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(54) **MACHINE AND INSTALLATION FOR BENDING METAL STRAPPING**

(57) The present invention allows folding in various directions, such as the thickness, width and length of the metal strapping (26). The machine (1) comprises a first frame (2), and first folding stations (3), mounted on the first frame (2) and each configured to perform folding in multiple directions, each folding station (4) comprising a multi-axis folding tool (5) and a servomotor to drive the folding tool (5). The folding tool (5) comprises a hollow outer body (6) and a movable and rotatable inner body (10), with a T-shaped recess with a horizontal slot (13) and a vertical slot (12), suited to the width and the thickness of the strapping (26). The folding tool (5) is replaceably mountable. The first folding stations (3) are movable to automatically go to the area of the strapping (26) on which they must perform the folding.

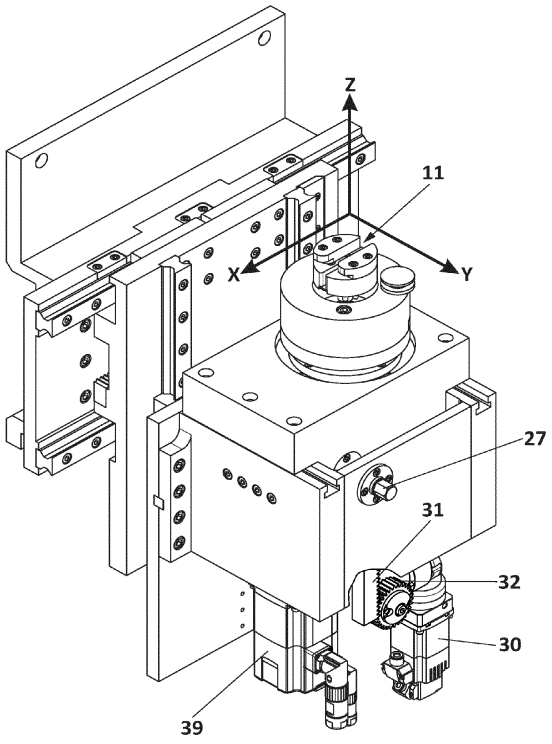

FIG. 4

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Description

OBJECT OF THE INVENTION

[0001] The present invention is included in the technological sector of forming metal strapping by means of folding. Likewise, the invention can also be included in the field of electric batteries. More specifically, the object of the invention relates to a machine, as well as an installation, for bending metal strapping, in particular, that which is used in mobile connectivity, such as, for example, busbar-type connectors for electric batteries.

BACKGROUND OF THE INVENTION

[0002] To fold metal strapping, for example, for busbar-type electrical connectors used to connect battery terminals, machines are used which, in one or more positions, are equipped with heads towards which the strapping to be bent is transferred, to perform bending with respect to axes in the direction of the thickness, width or length of the strapping.

DESCRIPTION OF THE INVENTION

[0003] The present invention describes a machine and an installation for bending metal strapping according to the main claim. The dependent claims describe optional configurations of the machine and/or the installation.

[0004] The invention allows all types of stamping parts to be worked, making folds in any of the directions (thickness, width, longitudinal) of the metal strapping.

[0005] The machine of the invention allows a simple change of measures, providing flexibility in production and efficiency during replacement, due to its interchangeable stations/heads. Likewise, the machine facilitates a higher production speed, since it has movable stations/heads.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Other features and advantages of the invention will become apparent from the description of a preferred but not exclusive embodiment, illustrated by way of non-limiting example in the attached drawings, in which:

Figure 1 shows a general perspective of the machine of the invention.

Figure 2 shows a detailed perspective view of the machine in Figure 1, where the configuration of a folding tool can be seen according to a first exemplary embodiment of a support assembly.

Figure 3 shows another detailed perspective view of the machine in Figure 1, where the configuration of the folding tool can be appreciated, according to a second exemplary embodiment of a support assembly.

Figure 4 shows a detailed perspective view of the machine in Figure 1, where the manual displacement of the folding station in the transverse local direction y can be seen.

Figure 5 shows a detailed perspective view of the machine in Figure 1, in a rotated position, for greater clarity, where the automatic displacement of the folding station in the longitudinal direction x can be seen.

Figure 6 shows a schematic plan view of an installation according to the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0007] A detailed description of a preferred embodiment of a machine (1) for folding metal strapping (26) according to the present invention is offered below, with the help of attached figures 1-6.

[0008] The machine (1) of the invention allows metal strapping (26) to be folded according to axes oriented in three folding directions: folding direction according to thickness, folding direction according to width and longitudinal folding direction. The machine (1) is specially designed to provide the intricate shape characteristic of the busbar connectors used in electric mobility, for example, in modular batteries of electric vehicles.

[0009] The metal strapping (26) can be of the ferrous type, as well as non-ferrous, alloys, etc.

[0010] The machine (1) includes a first frame (2) on which one or more folding stations (3, 4) are mounted, in respective folding positions. The folding station or stations (3, 4) include one or more first folding stations (3), each of which is configured to perform folding in multiple folding directions, such as for example in the folding direction according to the width and in the folding direction according to the thickness of the starting metal strapping (26), as explained below. Preferably, one or more second folding stations (4) configured to carry out folding in the longitudinal folding direction, for example, by means of torsion, can additionally be provided.

[0011] The folding stations (3, 4), at least the first folding stations (3), are movable, by means of displacement means (23, 24, 25, 27). The displacement means (23, 24, 25) in turn comprise automatic displacement means, to automatically direct the folding stations (3, 4), a number of folding stations (3, 4) independently with respect to others, to the area of the strapping (26) on which a fold is required at each moment. The automatic displacement means (23, 24, 25) preferably allow displacement of the folding stations (3, 4), in particular, of the first folding stations (3), along various local displacement directions relative to the tool such that in the direction of longitudinal local displacement (local axis x), and/or in the direction of vertical local displacement (local axis z).

[0012] In this document, the term "local" relates to a

displacement direction or to an axis, considered with respect to a reference system integral to the folding station (3, 4) referred to in each case.

[0013] By way of example, as shown in the figures, the automatic displacement means (23, 24, 25) are of the rack-and-pinion type, wherein, to provide, for example, longitudinal displacement, i.e., along the local axis x, the automatic displacement means (23, 24, 25) have: one or more automatic displacement racks (23), attached to the first frame (2), and arranged in the displacement direction, in this case, in the direction of local axis x; one or several automatic displacement pinions (24) rotatably mounted in the first folding station (3), to engage along the automatic displacement rack(s) (23); and an automatic displacement servomotor (25), which drives the rotation of the automatic displacement pinions (24).

[0014] Additionally, the displacement means (23, 24, 25, 27) can include non-automatic displacement means (27), such as manual displacement means, to displace the folding stations (3, 4) along another of the local displacement directions, such as the transverse local displacement direction, according to the local axis y. The manual displacement means (27) can include a manual regulator (27), for example, a rotary regulator (27) which, when driven, makes it possible to displace the corresponding folding station (3, 4) along the transverse local displacement direction (local axis y), for example, in cooperation with worm screw(s) or pinion(s), not shown in the figures, and with guides (34).

[0015] According to the example just explained, one or more of the folding stations (3, 4), in particular the first folding stations (3), are automatically displaceable towards the strapping (26) during folding operations, along the longitudinal and vertical local displacement directions, while being manually displaceable along the transverse local displacement direction. This makes it possible, with substantial cost and development savings compared to including automatic displacement means (23, 24, 25) in the three local displacement directions, to use the non-automatic displacement means (27) to predefine the position of the folding stations (3, 4) prior to the execution of each series, maintaining the position with respect to the transverse local folding direction for all the pieces folded in the same series, so that, during the folding of each piece, the displacements in the longitudinal and vertical local folding directions are performed automatically.

[0016] The folding stations (3, 4), as can be seen in Figure 1, can be oriented in various ways. For example, it can be seen that a number of folding stations (3, 4) are oriented with their local vertical direction (local axis z) coinciding with the inertial, i.e., "actual", direction z while other folding stations (3, 4) are oriented with said local vertical direction oriented according to the actual longitudinal direction or according to the actual transverse direction. In particular, Figure 1 shows four folding stations (3, 4), which comprise first folding stations (3), located at the ends, and second folding stations (4), located between the first two folding stations (3) wherein, of the first two folding stations (3), the one on the right in Figure 1, has its local axis z oriented in the actual vertical direction, while the one on the left in Figure 1 has its local axis z horizontally oriented. For its part, of the two second folding stations (4), the one on the right is a second folding machine (4) configured to carry out folding only in the thickness folding direction, while the one on the left is a second folding machine (4) configured to carry out folding only in the longitudinal folding direction, by means of torsion, the description of which is beyond the scope of the present invention.

[0017] Each folding station (3, 4) has a folding drive (29, 30, 31, 32) as well as a folding tool (5), which is driven by the folding drive (29, 30, 31, 32), to carry out the folding of the strapping (26). In the particular case of the first folding stations (3), according to the example shown, the folding tool (5) has a particular configuration that allows folding in the width folding direction and in the thickness folding direction. To do this, the folding tool (5) includes:

- an outer body (6), having:
- a vertical hole, oriented in the vertical local displacement direction, and
- a flat upper face (7), preferably perpendicular to the vertical local displacement direction, to support the strapping (26);
- an inner body (10), which is house, for instance coaxially, in the vertical hole, and movable, both rotatably, as well as displaceably in the vertical local displacement direction, along the vertical hole, as well as equipped with an upper head (11) in which a T-shaped recess is defined formed by a vertical slot (12) and a horizontal slot (13), wherein the horizontal slot (13) has a width equivalent to the width of the strapping (26) and the vertical slot (12) has a width equivalent to the thickness of the strapping (26). With this configuration, the folding tool (5) can produce folds in two folding directions: according to the thickness of the strapping (26) and according to the width of the strapping (26).

[0018] In order to produce the aforementioned folds in two directions, the folding tool (5) further incorporates a support assembly (8), adjacent to the inner body (10), and equipped with a support and a horizontal groove (9) to, by coaxial rotation of the head (11), carry out the folding in the direction of the thickness in contact with the groove (9), in a lowered position, with the strapping (26) housed in the horizontal slot (13), as well as to perform the folding in the direction of the width of the strapping (26), by coaxial rotation of the head (11), in a raised position, in contact with the support of the support assembly (8), with the strapping (26) housed in the vertical slot (12). The coaxial vertical local displacement of the inner body (10) allows switching between the raised position and the lowered position in which the horizontal slot (13) of

the inner body (10) and the groove (9) of the outer body (6) are levelled.

[0019] The folding drive (29, 30, 31, 32) is responsible for driving both the rotation of the head (11), for example, by means of a rotation servomotor (29) that is coaxial with the rotation of the head (11), as well as the vertical displacement of the inner body (10), for example, by means of a folding displacement servomotor (30), a folding displacement rack (31) and one or more folding displacement pinions (32). Two illustrative exemplary embodiments of the support assembly (8) are described below.

[0020] According to a first exemplary embodiment, represented in Figure 2A, the support assembly (8) comprises a support roller (35), having a cylindrical configuration, which protrudes from the upper face (7) of the outer body (6), and which includes the groove (9) in a perimeter location around the support roller (35). In this case, the support is ideally a linear support along a generatrix of the support roller (35).

[0021] According to a second exemplary embodiment, represented in Figure 2B, the support assembly (8) comprises a support block (36), having a prismatic configuration, and which protrudes from the upper face (7) of the outer body (6), wherein the support is ideally a surface support on one or more flat faces (28) that define the support block (36), and wherein the groove (9) is made on the flat faces (28) that serve as support.

[0022] As seen in the attached figures, which illustrate the described preferred embodiments, the folding tool (5), in particular its components, as described below, are replaceably mounted on the folding station (3, 4), for example, by means of bolted joints (33). In particular, by way of example, two first removable parts (14) are spaced apart defining the vertical slot (12), and on which are mounted, also separably, two second removable parts (15) that are spaced apart defining the horizontal slot (13). In this way, by assembling and disassembling (for example, screwing and unscrewing) the first (14) and second (15) parts, the folding tool (5) is configured to fold in the thickness direction and in the width direction of a strapping (26) of determined thickness and width dimensions. The cost of a folding tool (5) formed by removable parts is substantially lower.

[0023] As regards the support assembly (8), it is also expected to be replaceable. Optional solutions are described below for the case of the two examples described above.

[0024] With respect to the first example, with a cylindrical support roller (35) with linear support along the generatrix, the support roller (35) can be attached to, or form part of, a support rod (37), which is threaded, which passes through the outer body (6) and is held by one or more nuts (38). Preferably, the support rod (37) can be additionally screwed into the outer body (6).

[0025] Regarding the second example, with a prismatic support block (36) with superficial support on the flat faces (28), bolted joints (33) are included, as shown in Figure 3.

[0026] At least the first folding stations (3) are displaceable, both in a horizontal plane, as well as in the vertical direction, as explained before, to directly access the position of the strapping (26) where the folding must take place, facilitating the consequent saving of time in folding operations.

[0027] The described folding machine (1) forms part of an installation (16) in which additional operations can be carried out on the strapping (26), as described below. In particular, the installation can include one or more die cutting machines (17), preferably two die cutting machines (17) in parallel, to punch with the required accuracy a hole (not shown) in a predetermined manner in each of the ends of the strapping (26) already folded, which serve to connect corresponding terminals of modular electric batteries. Likewise, the installation (16) can also include a cutting station (18), for example, laser and/or mechanical cutting, to remove from the ends of the strapping (26), if applicable, a sheet of insulating electric material that covers the strapping (26). Moreover, the installation (16) can also include a cleaning station (19), where the finished strapping (26) is subjected to degreasing, based on predetermined cleaning conditions.

[0028] According to a particularly preferred example of the invention, the installation (16) also comprises a pressing station (20), where the metal strapping (26) is obtained by pressing from starting metal material. The pressing station (20) comprises a second frame (21), which supports one or more presses (22) each equipped with a servomotor (not shown) that can be independently controlled, to provide pressing force, for example, of 30 tons for each press, jointly or separately. The presses preferably comprise screws (not shown) to transfer the pressing force from the servomotors.

List of elements

[0029]

1	Folding machine
2	First frame
3	First folding stations
4	Second folding stations
5	Folding tool
6	Outer body
7	Upper face
8	Support assembly
9	Groove
10	Inner body
11	Head
12	Vertical slot
13	Horizontal slot
14	First parts
15	Second parts
16	Installation
17	Die cutting machines
18	Cutting station

19 Cleaning station
20 Pressing station
21 Second frame
22 Presses
23 Automatic displacement racks
24 Automatic displacement pinions
25 Automatic displacement servomotor
26 Strapping
27 Manual regulator
28 Flat faces
29 Rotation servomotor
30 Folding displacement servomotor
31 Folding displacement rack
32 Folding displacement pinions
33 Bolted joints
34 Guides for transverse displacement
35 Support roller
36 Support block
37 Support rod
38 Nuts

Claims

1. A machine (1) for folding metal strapping (26), **characterised in that** it comprises:

- first frame (2); and
- one or more folding stations (3, 4) mounted in respective folding positions of the first frame (2), wherein the folding stations (3, 4) comprise first folding stations (3) each configured to perform folds in multiple directions, wherein each first folding station (3) comprises:

  - a multi-axis folding tool (5); and
  - a folding drive (29, 30, 31, 32) to drive the folding tool (5).

2. The machine (1) for folding metal strapping (26) according to claim 1, wherein the folding tool (5) comprises:

- an outer body (6), having: a vertical hole oriented in a vertical local displacement direction; and a flat upper face (7) for supporting the strapping (26);
- an inner body (10), coaxially housed in the vertical hole, and movable, both rotatably, as well as displaceably in the vertical local displacement direction, along the vertical hole, as well as equipped with an upper head (11) in which a T-shaped recess is defined formed by a vertical slot (12) and a horizontal slot (13), wherein the horizontal slot (13) has a width equivalent to the width of the strapping (26) and the vertical slot (12) has a width equivalent to the thickness of the strapping (26).

3. The machine (1) for folding metal strapping (26) according to claim 2, wherein the folding tool (5) additionally comprises a support assembly (8), adjacent to the inner body (10), and equipped with a support and a horizontal groove (9) for, by coaxial rotation of the head (11), carrying out the folding in the thickness direction in contact with the groove (9), in a lowered position, with the strapping (26) housed in the horizontal slot (13), as well as for performing the folding in the width direction of the strapping (26) by coaxial rotation of the head (11), in a raised position, in contact with the support of the support assembly (8), with the strapping (26) housed in the vertical slot (12).

4. The machine (1) for folding metal strapping (26) according to claim 3, wherein the support assembly (8) comprises a support block (36), having a prismatic configuration, and which protrudes from the upper face (7) of the outer body (6), wherein the support is a surface support on one or more flat faces (28) that define the support block (36), and wherein the groove (9) is made on the flat faces (28) that serve as support.

5. The machine (1) for folding metal strapping (26) according to claim 3, wherein the support assembly (8) comprises a support roller (35), having a cylindrical configuration, which protrudes from the upper face (7) of the outer body (6), and which includes the groove (9) in a perimeter location around the support roller (35), wherein the support is a linear support along a generatrix of the support roller (35).

6. The machine (1) for folding metal strapping (26), according to any of claims 3 to 5 wherein, in the lowered position, the horizontal slot (13) and the groove (9) are levelled.

7. The machine (1) for folding metal strapping (26), according to any of claims 1 to 6, wherein the folding tool (5) is replaceably mounted in the folding station (3, 4), such as by means of bolted joints (33).

8. The machine (1) for folding metal strapping (26), according to claims 2 and 7 simultaneously, wherein the inner body (10) comprises:

- two first removable parts (14) which are spaced apart defining the vertical slot (12), and
- two second removable parts (15), which are spaced apart defining the horizontal slot (13), and which are detachably mounted on the first parts (14).

9. The machine (1) for folding metal strapping (26), according to claims 4 and 7 simultaneously, wherein the support roller (35) is attached to, or forms part

of, a threaded support rod (37), which passes through the outer body (6) and is held by one or more nuts (38).

10. The machine (1) for folding metal strapping (26), according to any of claims 1 to 9, wherein at least the first folding stations (3) are displaceable, in at least one local displacement direction, preferably in two local displacement directions, by means of automatic displacement means (23, 24, 25), configured to automatically direct said first folding stations (3), a number of first folding stations (3) independently with respect to others, to the area of the strapping (26) on which a fold is required at each moment.

11. The machine (1) for folding metal strapping (26), according to claim 10, wherein the automatic displacement means (23, 24, 25) comprise:

- one or several automatic displacement racks (23), attached to the first frame (2), and arranged in the local displacement direction;
- one or more automatic displacement pinions (24), rotatably mounted in the first folding station (3), to engage along the automatic displacement rack(s) (23); and
- an automatic displacement servomotor (25), to drive the rotation of the automatic displacement pinions (24).

12. The machine (1) for folding metal strapping (26), according to any of claims 1 to 9, wherein the folding stations (3, 4) are displaceable in one of the local displacement directions, by means of non-automatic displacement means (27), for example, manual displacement means, which include a manual regulator (27), for example, a rotary regulator (27) which, when driven, makes it possible to displace the corresponding folding station (3, 4) along the aforementioned transverse local displacement direction, for example, in cooperation with worm screw(s) or pinion(s), and/or with guides (34).

13. An installation (16) for folding metal strapping (26), **characterised in that** it includes the folding machine (1) as described in any of claims 1 to 12.

14. The installation (16) according to claim 13, further comprising a cleaning station (19) to degrease the strapping (26).

15. The installation (16) according to any of claims 13 to 14, further comprising a pressing station (20), to obtain the metal strapping (26) by pressing from starting metal material, wherein the pressing station comprises a second frame (21), which supports one or more presses (22), each equipped with an independently controlled servomotor, to provide pressing force jointly or separately.

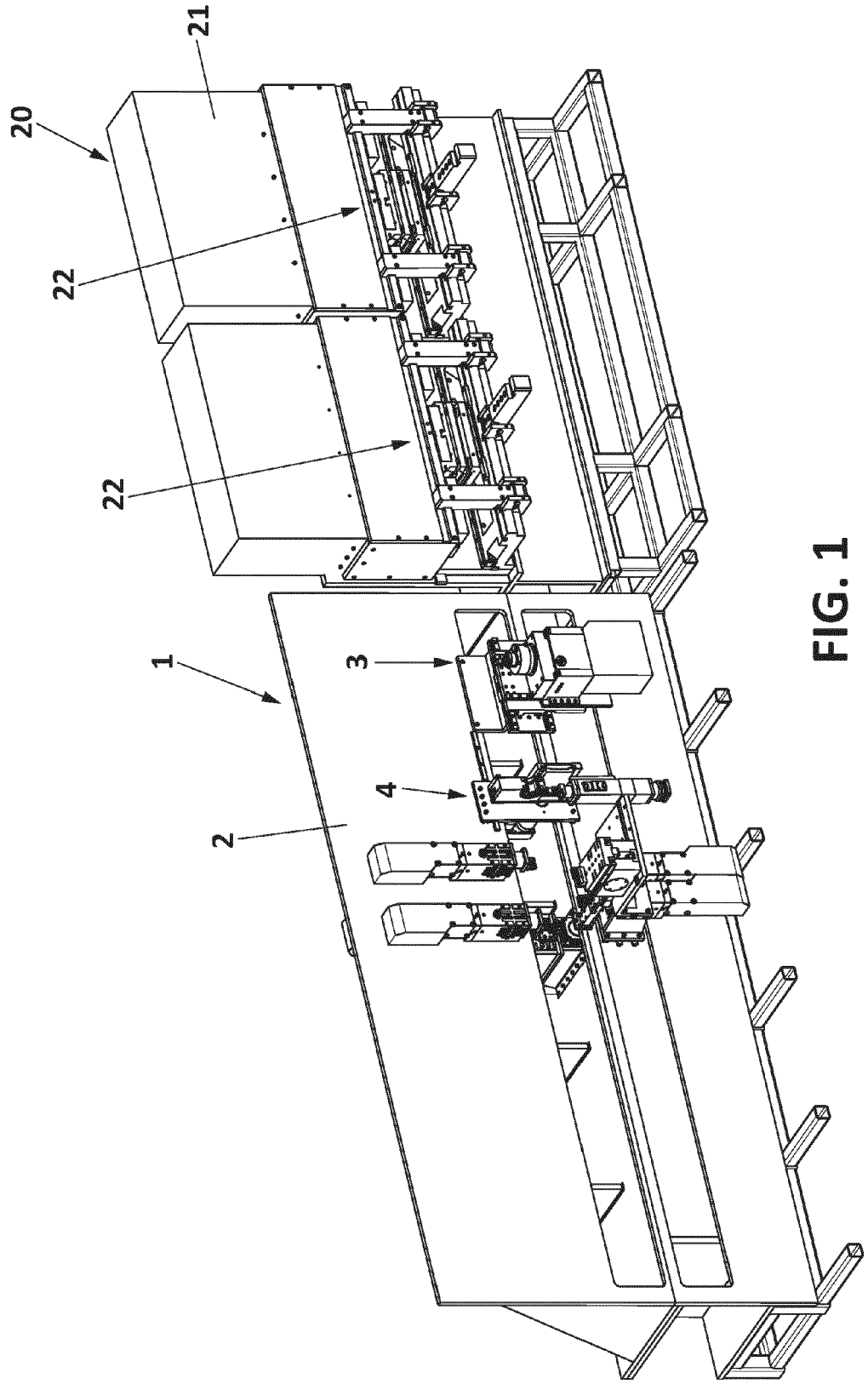

FIG. 1

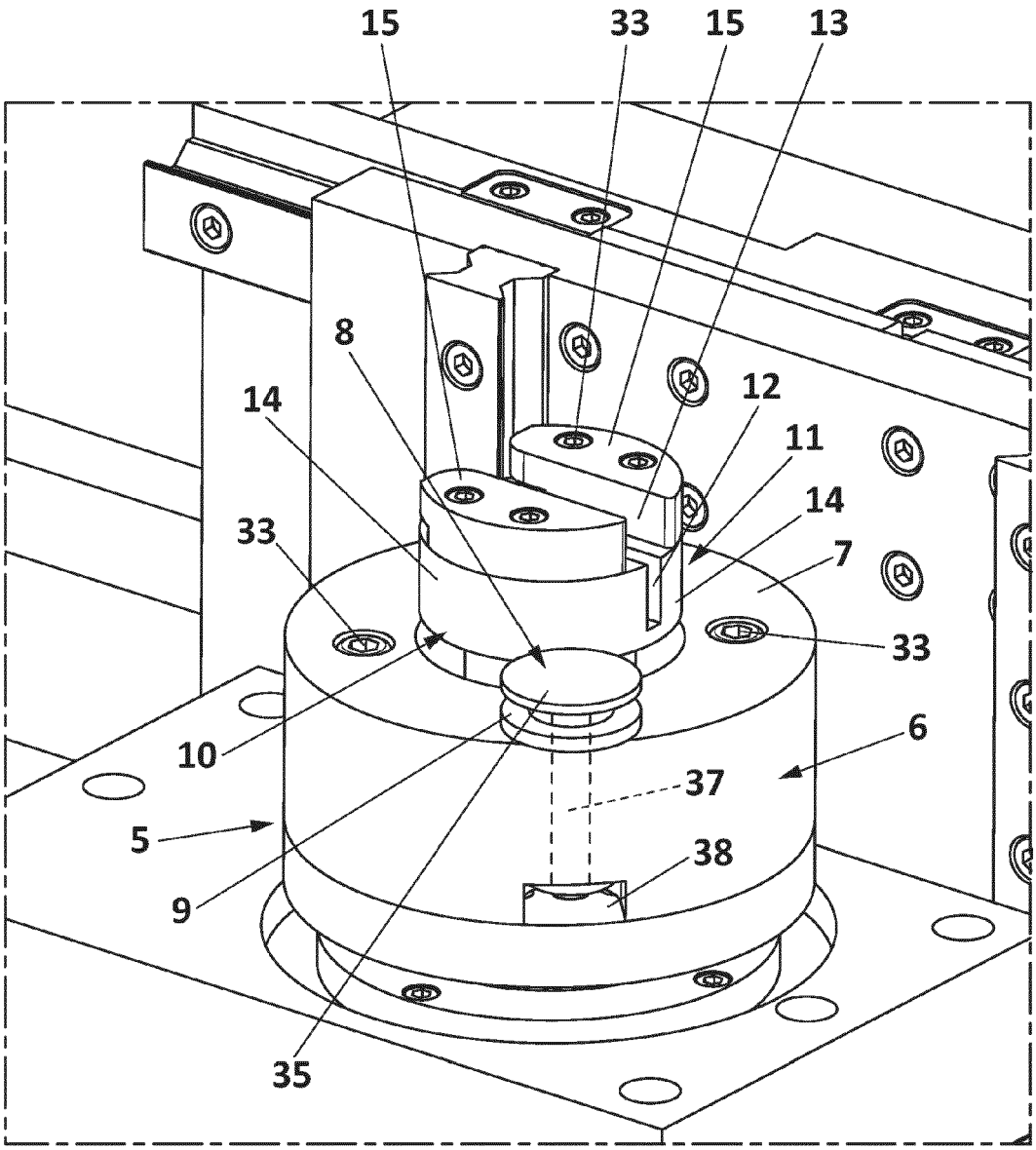

FIG. 2

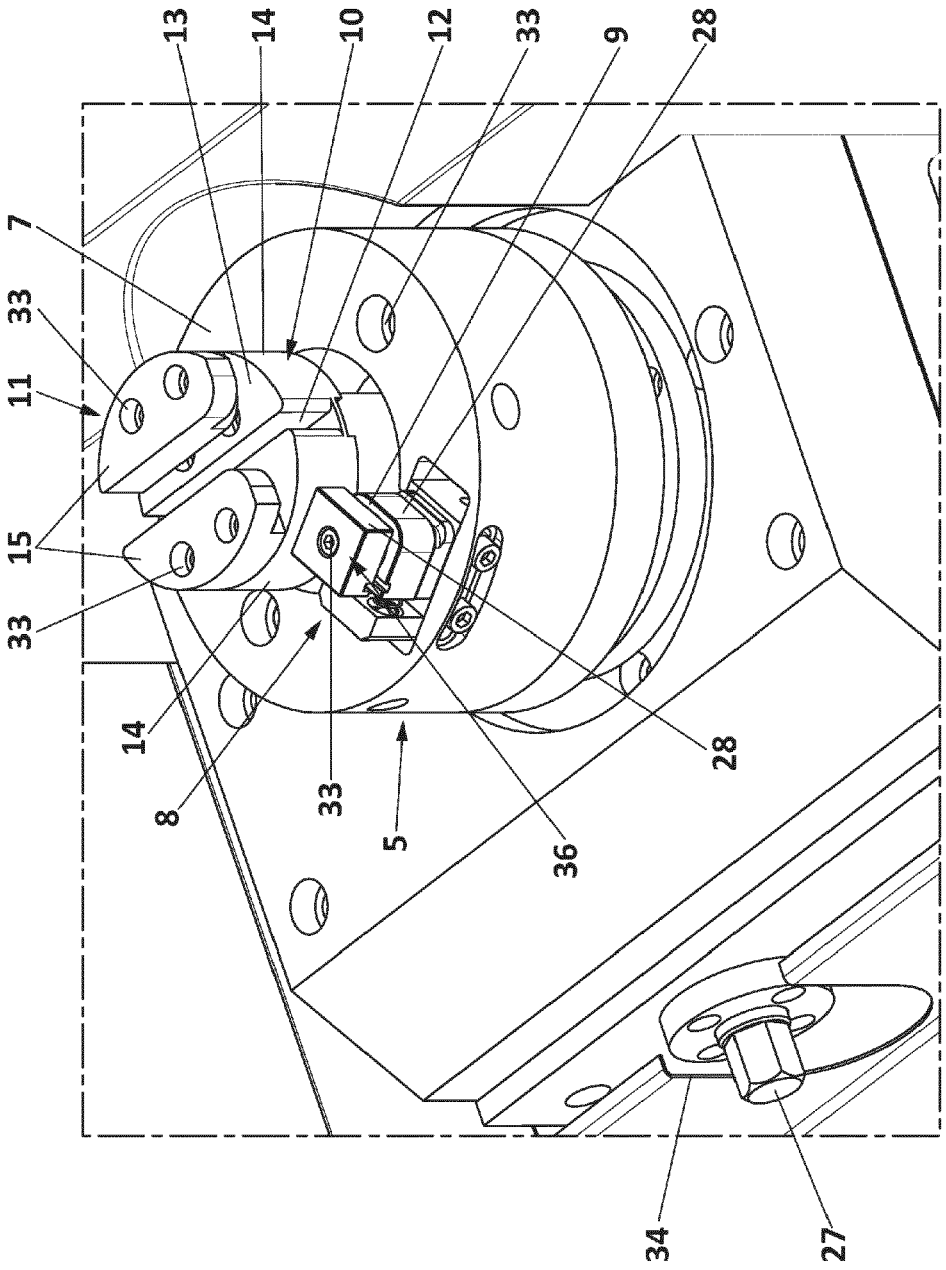

FIG. 3

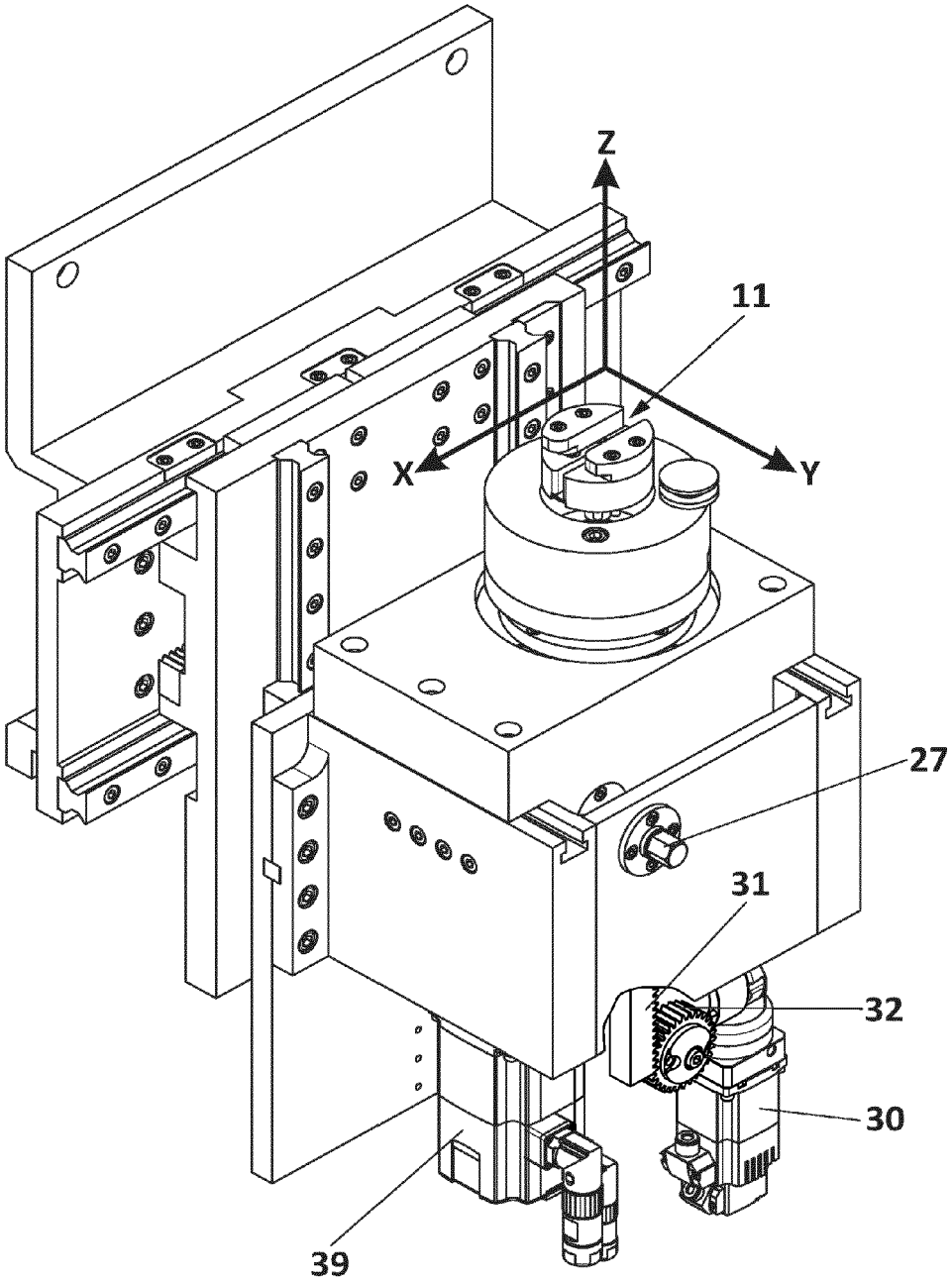

FIG. 4

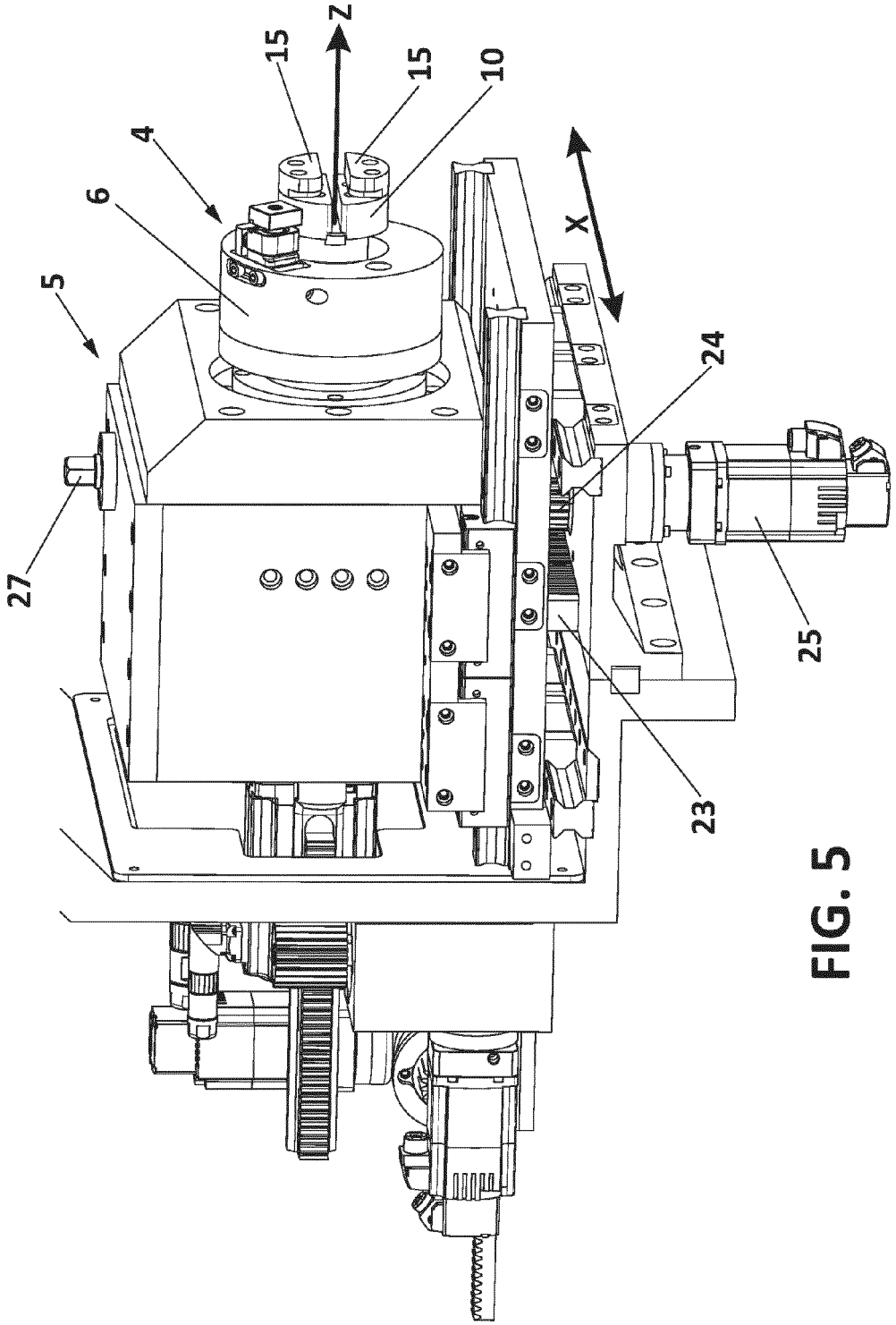

FIG. 5

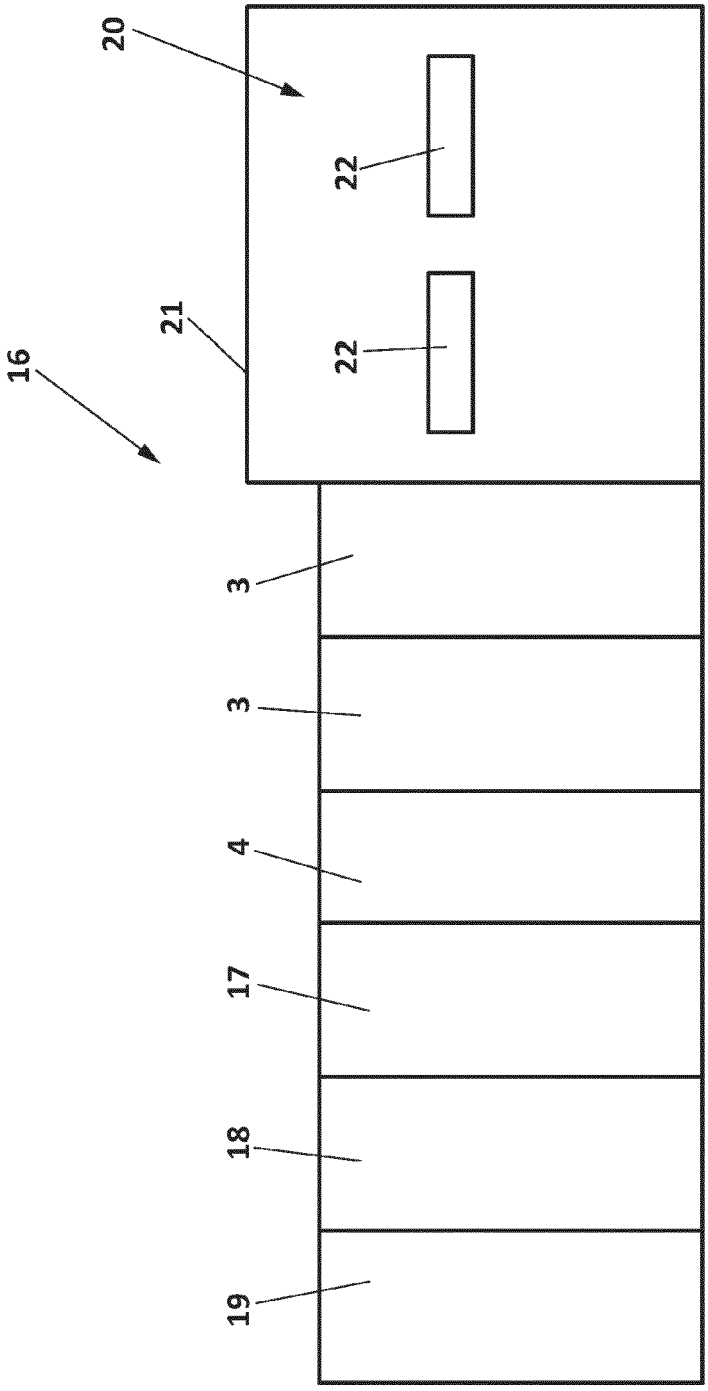

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 38 2152

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	Wafios Aktiengesellschaft: "BMF 60: Automized Busbar Production / Vollautomatisierte Stromschienen-Fertigung", , 25 March 2021 (2021-03-25), XP093067368, Retrieved from the Internet: URL:https://www.youtube.com/watch?v=2NoF3ges9Hw&ab_channel=WAFIOSAktiengesellschaft [retrieved on 2023-07-25] * the whole document *	1-15	INV. B21D7/024 B21D7/04 B21D22/02 B21D35/00 B21D43/28 B21F1/00 H01R43/16 B21D53/00 H02G5/00
X	Cinderellon Wang: "Copper busbar production - YouTube", , 19 August 2022 (2022-08-19), XP093067373, Retrieved from the Internet: URL:https://www.youtube.com/shorts/tQG3bchgTgE [retrieved on 2023-07-25] * the whole document *	1-15	
X	BLM Group: "Bending and twisting machine for copper busbars ¦ BLM GROUP", , 25 June 2022 (2022-06-25), XP093067376, Retrieved from the Internet: URL:https://www.youtube.com/watch?v=7ynpOYn1SXg&ab_channel=BLMGROUP [retrieved on 2023-07-25] * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) B21D H01R B21L B21F H02G
X	DE 10 2018 209883 A1 (WAFIOS AG [DE]) 19 December 2019 (2019-12-19) * figures 1-4 *	1-15	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 July 2023	Stanic, Franjo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	DE 10 2018 209889 B3 (WAFIOS AG [DE]) 14 November 2019 (2019-11-14) * figures 1, 2 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 July 2023	Stanic, Franjo

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L : document cited for other reasons

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