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(54) **FOLDING APPARATUS AND PACKAGING MACHINE HAVING A FOLDING APPARATUS**

(57) There is described a folding apparatus (16) for producing finalized packages (2) from semi-finalized packs (5) and comprising a plurality of retaining pockets (32) and a conveying device (33) configured to advance the retaining pockets (32). Each retaining pocket (32) comprises a respective fin folding device (48) configured to fold a respective sealing fin (8) of the semi-finalized package (5) from an unfolded position to a folded position in which the sealing fin (8) is folded onto and/or towards a central main body (9) of the semi-finalized package (5). Each fin folding device (48) comprises a free space (49) for receiving the sealing fin (8) in the unfolded position at the receiving station (34) and a folding element (50) moveable between a rest position in which the folding element (50) frees the free space (49) and an active position in which the folding element (50) interacts with the sealing fin (8) for moving the sealing fin (8) to the folded position. The folding apparatus (16) further comprises an actuation unit (51) configured to set the folding element (50) in the rest position at the receiving station (34) and to move the folding element (50) from the rest position to the active position during advancement of the respective retaining pocket (32) from the receiving station (34) and along the endless path (R).

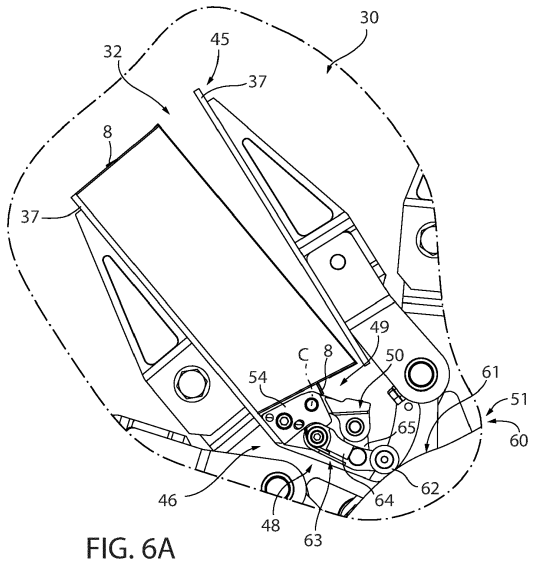

FIG. 6A

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Description

TECHNICAL FIELD

[0001] The present invention relates to a folding apparatus for folding semi-finalized packs of a pourable product, preferentially a pourable food product, into finalized packages of the pourable product, preferentially the pourable food product.

[0002] Advantageously, the present invention also relates to a packaging machine for packaging a pourable product, preferentially a pourable food product, into finalized packages and having a folding apparatus for folding semi-finalized packs into the finalized packages.

BACKGROUND ART

[0003] As is known, many liquid or pourable food products, such as fruit juice, UHT (ultra-high-temperature treated) milk, wine, tomato sauce, etc., are sold in packages made of sterilized packaging material.

[0004] A typical example is the parallelepiped-shaped package for pourable food products known as Tetra Brik Aseptic (registered trademark), which is made by sealing and folding a laminated packaging material. The packaging material has a multilayer structure comprising a carton and/or paper base layer, covered on both sides with layers of heat-seal plastic material, e.g. polyethylene. In the case of aseptic packages for long-storage products, the packaging material also comprises a layer of oxygenbarrier material, e.g. an aluminum foil, which is superimposed on a layer of heat-seal plastic material, and is in turn covered with another layer of heat-seal plastic material forming the inner face of the package eventually contacting the food product.

[0005] Packages of this sort are normally produced on fully automatic packaging machines.

[0006] There are known packaging machines that advance a web of packaging material through a sterilization apparatus for sterilizing the web of packaging material and into an isolation chamber in which the sterilized web of packaging material is maintained and advanced. During advancement of the web of packaging material within the isolation chamber, the web of packaging material is folded and sealed longitudinally to form a tube, the tube being further fed along an (vertical) advancing direction. In order to complete the forming operations, the tube is filled with a pourable product, in particular a pourable food product, and is transversally sealed and subsequently cut along equally spaced transversal cross sections within a pack forming unit of the packaging machine during advancement along the advancing direction. Pillow packages are so obtained. These pillow packages define sealed semi-finalized packs having each a central main body, two sealing fins resulting from the transversal sealing and cutting of the tube and protruding from the respective central main body and a plurality of flaps laterally protruding from the central main body. In order to obtain the finalized packages, the pillow packages are further formed and the sealing fins and the flaps are folded and sealed onto the respective central main bodies.

[0007] A typical packaging machine of this type comprises:

- a forming apparatus configured to form the semi-finalized packs being filled with the pourable product; and
- a folding apparatus configured to receive the semi-finalized packs from the forming apparatus and to form the finalized packages from the semi-finalized packs.

[0008] A typical folding apparatus comprises an infeed conveyor, which is configured to receive the semi-finalized packs from the forming apparatus and to feed the semi-finalized packs to a folding unit of the folding apparatus, the folding unit being configured to fold the semi-finalized packs into the finalized packages.

[0009] There is known a type of folding unit that comprises a plurality of retaining pockets configured to retain the semi-finalized packs and a conveying device configured to intermittently advance the retaining pockets along an endless path and through a receiving station at which the semi-finalized packs are fed into the retaining pockets, and a release station at which the finalized packages are released.

[0010] The folding unit also comprises a flap folding device arranged at a treatment station interposed between the receiving station and the release station and configured to simultaneously fold the flaps onto the respective central main body. Thereby, the flap folding device also folds the sealing fins.

[0011] Moreover, the folding unit also comprises a thermal treatment device arranged at a thermal treatment station interposed between the treatment station and the release station and configured to thermally treat the flaps and/or portions of the respective central main bodies so as to seal the flaps onto the respective central main bodies.

[0012] Even though the known folding apparatuses, in particular the known folding units, work satisfyingly well, there is a need felt in the sector to further improve the known folding apparatuses, in particular the known folding units.

DISCLOSURE OF INVENTION

[0013] It is therefore an object of the present invention to provide an improved folding apparatus.

[0014] It is an even further object of the present invention to provide an improved packaging machine.

[0015] According to the present invention, there is provided a folding apparatus according to the independent claim.

[0016] Preferred embodiments are claimed in the dependent claims.

[0017] According to the present invention, there is also provided a packaging machine according to claim 16.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a packaging machine having a folding apparatus according to the present invention, with parts removed for clarity;
Figure 2 is a schematic representation of the transformation of a semi-finalized pack into a finalized package, with parts removed for clarity;
Figure 3 is an enlarged perspective view of the folding apparatus of Figure 1, with parts removed for clarity;
Figure 4 is an enlarged side view of a detail of the folding apparatus of Figure 1, with parts removed for clarity;
Figure 5 is an enlarged perspective view of a further detail of the folding apparatus of Figure 1, with parts removed for clarity;
Figures 6a and 6b are side views of a portion of the folding apparatus of Figure 1 during two different moments of operation, with parts removed for clarity;
Figure 7 is an enlarged perspective view of a further portion of the folding apparatus of Figure 1, with parts removed for clarity;
Figure 8 is an enlarged perspective view of a flap folding device of the folding apparatus of Figure 1, with parts removed for clarity;
Figures 9A to 9C are enlarged views of details of the flap folding device of Figure 8 during different operational states, with parts removed for clarity; and
Figure 10 is another enlarged perspective view of a flap folding device of the folding apparatus of Figure 1, with parts removed for clarity.

BEST MODES FOR CARRYING OUT THE INVENTION

[0019] Number 1 indicates as a whole a packaging machine for producing, preferentially sealed, finalized packages 2 of a pourable product, preferentially a pourable food product such as pasteurized milk, fruit juice, wine, tomato sauce, yoghurt, milk drinks, yoghurt drinks, emulsions, beverages with pulp, salt, sugar and the like.

[0020] Preferentially, packages 2 may be formed from a multilayer packaging material. Even more preferentially, packages 2 may be formed from a web of packaging material 3.

[0021] More specifically, the multilayer packaging material, preferentially web of packaging material 3, may comprise at least a layer of fibrous material, such as e.g. a paper or cardboard layer, and at least two layers of heat-seal plastic material, e.g. polyethylene, interposing the layer of fibrous material in between one another. One of these two layers of heat-seal plastic material may define the respective inner face of finalized packages 2 eventually contacting the pourable product.

[0022] According to some possible non-limiting embodiments, the multilayer packaging material, preferentially web of packaging material 3, may also comprise a layer of gas- and light-barrier material, e.g. aluminum foil or ethylene vinyl alcohol (EVOH) film, preferentially being arranged between one of the layers of the heat-seal plastic material and the layer of fibrous material. Preferentially, the multilayer packaging material, preferentially web of packaging material 3, may also comprise a further layer of heat-seal plastic material being interposed between the layer of gas- and light-barrier material and the layer of fibrous material.

[0023] In more detail, each finalized package 2 may extend along a longitudinal axis, and preferentially may have a longitudinal seam portion (extending along the respective longitudinal axis) and a pair of transversal sealing fins, preferentially a transversal top sealing fin and a transversal bottom sealing fin.

[0024] In particular, each finalized package 2 may have a substantially parallelepiped structure.

[0025] Furthermore, each finalized package 2 may comprise at least a first end portion and a second end portion arranged at opposite sides of finalized package 2 and an intermediate portion interposed between the first end portion and the second end portion. In particular, each first end portion may define a bottom of the respective finalized package 2 and each second end portion may define a top of the respective finalized package 2.

[0026] In further detail, each first end portion and each second end portion may comprise at least one respective transversal wall (being transversal to the respective longitudinal axis of the respective finalized package 2).

[0027] Preferentially, each intermediate portion may comprise and/or define a side wall, e.g. formed by a plurality of interconnected side wall portions, extending between the respective transversal walls.

[0028] More specifically, the respective transversal wall of each first end portion may define a bottom wall and the respective transversal wall of each second end portion may define a top wall. Preferentially, the bottom wall may have a support surface adapted to be placed on a (horizontal) plane, such as e.g. a shelf within a distribution point, and the top wall may be opposite to the bottom wall.

[0029] According to some possible non-limiting embodiments, each finalized package 2 may also comprise an opening device, such as a closure.

[0030] According to some possible non-limiting embodiments, each opening device may be applied to the respective multilayer packaging material, preferentially web of packaging material 3, or onto semi-finalized packs 5 or onto finalized packages 2.

[0031] Preferentially, each opening device may be provided on the respective second end portion, preferentially the respective transversal wall defining the respective

top wall.

[0032] With particular reference to Figures 1 and 2, packaging machine 1 may be configured to produce (sealed) semi-finalized packs 5, such as e.g. pillow packs, being filled with the pourable product and to further treat and/or manipulate and/or form semi-finalized packs 5 for obtaining finalized packages 2.

[0033] With particular reference to Figure 2, each semi-finalized pack 5 may extend along a respective longitudinal axis A, and preferentially may comprise a longitudinal sealing band 6 (extending along and/or being parallel to longitudinal axis A).

[0034] According to some possible non-limiting embodiments, each semi-finalized pack 5 may comprise at least one transversal sealing fin 8, preferentially transversal to longitudinal axis A, arranged at a respective end portion 7 of the respective semi-finalized pack 5.

[0035] Preferentially, each semi-finalized pack 5 may comprise at least two transversal sealing fins 8, preferentially transversal to longitudinal axis A, arranged at respective end portions 7 of the respective semi-finalized pack 5 opposite to one another.

[0036] Moreover, each sealing fin 8 may define a respective transversal sealing fin of the respective finalized package 2 (obtained from the respective semi-finalized pack 5).

[0037] Preferentially, each longitudinal sealing band 6 may define a corresponding longitudinal seam portion of the respective finalized package 2 (obtained from the respective semi-finalized pack 5).

[0038] Furthermore, each semi-finalized pack 5 may comprise a central main body 9 and the one or more sealing fins 8 may protrude, preferentially along a direction parallel to the respective longitudinal axis A, from the respective central main body 9.

[0039] In the specific case shown, each semi-finalized pack 5 may comprise two sealing fins 8, each one protruding from one respective end portion 7 opposite to the other end portion 7.

[0040] According to some preferred non-limiting embodiments, each end portion 7 may taper from the respective central main body 9 to the respective sealing fin 8.

[0041] Additionally, each semi-finalized pack 5 may also comprise one or more flaps 10 protruding away, preferentially protruding sideways, from the respective central main body 9.

[0042] In particular, each flap 10 may carry a portion of a respective sealing fin 8.

[0043] In more detail, at least one end portion 7 may comprise two respective flaps 10 laterally extending from opposite lateral sides of the respective central main body 9. In even further detail, each end portion 7 may comprise at least two respective flaps 10.

[0044] In further detail, each semi-finalized pack 5 may comprise a respective first end portion 11, a respective second end portion 12 opposite to the respective first end portion 11 and an intermediate portion 13 interposed between first end portion 11 and second end portion 12.

[0045] Preferentially, each first end portion 11, each second end portion 12 and each intermediate portion 13 form respectively the respective first end portion, the respective second end portion and the respective intermediate portion of the respective finalized package 2.

[0046] Each first end portion 11 and each second end portion 12 may comprise one respective sealing fin 8 and a respective pair of flaps 10.

[0047] Moreover, each first end portion 11 and each second end portion 12 may comprise one respective end portion 7.

[0048] With particular reference to Figure 1, packaging machine 1 may comprise at least:

- a forming apparatus 15 configured to form and/or obtain semi-finalized packs 5 of the pourable product; and
- a folding apparatus 16 configured to receive the semi-finalized packs 5 from forming apparatus 15 and to form finalized packages 2 of the pourable product from semi-finalized packs 5.

[0049] In more detail, forming apparatus 15 may comprise:

- an isolation chamber 17 configured to separate an inner (sterile) environment from an outer (hostile) environment;
- a conveying device 18 configured to advance web of packaging material 3 along a web advancement path P at least to a tube forming station at which web of packaging material 3 is formed, in use, into a tube 19 and for advancing tube 19 along a tube advancement path Q;
- a tube forming and sealing device 20 at least partially arranged within isolation chamber 17 and configured to form and longitudinally seal tube 19 at the tube forming station within isolation chamber 17;
- a filling device 21 for filling tube 19 with the pourable product; and
- a pack forming unit configured to at least form and transversally seal tube 19, preferentially to also transversally cut tube 19, preferentially during advancement of tube 19 along tube advancement path Q, for obtaining and/or producing semi-finalized packs 5.

[0050] In particular, each sealing fin 8 may result from the transversal sealing and cutting of tube 19.

[0051] Preferentially, the pack forming unit may be arranged downstream of isolation chamber 17 and tube forming and sealing device 20 along tube advancement path Q.

[0052] Moreover, tube 19 may extend along a longitudinal axis, preferentially having a vertical orientation.

[0053] Furthermore, packaging machine 1 may further

comprise a sterilization apparatus for sterilizing at least a portion of web of packaging material 3 at a sterilization station arranged upstream of the tube forming station along web advancement path P.

[0054] In more detail, filling device 21 may comprise at least a filling pipe 22 being in fluid connection or being controllable to be in fluid connection with a pourable product storage tank (not shown and known as such) and being, in use, partially placed within tube 19 for feeding the pourable product into the, in use, advancing tube 19.

[0055] More specifically, tube forming and sealing device 20 may comprise at least a tube forming assembly 23 configured to form tube 19 from web of packaging material 3, in particular by overlapping the respective opposite lateral edges of web of packaging material 3, and at least a sealing head 24 configured to longitudinally seal tube 19, in particular along the portion of tube 19 obtained by overlapping the opposite lateral edges of web of packaging material 3.

[0056] Even more specifically, tube forming assembly 23 and sealing head 24 may be arranged within isolation chamber 17.

[0057] According to some preferred non-limiting embodiments, the pack forming unit may comprise:

- a plurality of pairs of at least one operative assembly (not shown and known as such) and at least one respective counter-operative assembly (not shown and known as such); and
- a conveying unit (not shown and known as such) configured to advance the operative assemblies and the respective counter-operative assemblies along respective conveying paths.

[0058] More specifically, each operative assembly may be configured to cooperate, in use, with the respective counter-operative assembly of the respective pair for forming, transversally sealing, and preferentially also transversally cutting, tube 19 for obtaining one respective semi-finalized pack 5, in particular when, in use, advancing along a respective operative portion of the respective conveying path.

[0059] With particular reference to Figures 1 and 3, folding apparatus 16 may comprise at least a folding unit 30 configured to obtain finalized packages 2 from the respective semi-finalized packs 5, and preferentially an infeed conveyor 31 configured to advance semi-finalized packs 5 to folding unit 30.

[0060] In more detail, infeed conveyor 31 may be interposed between folding unit 30 and forming apparatus 15 and may be configured to receive semi-finalized packs 5 from forming apparatus 15 and to feed semi-finalized packs 5 to folding unit 30.

[0061] With particular reference to Figures 1 and 3 to 7, folding apparatus 16, in particular folding unit 30, may comprise:

- a plurality of retaining pockets 32 configured to receive one respective semi-finalized pack 5 at a time; and
- a conveying device 33 configured to advance retaining pockets 32 along an endless path R and through a receiving station 34 at which each semi-finalized pack 5 is fed into one respective retaining pocket 32, and preferentially a release station 35 at which each finalized package 2 is released from the respective retaining pocket 32.

[0062] In more detail, in use, each semi-finalized pack 5 may be folded into the respective finalized package 2 while being retained within the respective retaining pocket 32 and during advancement of the respective retaining pocket 32 between receiving station 34 and release station 35.

[0063] With particular reference to Figures 1 and 3 to 7, each retaining pocket 32 may comprise a retaining space, preferentially delimited by at least two respective retaining plates 37 of the respective retaining pocket 32.

[0064] More specifically, one retaining plate 37 may be arranged upstream of the other retaining plate 37 along endless path R. In other words, each retaining pocket 32 may comprise a leading retaining plate 37 (with respect to endless path R) and a trailing retaining plate 37 (with respect to endless path R).

[0065] Preferentially but not necessarily, the respective retaining plates 37 of each retaining pocket 32 may be configured to execute a relative movement such that retaining plates 37 get into engagement with the respective semi-finalized pack 5 and the respective finalized package 2, e.g. for securing and/or shaping the respective semi-finalized pack 5 and the respective finalized package 2.

[0066] With particular reference to Figures 1 and 3, conveying device 33 may be configured to advance retaining pockets 32 through receiving station 34 at which one semi-finalized pack 5 at a time is fed into a respective retaining pocket 32. Preferentially, conveying device 33 may also be configured to advance retaining pockets 32 through release station 35 at which finalized packages 2 formed form semi-finalized packs 5 during advancement within retaining pockets 32 are released out of retaining pockets 32.

[0067] As will be explained in more detail further below, conveying device 33 may also be configured to advance retaining pockets 32 through one or more treatment stations, the treatment stations being interposed between receiving station 34 and release station 35.

[0068] According to some possible non-limiting embodiments, conveying device 33 may be configured to intermittently advance retaining pockets 32 along endless path R.

[0069] In more detail, conveying device 33 may comprise a conveyor wheel 38 rotatable around a respective rotation axis B.

[0070] Additionally, conveying device 33 may comprise an actuation unit configured to actuate rotation of

conveyor wheel 38 for advancing retaining pockets 32 along endless path R.

[0071] According to some possible non-limiting embodiments, each retaining pocket 32 may be carried by conveyor wheel 38. Preferentially, retaining pockets 32 may be angularly spaced apart from one another about rotation axis B.

[0072] In more detail, each retaining plate 37 may radially protrude from conveyor wheel 38.

[0073] With particular reference to Figure 1, each semi-finalized pack 5 is fed to receiving station 34 by infeed conveyor 31. At receiving station 34 each semi-finalized pack 5 is transferred from infeed conveyor 31 to the respective retaining pocket 32.

[0074] With particular reference to Figures 1 and 3 to 7, each retaining pocket 32 may comprise a first terminal portion 45 and a second terminal portion 46 opposite to first terminal portion 45. Preferentially, each second terminal portion 46 may be adjacent and/or connected to conveyor wheel 38.

[0075] Moreover, each retaining pocket 32 may comprise an open end arranged at the respective first terminal portion 45.

[0076] According to some possible non-limiting embodiments, each semi-finalized pack 5 may be arranged within the respective retaining pocket 32 such that the respective second end portion 12 is placed adjacent to the respective second terminal portion 46 and the respective first end portion 11 is arranged adjacent to the respective first terminal portion 45.

[0077] Moreover, each semi-finalized pack 5 may be fed into the respective retaining pocket 32 with the respective sealing fins 8 being in an unfolded position, meaning that the sealing fins 8 protrude from the respective central main body 9.

[0078] In operation, folding apparatus 16, in particular folding unit 30, folds each sealing fin 8 from the respective unfolded position to a respective folded position in which each sealing fin 8 is folded onto and/or towards the respective central main body 9, preferentially the respective second end portion 12.

[0079] With particular reference to Figures 3 to 7, each retaining pocket 32 may comprise a respective fin folding device 48 configured to fold one respective sealing fin 8 at a time from the respective unfolded position to the respective folded position. Preferentially, each fin folding device 48 may be configured to fold the respective sealing fin 8 being placed at the respective second terminal portion 46.

[0080] Moreover, each fin folding device 48 may be configured to fold the respective sealing fin 8 protruding from the respective second end portion 12.

[0081] According to some preferred non-limiting embodiments, each fin folding device 48 may be arranged at and/or may define the respective second terminal portion 46.

[0082] In particular, each semi-finalized pack 5 is inserted, in use, into the respective retaining pocket 32 such that each fin folding device 48 may be configured to fold the respective sealing fin 8 which is placed within the respective retaining pocket 32 prior to the other sealing fin 8 of the respective semi-finalized pack 5. Thus, for the following description we rely on the term leading sealing fin 8 for the respective sealing fin 8 entering at first the respective retaining pocket 32 and the term trailing sealing fin 8 for the respective sealing fin 8 following the leading sealing fin 8 (i.e. the trailing sealing fin 8 is the sealing fin opposite to the leading sealing 8). Thus, each leading sealing fin 8 is positioned adjacent to the respective second terminal portion 46 and each trailing sealing fin 8 is positioned adjacent to the respective first terminal portion 45.

[0083] Moreover, each fin folding device 48 may be configured to fold the respective leading sealing fins 8.

[0084] As will be shown further below, according to the present non-limiting embodiment, trailing sealing fins 8 are folded by an alternative mechanism and not by fin folding devices 48.

[0085] Advantageously, each fin folding device 48 may comprise:

- a free space 49 for receiving the respective leading sealing fin 8 in the unfolded position at receiving station 34; and
- a folding element 50 moveable between a rest position (see e.g. Figure 6A) in which folding element 50 frees free space 49, in particular so that the respective leading sealing fin 8 can enter free space 49 without being moved from the unfolded position and/or without impacting with any portions of the respective retaining pocket 32, and an active position (see e.g. Figure 6B) in which folding element 50 interacts with the respective leading sealing fin 8 for moving the respective leading sealing fin 8 to the respective folded position.

[0086] This guarantees that during insertion of each semi-finalized pack 5 into the respective receiving pocket 32, the respective leading sealing fin 8 entering into the respective retaining space is not subject to any undesired mechanical impacts. Furthermore, this allows a gentle treatment of semi-finalized packs 5.

[0087] Moreover, folding apparatus 16, in particular folding unit 30, may further comprise an actuation unit 51 configured to set each folding element 50 in the respective rest position at receiving station 34 and to move each folding element 50 from the respective rest position to the respective active position during advancement of the respective retaining pocket 32 from receiving station 34 and along endless path R.

[0088] Thus, only once each semi-finalized pack 5 is arranged within the respective retaining pocket 32, any mechanical interaction with the respective leading sealing fin 8 may start.

[0089] In further detail, each folding element 50 may be configured to free the respective free space 49 when

being in the respective rest position, in particular so that the respective leading sealing fin 8 can enter the respective free space 49 without interaction with any part of the respective retaining pocket 32.

[0090] Additionally, each folding element 50 may be configured to close and/or occupy and/or fill the respective free space 49 when being in the respective active position, in particular thereby interacting with the respective leading sealing fin 8 and folding the respective leading sealing fin 8 to the respective folded position.

[0091] In more detail, each folding element 50 may be angularly moveable about a respective rotation axis C so as to be moveable between the respective rest position and the respective active position.

[0092] According to some preferred non-limiting embodiments, each folding element 50 may comprise an interaction surface 52 configured to interact with the respective leading sealing fin 8, preferentially such to fold the respective leading sealing fin 8 from the unfolded position to the folded position when moving folding element 50, in use, from the rest position to the active position.

[0093] According to some preferred non-limiting embodiments, each folding element 50 may be configured such that during movement of folding element 50 from the respective rest position to the respective active position, folding element 50, preferentially by means of the respective interaction surface 52 engaging the respective leading sealing fin 8, folds the respective leading sealing fin 8 in an advancement direction, i.e. a direction of advancement of the respective retaining pocket 32.

[0094] This is of particular advantage when semi-finalized pack 5 is provided with an opening device. In fact, folded sealing fin 8 would reduce the space available for the application of an opening device if folded along a direction opposite to the advancement direction.

[0095] With particular reference to Figures 3 and 5, each retaining pocket 32 may also comprise an abutment surface 53, preferentially arranged at and/or partially defining the respective second terminal portion 46, designed to receive and/or carry an engagement portion of the respective central main body 10, preferentially of the respective second end portion 12, of the respective semi-finalized pack 5.

[0096] In particular, in use, the respective semi-finalized pack 5 may be introduced into the respective receiving pocket 32 until the respective engagement portion abuts against the respective abutment surface 53.

[0097] Preferentially, the respective sealing fin 8 may protrude from the respective engagement portion into the free space 49 with the engagement portion being engaged with the respective abutment surface 53, and the respective folding element 50 being in the respective rest position.

[0098] Advantageously, actuation unit 51 may be configured to control each folding element 50 from the respective rest position to the respective active position with the respective engagement portion abutting, in use, against the respective abutment surface 53 and the respective sealing fin 8 protruding into the free space 49. In other words, in use, only after the respective engagement portion abuts against the respective abutment surface 53, actuation unit 51 moves the respective folding element 50 from the respective rest position to the respective active position.

[0099] In this way, one guarantees a very gentle treatment of semi-finalized packs 5.

[0100] In more detail, each retaining pocket 32 may comprise a support structure 54, preferentially arranged at the respective second terminal portion 46, and having the respective abutment surface 53.

[0101] More specifically, each support structure 54 may be fixed to one respective retaining plate 37, preferentially the respective trailing retaining plate 37.

[0102] According to some preferred non-limiting embodiments, each folding element 50 may be hinged to the respective support structure 54, whereby the respective hinge axis defines the respective rotation axis C.

[0103] When reverting again to Figures 3 to 7, one notes that each interaction surface 52 may be aligned and inclined with respect to the respective abutment surface 53 with the respective folding element 50 being in respectively the active position and the rest position.

[0104] More specifically, each abutment surface 53 and the respective interaction surface 52 may substantially lie within a common plane with the respective folding element 50 being in the active position.

[0105] According to some preferred non-limiting embodiments, in use, and after control of the respective folding element 50 from the respective rest position to the respective active position, each semi-finalized pack 5, in particular the respective central main body 10, even more particular the respective second end portion 12, may abut against both the respective abutment surface 53 and the respective interaction surface 52.

[0106] With particular reference to Figures 3 to 6B, actuation unit 51 may comprise a cam mechanism 60 moving, preferentially selectively moving, each folding element 50 between the respective rest position and the respective active position.

[0107] Preferentially, cam mechanism 60 may comprise a cam profile 61 and a plurality of cam followers 62, each cam follower 62 being coupled to one respective folding element 50.

[0108] Preferentially, cam profile 61 may be fixed with respect to advancing retaining pockets 32 and/or rotating conveying wheel 38.

[0109] Moreover, in use, cam followers 62 may be arranged one after the other along endless path R and cyclically move along cam profile 61, preferentially such that the respective folding elements 50 cyclically move between the respective rest position and the respective active position.

[0110] In further detail, in use, the angular position of cam followers 62 with respect to rotation axis B may determine the position and/or movement of folding ele-

ments 50.

[0111] In more detail, cam mechanism 60 may also comprise a plurality of coupling structures 63, each one carrying one respective cam follower 62 and being operatively coupled to one respective folding element 50.

[0112] In even more detail, each coupling structure 63 may comprise a first arm 64 carrying the respective cam follower 62 and hinged to the respective support structure 54 and a second arm 65 hinged to the first arm 64 and carrying the respective folding element 50 in an angularly moveable manner.

[0113] With particular reference to Figure 5, each retaining pocket 32 may also comprise a seat 66 configured to receive an opening device of the respective semi-finalized pack 5. Each seat 66 may for example be provided in the form of an aperture provided in the respective support structure 54 and the respective folding element 50.

[0114] With particular reference to Figures 1, 3 and 8 to 10, folding apparatus 16, in particular folding unit 30, may also comprise a flap folding device 70 configured to fold at least one flap 10, preferentially two flaps 10 arranged at opposite sides of the respective central main body 9, onto and/or towards the respective central main body 9, in particular the respective intermediate portion 13.

[0115] In particular, flap folding device 70 may be configured to fold the flaps 10 of second end portion 12 and/or the flaps 10 being associated to leading sealing fin 8.

[0116] In analogy to distinguishing between leading sealing fin 8 and trailing sealing fin 8, it is also possible to distinguish between leading flaps 10 and trailing flaps 10.

[0117] In particular, leading flaps 10 are the flaps 10 of each semi-finalized pack 5 that are placed into the respective retaining pocket 32 earlier than the other flaps 10. In other words, leading flaps 10 are the flaps 10 that are placed at the respective second terminal portion 46.

[0118] Even more particular, leading flaps 10 are associated to the respective leading sealing fin 8.

[0119] Preferentially, flap folding device 70 may be configured to fold the respective flaps 10 after folding the respective sealing fins 8.

[0120] According to some preferred non-limiting embodiments, flap folding device 70 may be configured to fold leading flaps 10 onto and/or towards the respective central main body 9, preferentially the respective intermediate portion 13.

[0121] According to some preferred non-limiting embodiments, flap folding device 70 may be arranged at a flap folding station 71 interposed between receiving station 34 and release station 35. In other words, flap folding device 70 may define a treatment station of folding apparatus 16, preferentially of folding unit 30.

[0122] Preferentially, flap folding device 70 may be stationary, i.e. flap folding device 70 does not move with retaining pockets 32 and/or conveyor wheel 38.

[0123] Preferentially, folding apparatus 16, in particular folding unit 30, may comprise a single flap folding device 70.

[0124] Flap folding device 70 may comprise at least:

- one, preferentially two, folding elements 72, each moveable between an idle position and a folding position and being configured to fold respective flaps 10 onto and/or towards the respective central main body 9, preferentially the respective intermediate portion 13; and
- an actuation group 73 configured to control each flap folding element 72 between the respective idle position and the respective folding position.

[0125] Preferentially, actuation group 73 may be configured to simultaneously move the two folding elements 72 between the respective idle position and the respective folding position.

[0126] In more detail, folding elements 72 may be spaced apart from one another. One folding element 72 is configured to fold one respective flap 10 of the respective pair of flaps 10, while the other flap folding element 72 is configured to fold the other flap 10 of the respective pair of flaps 10.

[0127] Advantageously, actuation group 73 may be configured to actuate both a linear movement and an angular movement about a respective rotation axis E on each flap folding element 72 so as to move each flap folding element 72 between the respective idle position and the respective folding position (see e.g. the sequence of Figures 9A to 9C) .

[0128] According to some preferred non-limiting embodiments, actuation group 73 may be configured to actuate, when controlling flap folding element 72 from the respective idle position to the respective folding position:

- at first the linear movement of each flap folding element 72; and
- then the angular movement about the respective rotation axis E of each flap folding element 72 after the start, but preferentially before the termination, of the linear movement.

[0129] In this way, one guarantees a gentle folding of flaps 10.

[0130] In addition, this configuration allows to have an effective and, at the same time, rather compact flap folding device 70.

[0131] The linear movement of each flap folding element 72 allows to approach flap folding elements 72 to flaps 10 and the angular movement allows to precisely control the folding of flaps 10.

[0132] According to some preferred non-limiting embodiments, actuation group 73 may be configured to actuate the linear movement of folding elements 72 towards flaps 10 and to actuate the angular movement about the respective rotation axis E after actuation of the linear movement.

[0133] According to some preferred non-limiting embodiments, each flap folding element 72 may comprise a respective engagement surface 74 configured to engage, in use, the respective flap 10 for folding the respective flap 10 onto and/or towards the respective central main body 9, preferentially the respective intermediate portion 13.

[0134] Preferentially, a respective normal axis N of each engagement surface 74 (i.e. an axis perpendicular to engagement surface 74) is substantially parallel to (see e.g. Figure 9A) and is substantially perpendicular (see e.g. Figure 9C) to the respective longitudinal axis A of the respective semi-finalized pack 5 with the respective flap folding element 72 being respectively in the respective idle position and in the respective folding position and with the respective semi-finalized pack 5 being at folding station 71.

[0135] In further detail, each flap folding element 72 may comprise a respective folding plate 75 having the respective engagement surface 74.

[0136] According to the specific embodiment, each folding plate 75 may have a substantially triangular shape.

[0137] With particular reference to Figures 8 to 10, actuation group 73 may comprise a support structure 76, preferentially a pair of support structures 76 spaced apart from one another.

[0138] Preferentially, each flap folding element 72 may be hinged to one respective support structure 76 and about the respective rotation axis E.

[0139] In further detail, actuation group 73 may comprise at least one linear rail 77, preferentially two linear rails 77 spaced apart from one another.

[0140] Moreover, each support structure 76 may be moveably coupled to one respective linear rail 77.

[0141] Additionally, actuation group 73 may comprise an actuating mechanism 78 configured to linearly move each support structure 76 along the respective linear rail 77. Each flap folding element 72 linearly moves, in use, with the respective support structure 76 linearly moving along the respective linear rail 77.

[0142] Moreover, actuating mechanism 78 may also be configured to actuate the angular movement of each flap folding element 72 about the respective rotation axis E.

[0143] In further detail, actuating mechanism 78 may comprise an axle 79 rotatable about a central axis F and one or more bars 80 coupled to axle 79. Each bar 80 may be coupled to one respective support structure 76.

[0144] Preferentially, each bar 80 may be connected to one respective support structure 76.

[0145] Preferentially, in use, rotation of axle 79 about central axis F actuates movement of each bar 80, thereby actuating the respective linear movement of each support structure 76.

[0146] According to some preferred non-limiting embodiments, actuating mechanism 78 may further comprise one or more shafts 81, each one coupled to one respective flap folding element 72 and to axle 79. Moreover, in use, rotation of axle 79 about central axis F actuates movement of each shaft 81 and thereby the angular movement of the respective flap folding element 72.

[0147] In further detail, each flap folding element 72 may be hinged to the respective support structure 76 at a first end portion 82 and each shaft 81 may be connected to the respective flap folding element 72 at a second end portion 83 opposite to the respective first end portion 82.

[0148] In even more detail, actuating mechanism 78 may further comprise a coupling lever 84 connected to and perpendicularly extending from axle 79, a coupling shaft 85 connected to and perpendicularly arranged to coupling lever 84 and at least one coupling bar 86, preferentially two coupling bars 86, coupled to and being perpendicularly arranged to coupling shaft 85. Preferentially, each coupling bar 86 may be connected to a respective end portion of coupling shaft 85.

[0149] Preferentially, each bar 80 may be connected to a first end 88 of the respective coupling bar 86 and each shaft 81 may be connected to a second end 89 of the respective coupling bar 86 opposite to the respective first end 88.

[0150] According to some preferred non-limiting embodiments, actuating mechanism 78 may also comprise an actuator group 87 configured to control the angular movement of axle 79 about rotation axis F.

[0151] According to some preferred non-limiting embodiments, folding apparatus 16, in particular folding unit 30, may further comprise a sealing device, preferentially having a heating unit, configured to seal leading flaps 10 onto the respective central main bodies 9, preferentially the respective intermediate portions 13.

[0152] According to some preferred non-limiting embodiments, folding apparatus 16, in particular folding unit 30, may further comprise a pressuring device configured to press leading flaps 10 onto the respective central main bodies 9, preferentially the respective intermediate portions 13, so as to contribute to the sealing operation of leading flaps 10 onto the respective central main bodies 9, preferentially the respective intermediate portions 13.

[0153] With particular reference to Figures 1 and 3, folding apparatus 16, in particular folding unit 30, may also comprise an auxiliary folding group 90 configured to fold each trailing sealing fin 8 and each trailing flap 10 independently from folding of the respective leading sealing fin 8 and of the respective leading flap 10.

[0154] In particular, auxiliary folding group 90 may be configured to fold each trailing flap 10 onto the respective first end portion 11, in particular onto the part of the semi-finished pack 5 that will become the bottom wall of the respective finalized package 2.

[0155] Moreover, folding apparatus 16, in particular folding unit 30, may also comprise an auxiliary sealing device for sealing each trailing flap 10 onto the respective central main body 9, preferentially the respective first end portion 11.

[0156] In use, packaging machine 1 forms finalized

packages 2 filled with the pourable product.

[0157] In particular, the method for forming packages 2 comprises the main steps of:

- forming semi-finalized packs 5 by operation of forming apparatus 15; and
- folding semi-finalized packs 5 into finalized packages 2 by operation of folding apparatus 16.

[0158] In more detail, the main step of forming packs 5, comprises at least the steps of:

- advancing web of packaging material 3 along advancement path P, in particular by operation of conveying device 18;
- folding web of packaging material 3 into tube 19, in particular within isolation chamber 17, by operation of tube forming and sealing device 20, in particular tube forming assembly 23;
- longitudinally sealing tube 19, in particular within isolation chamber 17, by operation of tube forming and sealing device 20, in particular sealing head 24;
- filling tube 19 with the pourable product by operation of filling device 21, in particular filing pipe 22;
- advancing tube 19 along tube advancement path Q by operation of conveying device 18 and/or the pack forming unit; and
- obtaining semi-finalized packs 5 from tube 19 by forming, transversally sealing and transversally cutting tube 19 by operation of the pack forming unit and during advancement of tube 19 along tube advancement path Q.

[0159] Moreover, the step of forming may also comprise the step of sterilizing web of packaging material 3 at the sterilization station.

[0160] In more detail, the step of folding semi-finalized packs 5 comprises the sub-steps of:

- feeding semi-finalized packs 5 to folding unit 30 by operation of infeed conveyor 31; and
- final folding semi-finalized packs 5 by operation of folding unit 30.

[0161] More specifically, during the sub-step of feeding, semi-finalized packs 5 may be fed into respective retaining pockets 32 at receiving station 34. While being fed into retaining pockets 32, the respective leading sealing fins 8 are placed within the respective free space 49, and preferentially at the same time the respective engagement portion of the respective semi-finalized pack 5 abuts against the respective abutment surface 53.

[0162] Moreover, during the sub-step of final folding, retaining pockets 32 advance, preferentially intermittently advance, along endless path R.

[0163] During advancement of retaining pockets 32 the respective fin folding devices 48 fold the respective leading sealing fins 8 from the respective unfolded position to the respective folded position by moving the respective folding element 50 from the respective rest position to the respective active position.

[0164] Preferentially, control of folding elements 50 from the respective rest position to the respective active position is driven by cam mechanism 60.

[0165] Afterwards and with the respective semi-finalized pack 5 having reached flap folding station 71, leading flaps 10 are folded onto and/or towards the respective central main body 9, preferentially the respective intermediate portion 13, by operation of flap folding device 70.

[0166] In more detail, flap folding device 70 moves flap folding elements 72 from the respective idle positions to the respective folding positions. Preferentially, each folding element 72 moves linearly and angularly. Even more preferentially, at first each folding element 72 starts to linearly move and during the linear movement starts to angularly move.

[0167] In one embodiment, the leading flaps 10 are sealed onto the respective central main bodies 9 by the sealing device.

[0168] Additionally, during the sub-step of final folding, also trailing sealing fin 8 and trailing flaps 10 are folded by auxiliary folding group 90.

[0169] Moreover, the auxiliary sealing device seals trailing flaps 10 onto the respective central main body 9, preferentially onto the respective first end portion 11.

[0170] The advantages of folding apparatus 16, preferentially folding unit 30, according to the present invention will be clear from the foregoing description.

[0171] In particular, semi-finalized packs 5 are gently treated, in particular as leading sealing fins 8 become folded only after a soft insertion of the respective semi-finalized packs 5 into the respective retaining pockets 32.

[0172] Clearly, changes may be made to folding apparatus 16 and/or packaging machine 1 as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

Claims

1. Folding apparatus (16) for producing finalized packages (2) from semi-finalized packs (5) filled with a pourable product, each semi-finalized pack (5) comprising a central main body (9) and at least one sealing fin (8) protruding from the central main body (9);

   the folding apparatus (16) comprises at least:

   - a plurality of retaining pockets (32) configured to receive respective semi-finalized packs (5); and
   - a conveying device (33) configured to advance the retaining pockets (32) along an endless path (R) and through a receiving station (34) at which each semi-finalized pack (5) is fed into one respective retaining

pocket (32);

wherein each retaining pocket (32) comprises a respective fin folding device (48) configured to fold the respective sealing fin (8) from an unfolded position in which the sealing fin (8) protrudes from the respective central main body (9) to a folded position in which the sealing fin (8) is folded onto and/or towards the central main body (9);
wherein each fin folding device (48) comprises:

- a free space (49) for receiving the sealing fin (8) in the unfolded position at the receiving station (34); and
- a folding element (50) moveable between a rest position in which the folding element (50) frees the free space (49) and an active position in which the folding element (50) interacts with the sealing fin (8) for moving the sealing fin (8) to the folded position;

wherein the folding apparatus (16) further comprises an actuation unit (51) configured to set the folding element (50) in the rest position at the receiving station (34) and to move the folding element (50) from the rest position to the active position during advancement of the respective retaining pocket (32) from the receiving station (34) and along the endless path (R).

2. Folding apparatus according to claim 1, wherein each folding element (50) is configured to free the free space (49) when being in the rest position.

3. Folding apparatus according to claim 1 or 2, wherein each folding element (50) is configured to close the free space (49) when being in the active position.

4. Folding apparatus according to any one of the preceding claims, wherein each retaining pocket (32) also comprises an abutment surface (53) designed to receive and/or carry an engagement portion of the respective central main body (9) of the respective semi-finalized pack (5);
wherein the respective sealing fin (8) protrudes from the respective engagement portion into the free space (49) with the engagement portion being engaged with the respective abutment surface (53).

5. Folding apparatus according to claim 4, wherein the actuation unit (51) is configured to control each folding element (50) from the respective rest position to the respective active position with the respective engagement portion engaging, in use, the respective abutment surface (53) and the respective sealing fin (8) protruding into the free space (49).

6. Folding apparatus according to claim 5, wherein each folding element (50) comprises an interaction surface (52) configured to interact with the respective sealing fin (8);

wherein each interaction surface (52) is aligned with respect to the respective abutment surface (53) with the respective folding element (50) being in the active position; and/or
wherein each interaction surface (52) is inclined with respect to the respective abutment surface (53) with the respective folding element (50) being in the rest position.

7. Folding apparatus according to claim 6, wherein each abutment surface (53) and the respective interaction surface (52) substantially lie within a common plane with the respective folding element (50) being in the active position.

8. Folding apparatus according to any one of the preceding claims, wherein the actuation unit (51) comprises a cam mechanism (60) moving each folding elements (50) between the respective rest position and the respective active position.

9. Folding apparatus according to claim 8, wherein the cam mechanism (60) comprises a cam profile (61) and a plurality of cam followers (62), each cam follower (62) being coupled to one respective folding element (50).

10. Folding apparatus according to any one of the preceding claims, wherein each folding element (50) is angularly moveable about a respective rotation axis (C) so as to be moveable between the rest position and the active position.

11. Folding apparatus according to any one of the preceding claims, wherein each folding element (50) is configured such that during movement of the folding element (50) from the rest position to the active position, the folding element (50) folds the respective sealing fin (8) in a direction of advancement of the respective retaining pocket (32).

12. Folding apparatus according to any one of the preceding claims, wherein the conveying device (33) is configured to intermittently advance the retaining pockets (32) along the endless path (R).

13. Folding apparatus according to any one of the preceding claims, wherein the conveying device (33) comprises a conveyor wheel (38) carrying the retaining pockets (32) and being rotatable about a respective rotation axis (B).

14. Folding apparatus according to any one of the pre-

ceding claims, wherein each sealing fin (8) protrudes from a respective end portion (12) of the respective semi-finalized pack (5);

wherein each semi-finalized pack (5) also comprises two flaps (10) protruding from opposite lateral sides of the respective end portion (12) of the respective central main body (9);
wherein the folding apparatus (16) further comprises at least one flap folding device (70) configured to fold the flaps (10) onto and/or towards the respective central main body (9);
wherein the flap folding device (70) is configured to fold the flaps (10) during or after folding of the respective sealing fin (8).

15. Folding apparatus according to any one of the preceding claims, wherein each retaining pocket (32) comprises a seat (66) configured to receive an opening device of the respective semi-finalized pack (5).

16. Packaging machine (1) for producing finalized packages (2) of a pourable product comprising at least:

- a forming apparatus (15) configured to form semi-finalized packs (5) of the pourable product; and
- a folding apparatus (16) according to any one of the preceding claims for forming the finalized packages (2) from the semi-finalized packs (5).

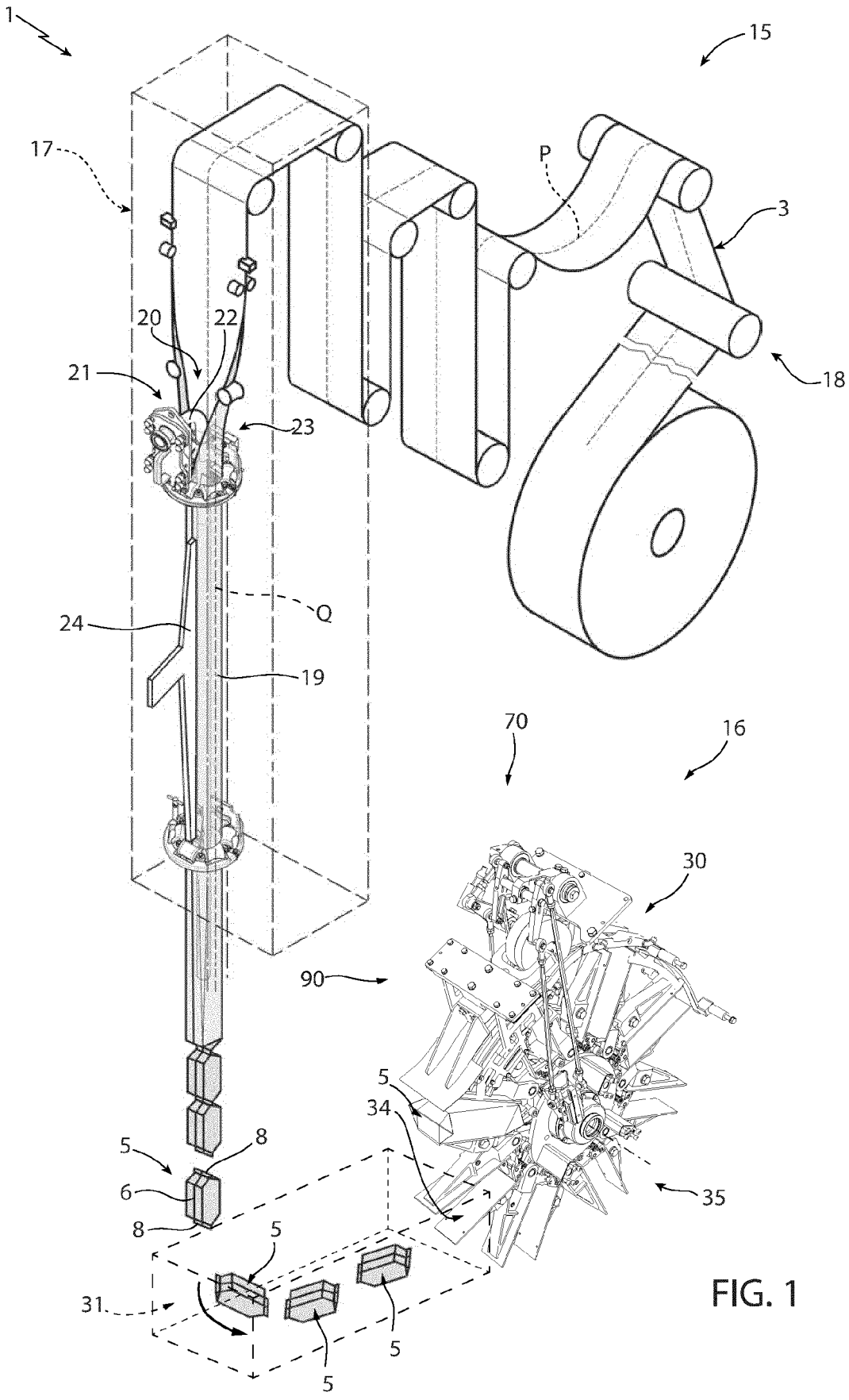
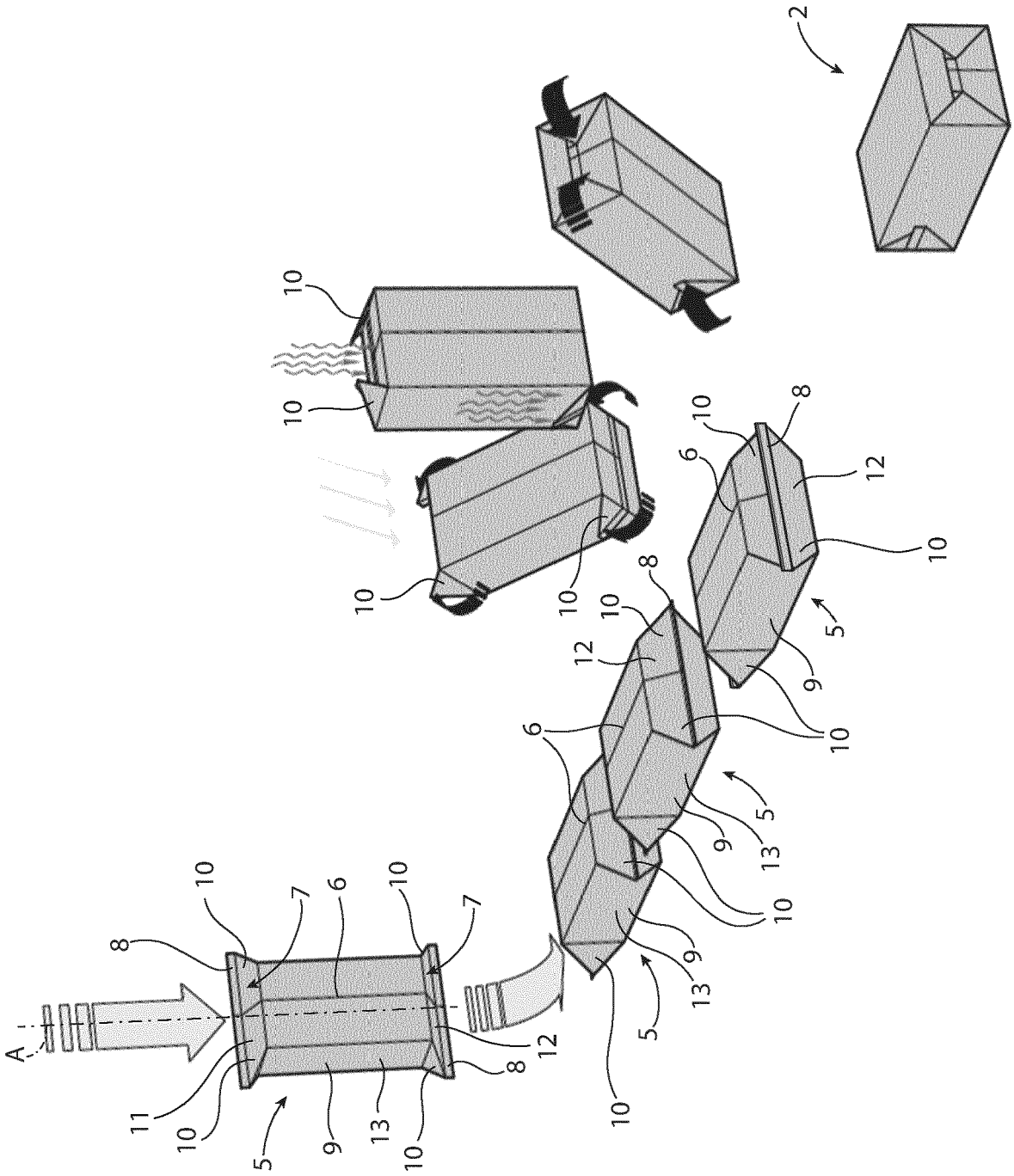


FIG. 1

FIG. 2



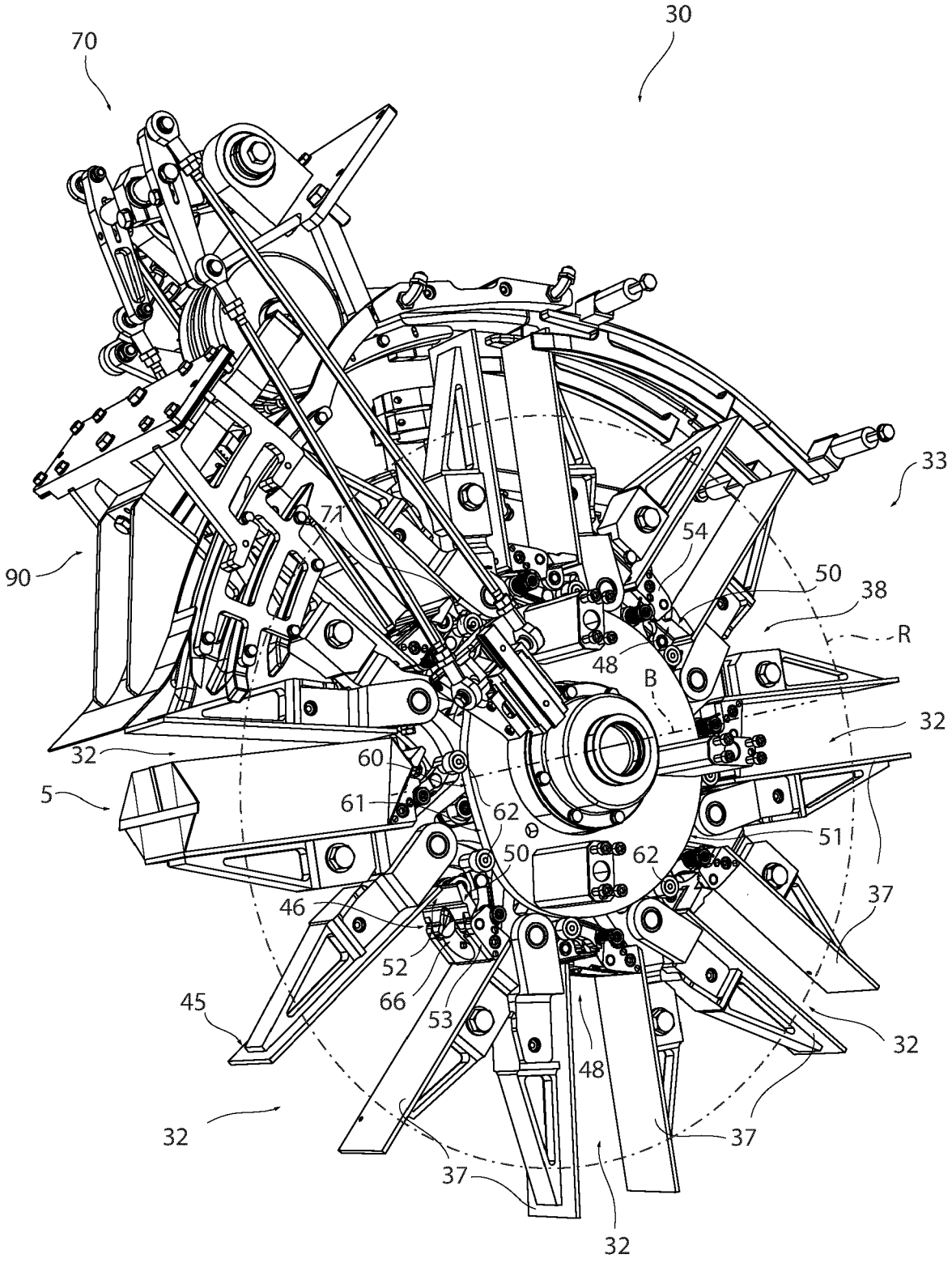

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FIG. 3

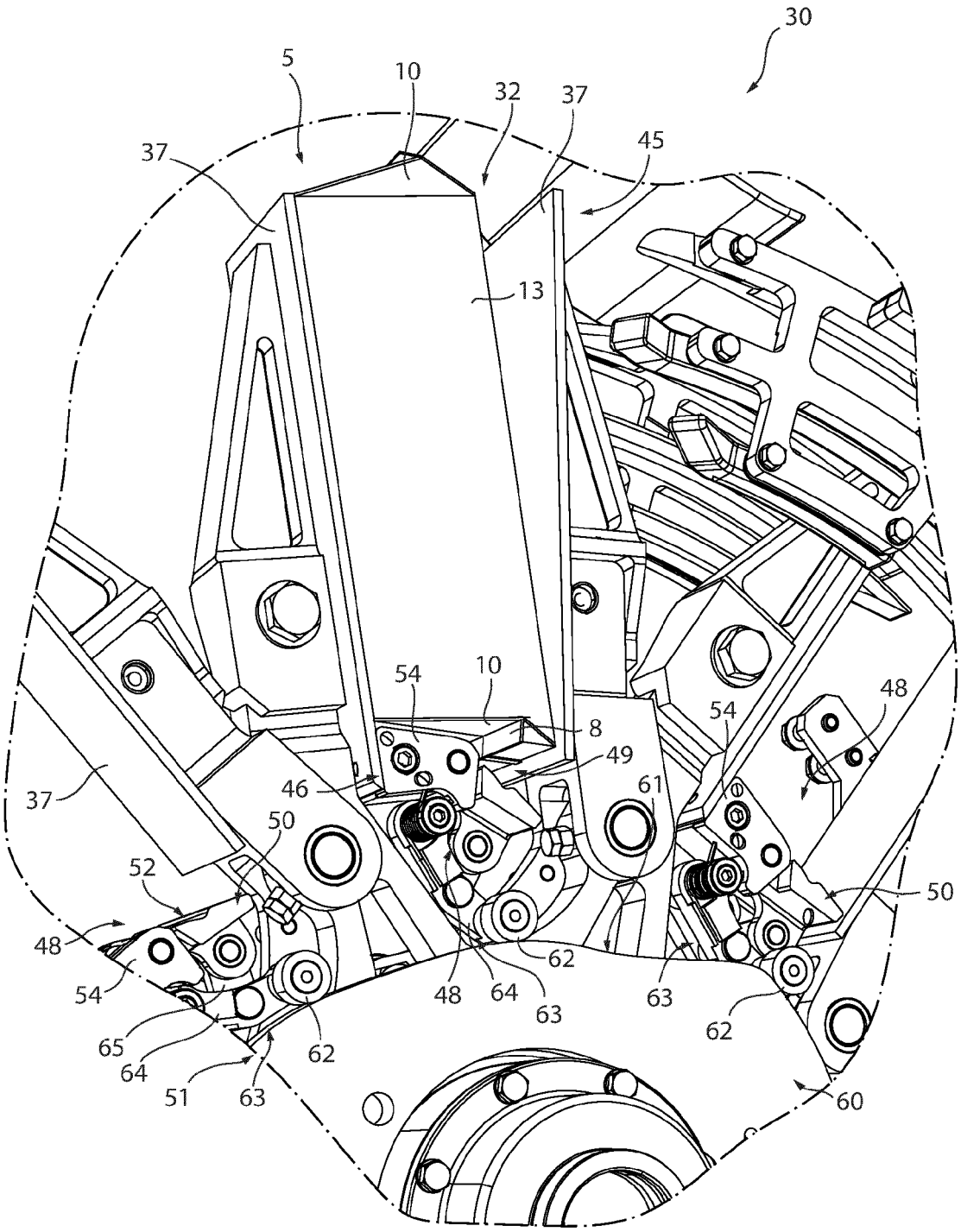
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FIG. 4

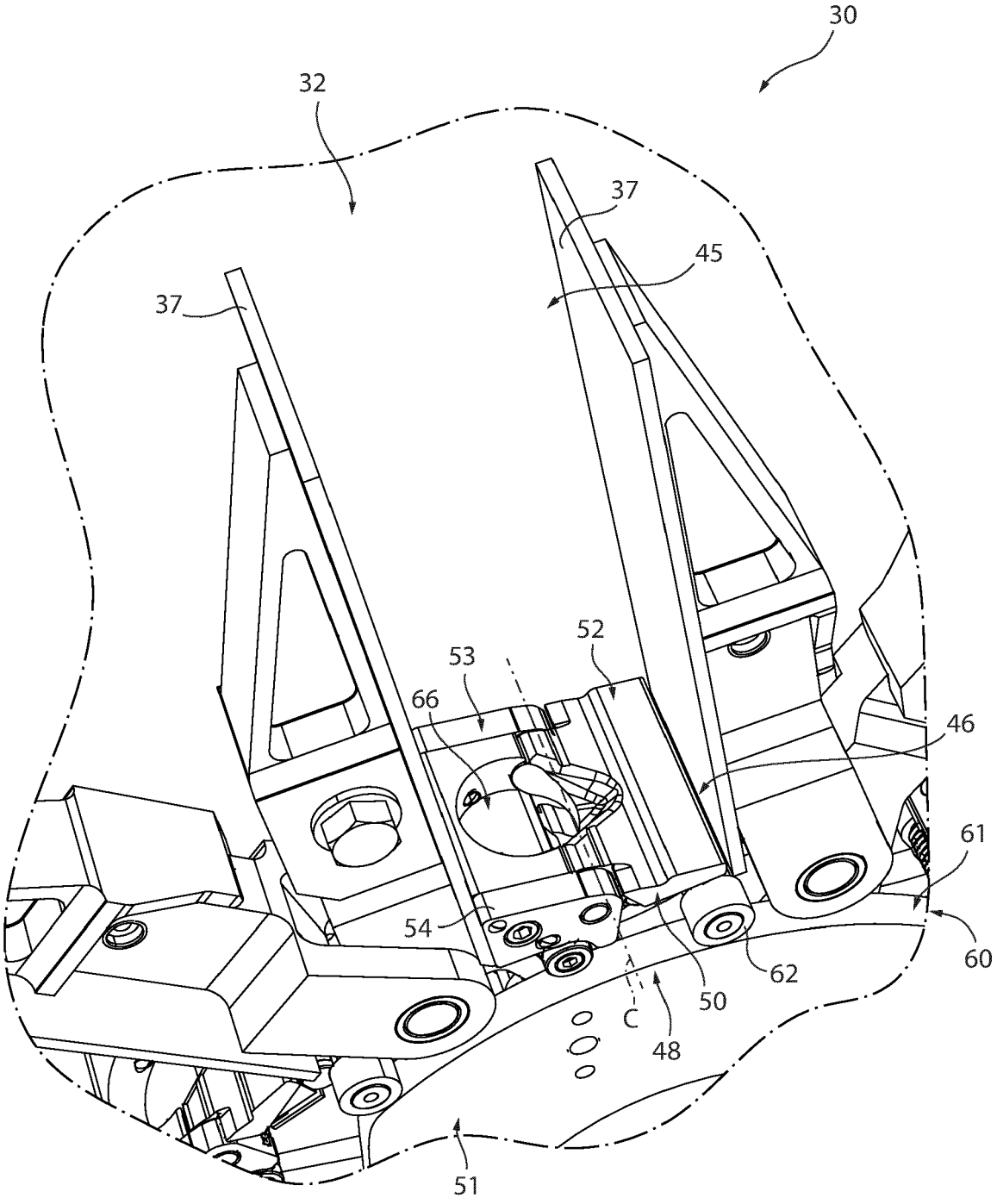
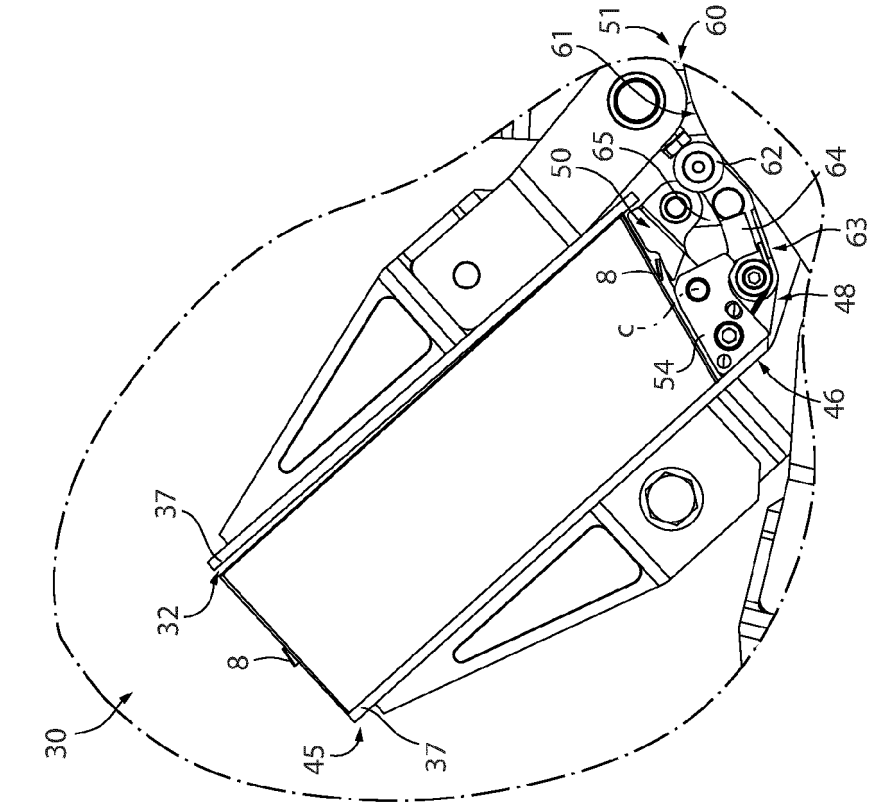


FIG. 5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C
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FIG. 6B

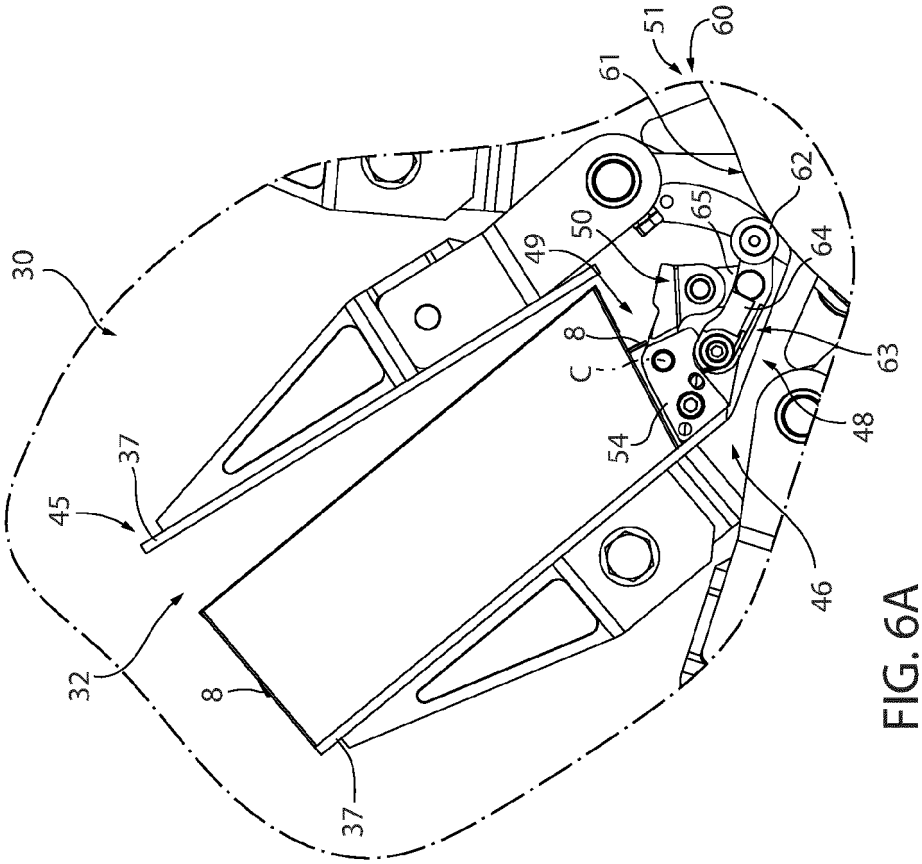
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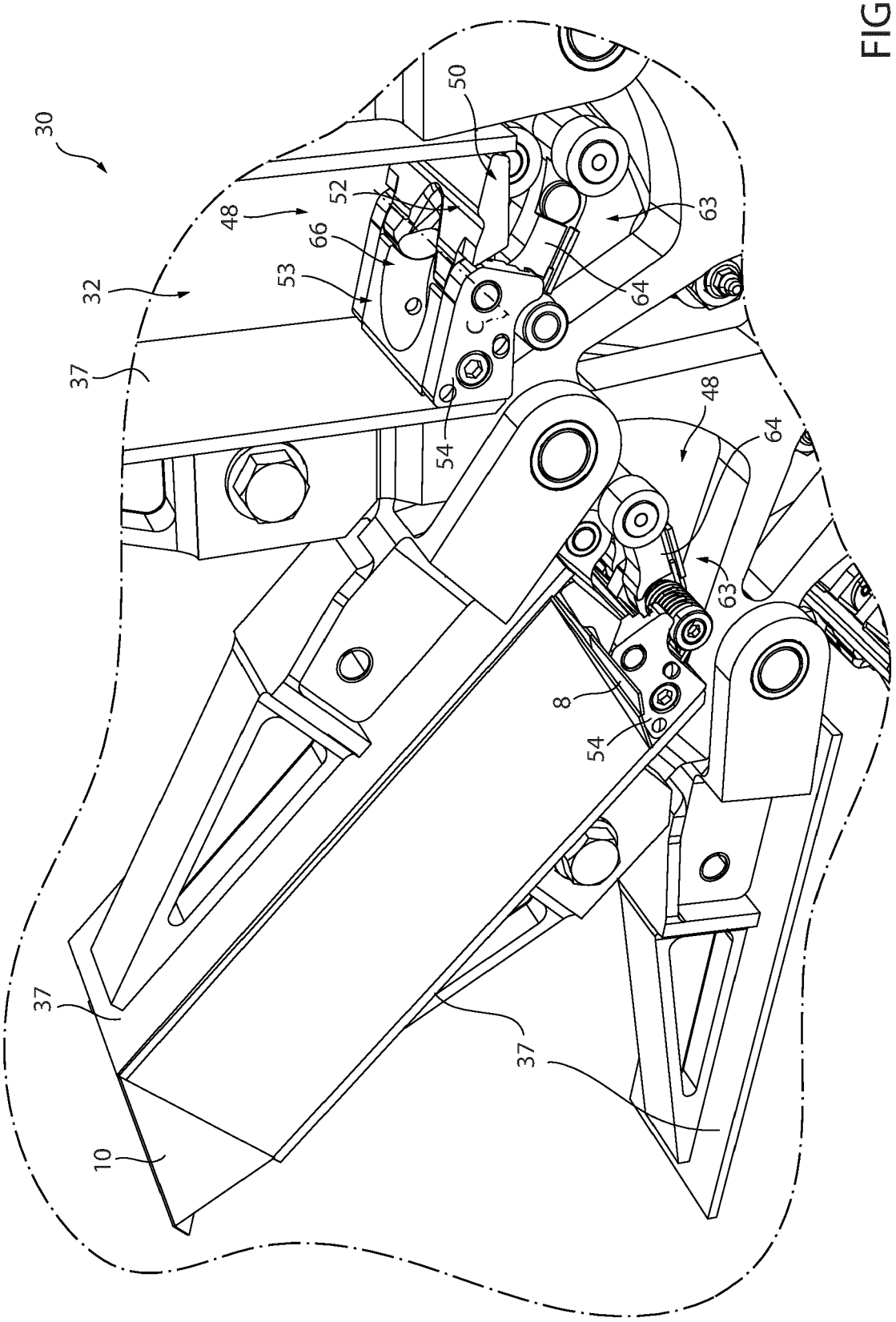
FIG. 6A

FIG. 7



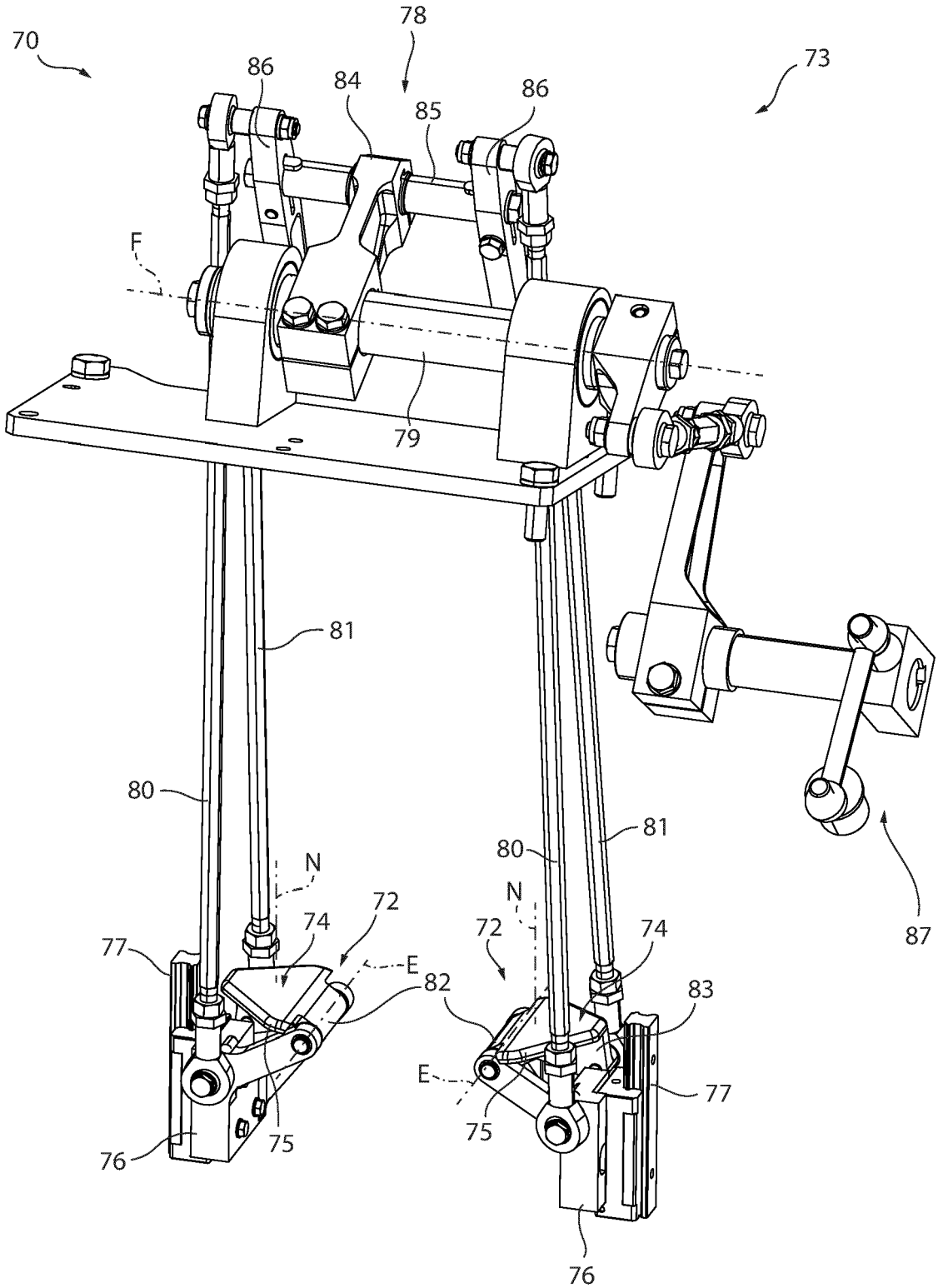

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FIG. 8

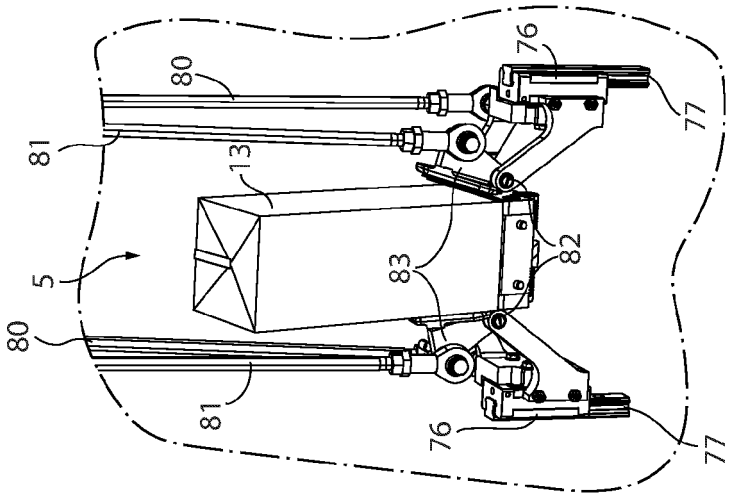

FIG. 9C

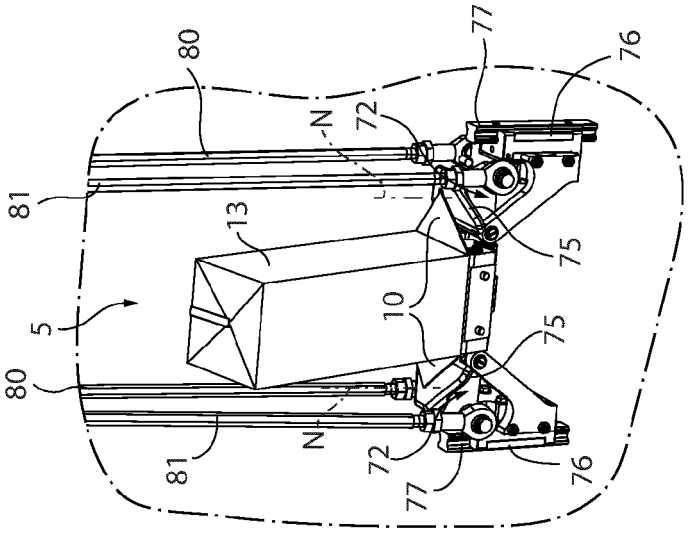

FIG. 9B

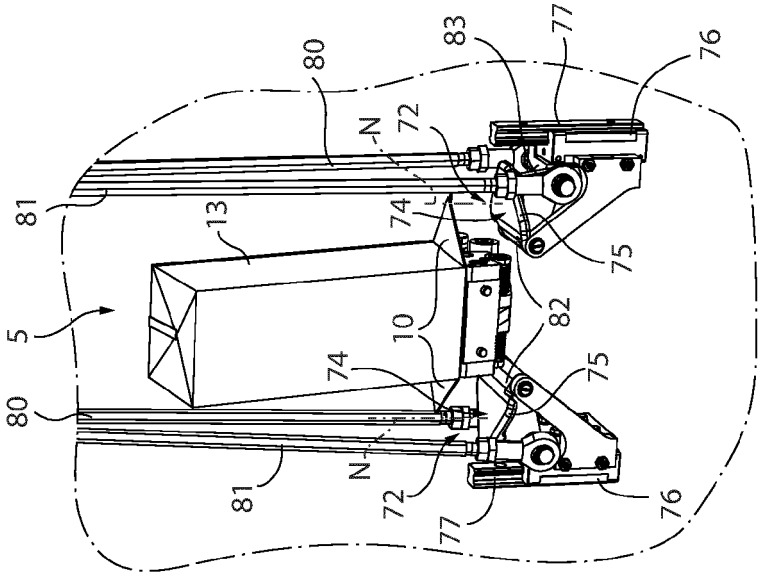

FIG. 9A

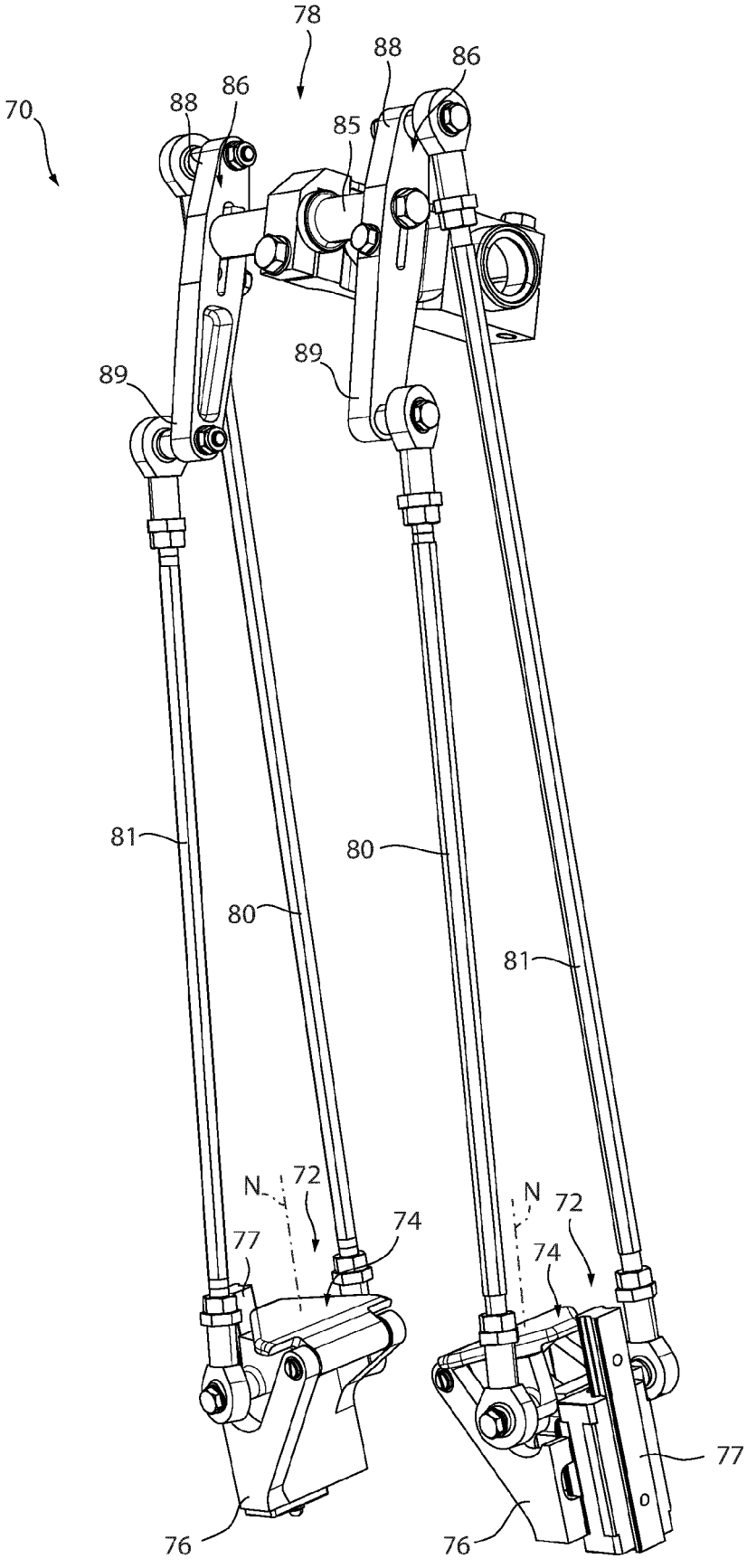

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 3285

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B65B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 January 2024	Lawder, M

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