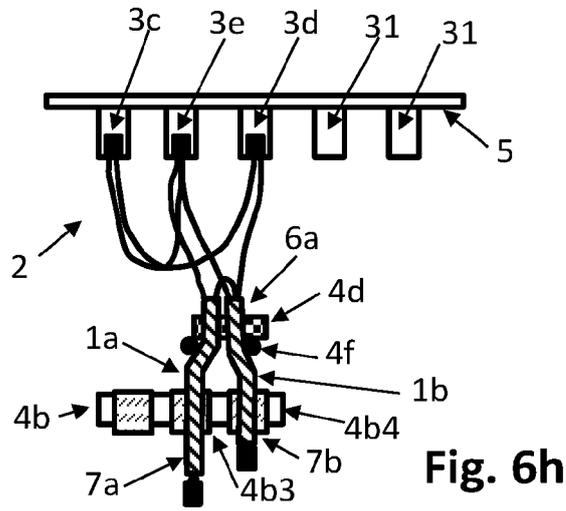
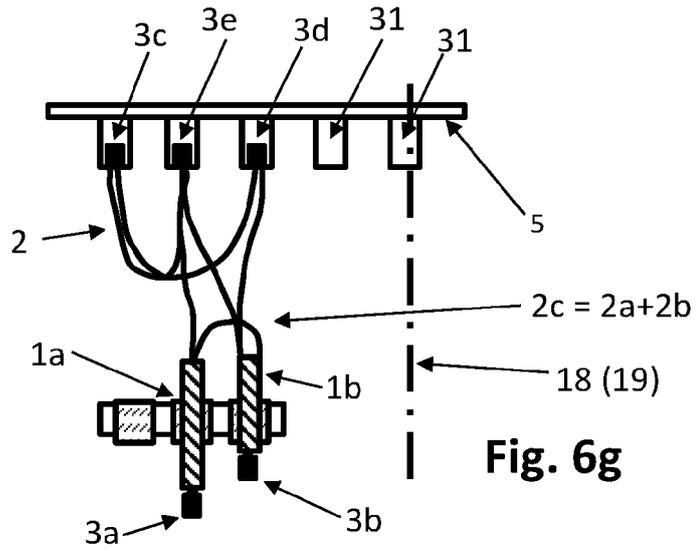


Fig. 6c





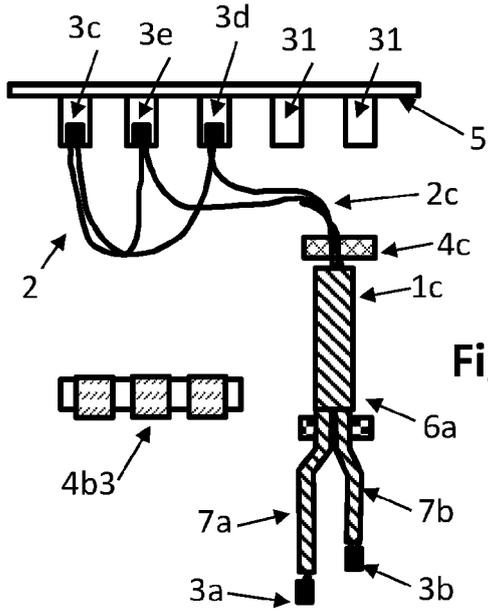


Fig. 6j

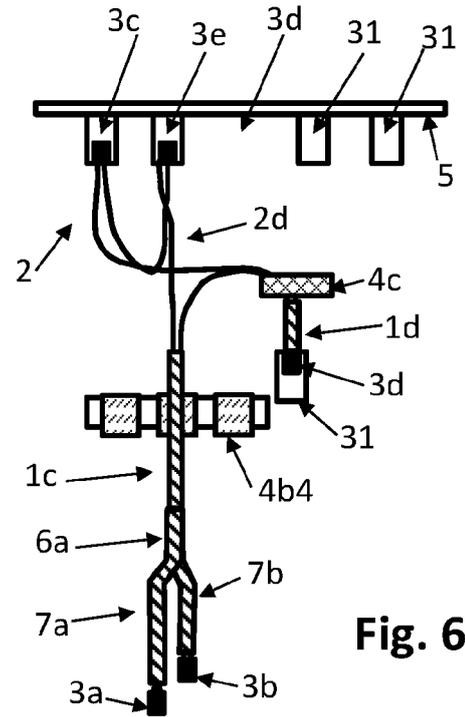


Fig. 6k

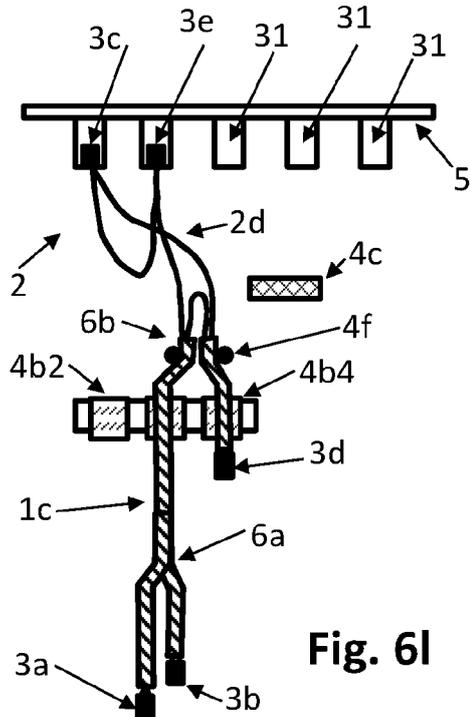
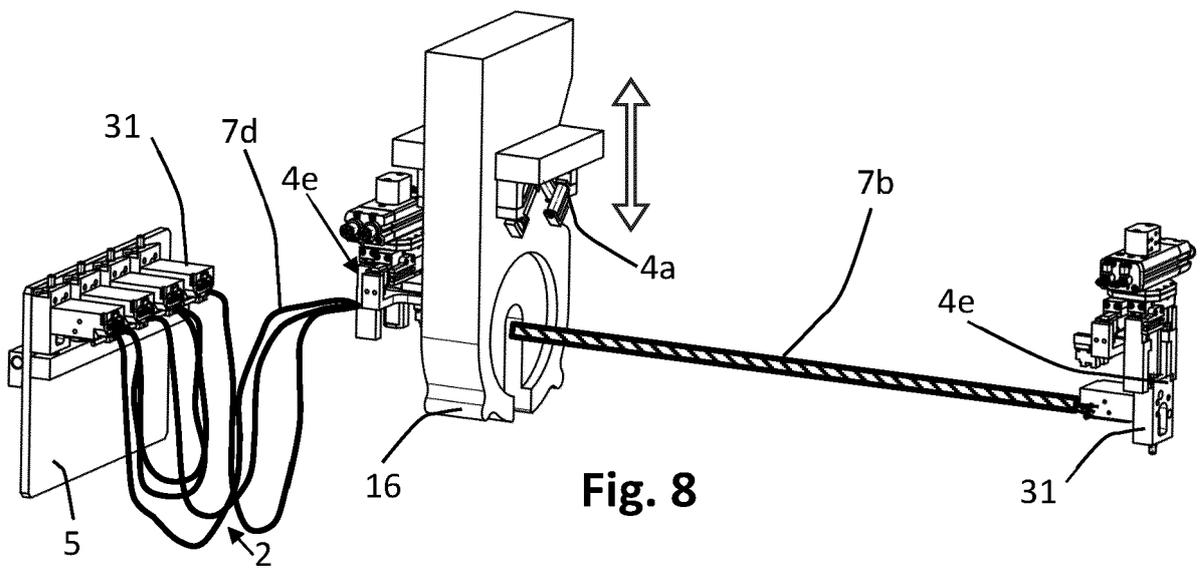
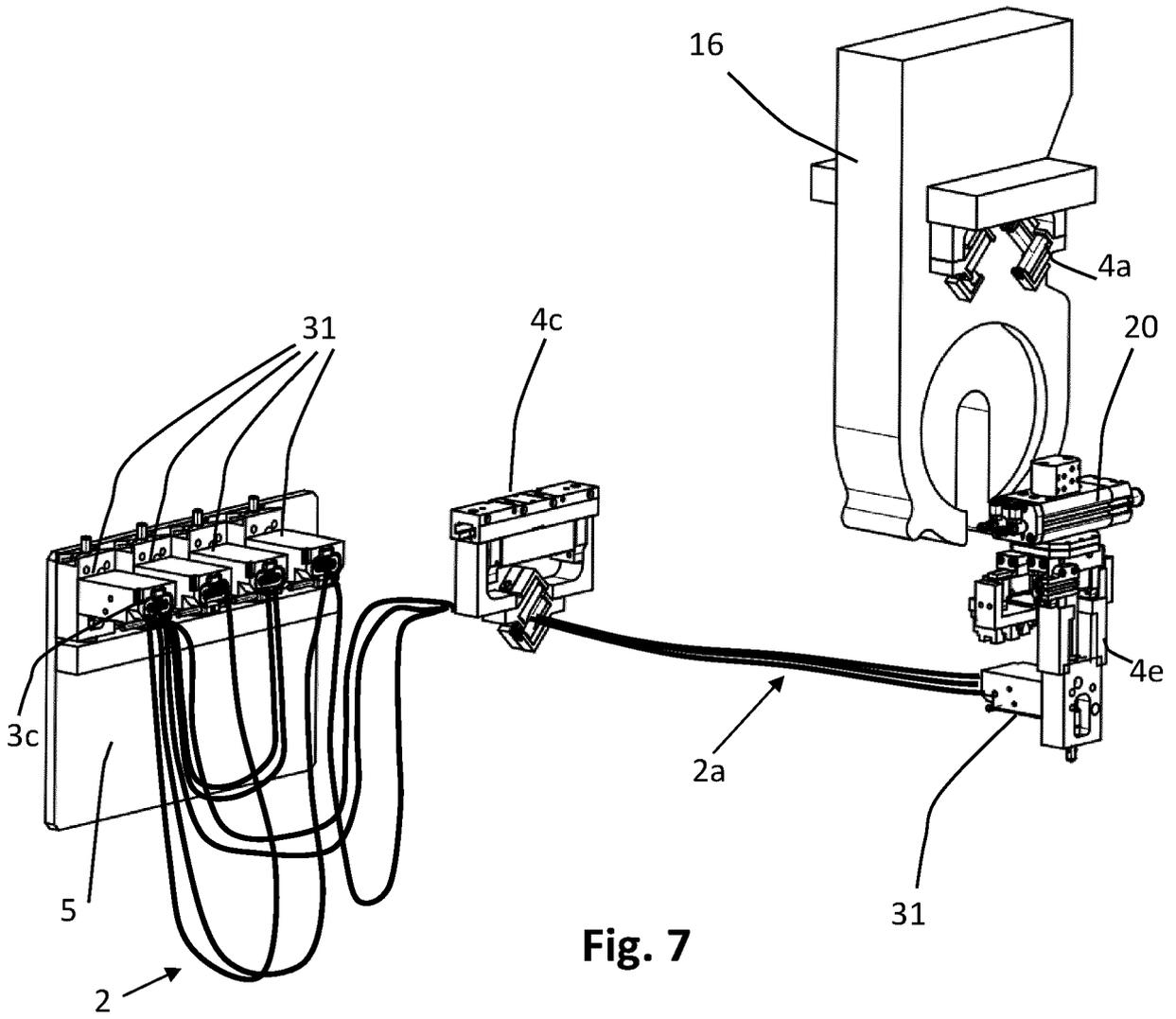


Fig. 6l



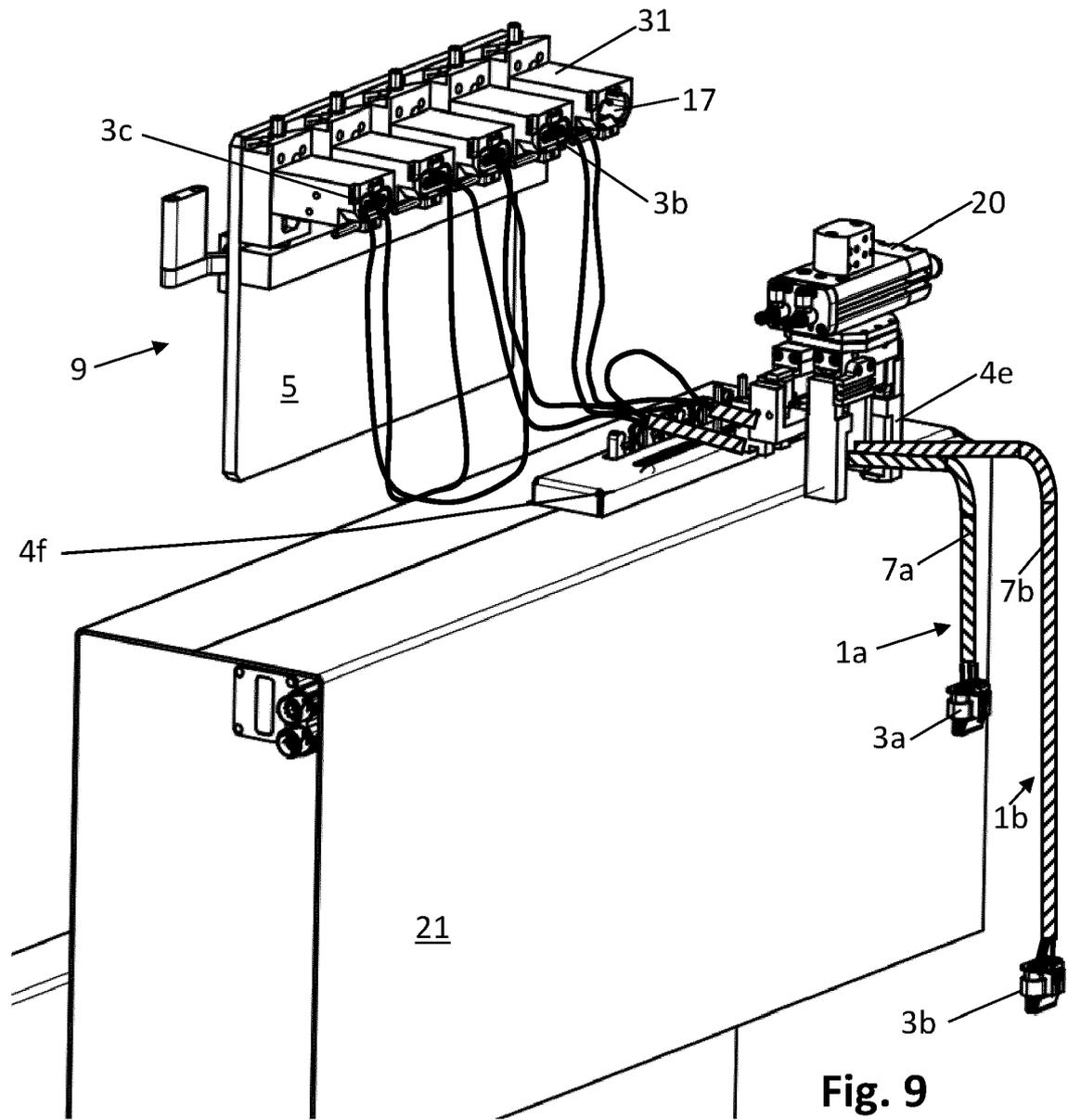


Fig. 9



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Application Number

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A	* figures 3, 20 *	1, 3-14, 17, 18	
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Place of search The Hague		Date of completion of the search 17 May 2024	Examiner Bossi, Paolo
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