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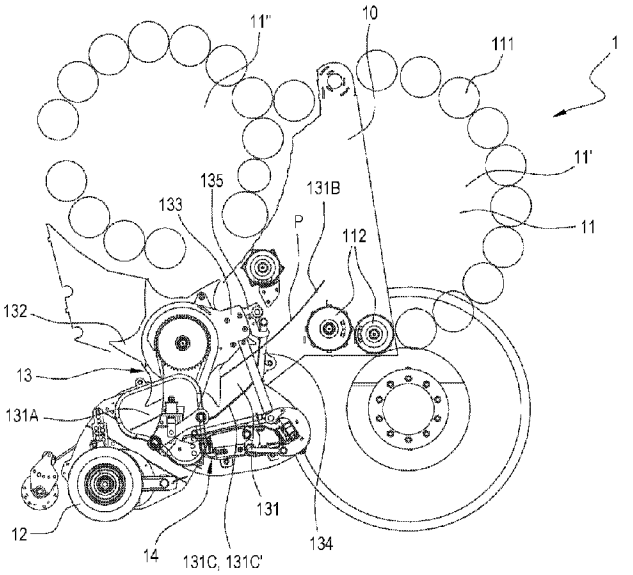
(54) Title: BALER WITH KNIFE PROTECTION SYSTEM

FIG. 1



(57) Abrégé/Abstract:
An agricultural machine (1) comprises: a frame (10); a receiver (11), for receiving crops; a pick-up device (12), configured for picking-up the crops from a field; a feeding assembly (13), including a feeding channel (131) and a feeding rotor (132), rotating in a feeding direction (F), to push the crops; a cutting assembly (14), which is configured to cut the crops passing through the feeding channel (131). The cutting assembly (14) includes: a plurality of knives (141), each one pivoting around a respective knife rotation point (142), between an extracted position (E) and a retracted position (R); for each knife of the plurality (141) of knives, a knife protection system (15), configured to retract the respective knife (141), selectively with respect to the other knives of the plurality (141) of knives, in response to an external force (FE) applied to the respective knife (141). For each knife protection system (15), in the extracted position (E) of the knife (141), the driving point (DP) is spaced from the knife rotation point (142) of a first distance, and, in the retracted position (R) of the knife (141), the driving point (DP) is spaced from the knife rotation point (142) of a second distance. The second distance is smaller than the first distance.

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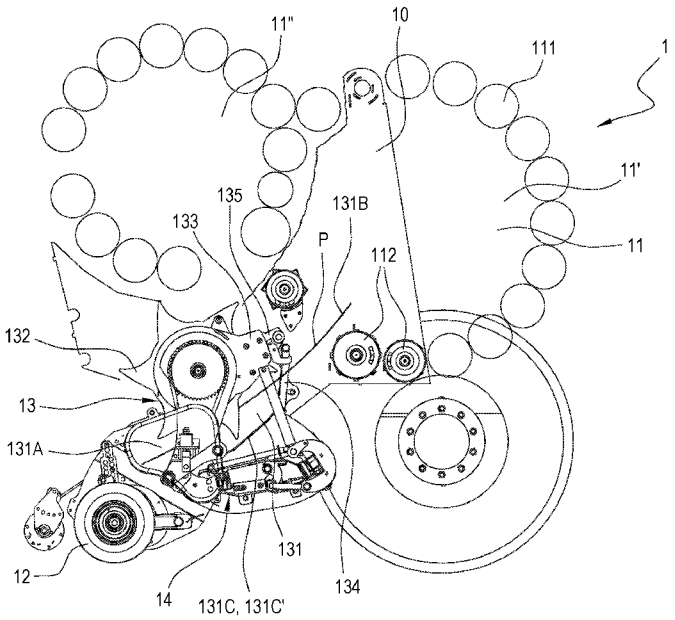
(54) Title: BALER WITH KNIFE PROTECTION SYSTEM

FIG. 1



(57) Abstract: An agricultural machine (1) comprises: a frame (10); a receiver (11), for receiving crops; a pick-up device (12), configured for picking-up the crops from a field; a feeding assembly (13), including a feeding channel (131) and a feeding rotor (132), rotating in a feeding direction (F), to push the crops; a cutting assembly (14), which is configured to cut the crops passing through the feeding channel (131). The cutting assembly (14) includes: a plurality of knives (141), each one pivoting around a respective knife rotation point (142), between an extracted position (E) and a retracted position (R); for each knife of the plurality (141) of knives, a knife protection system (15), configured to retract the respective knife (141), selectively with respect to the other knives of the plurality (141) of knives, in response to an external force (FE) applied to the respective knife (141). For each knife protection system (15), in the extracted position (E) of the knife (141), the driving point (DP) is spaced from the knife rotation point (142) of a first distance, and, in

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the retracted position (R) of the knife (141), the driving point (DP) is spaced from the knife rotation point (142) of a second distance. The second distance is smaller than the first distance.

DESCRIPTION

BALER WITH KNIFE PROTECTION SYSTEM

Technical field

This invention relates to an agricultural machine and to a method for operating an agricultural machine.

In particular, this disclosure relates to agricultural machines such as round balers, square balers, forage wagons or trailers. These machines typically include a feeding system for collecting crops from a field and feed them to a receiving unit such as a baling chamber; also, these machines include a cutting or chopping unit provided with knives configured to cut the crops advancing through the feeding system.

Background art

During the cutting operations, the crops picked-up from the field may include harder objects, such as rocks, that may damage the knives of the cutting unit. Hence, it is necessary that the knife retracts from a feeding channel of the feeding system, allowing the passage of the object and avoiding to be damaged.

The document EP2653025B1 discloses a cutting device for agricultural crops. This document describes a plurality of knife protection system, each one dedicated to a respective knife. Therefore, each knife is individually retracted when it impacts with a harder object.

EP2653025B1 discloses a spring, configured to urge the respective knife in extracted position till the knife impacts the object. The impact produces the retraction of the knife and a compression of the respective spring. When the object has passed the knife, the spring urges again the knife to the extracted position. However, this solution is highly responsive to the impact, in fact the impact force needed to overcome the spring force increase with the dimension of the object passing through the channel.

The document EP1584226B1 discloses a cutting device for agricultural crops. EP1584226B1 discloses a hydraulic cylinder, configured to urge the respective knife in extracted position till the knife impacts the object. The hydraulic cylinder

is connected to a first arm, rotating with a safety shaft. Each knife is connected to a respective second arm, rotating with the safety shaft. The impact produces the retraction of the knife, the rotation of the second arm, the rotation of the first arm and a compression of the hydraulic cylinder. When the object has passed the knife, the hydraulic cylinder urges again the knife to the extracted position.

This document describes a single knives protection system, configured to retract simultaneously all the knives in response to the impact of a harder object.

The system described in EP1584226B1 is not selective and causes the presence of significant amount of uncut crops even when a small object impact a single knife.

Another example of a known agricultural machine is provided by patent document EP3275303A1.

Disclosure of the invention

Scope of the present invention is to overcome the aforementioned drawbacks.

This scope is achieved by the agricultural machine and the method for recover crops that overcomes at least one of the aforementioned drawbacks.

This scope is achieved by the agricultural machine and the method for recover crops according to the appended claims.

According to one aspect of the present disclosure, it regards an agricultural machine. The agricultural machine may be one of the following machines: a round baler, a square baler, a forage wagon or loading wagon or trailer, or other machines. Loading Wagons are used to quickly collect a large quantity of materials, particularly after mowing grass or after a harvester has created a swath of straw; the loading wagon is provided with a pickup device with a plurality of knives. An example of a loading wagon machine is provided in patent document EP2478756A1, which is incorporated by reference herein, for providing a disclosure of those features which are peculiar of loading wagons.

The agricultural machine comprises a frame.

The agricultural machine (also indicated in the following as “machine”) comprises a receiver, for receiving crops.

The machine comprises a pick-up device, configured for picking-up the crops from a field. The pick up device is connected to the frame.

The machine comprises a feeding assembly. The feeding assembly is configured for feeding the crops from the pick-up device to the receiver.

The feeding system includes a feeding channel. The feeding channel has an inlet, for receiving the crops from the pick-up device, and an outlet, opened to the receiver for feeding the crops to the receiver.

The feeding channel is configured to feed crops along a feeding path. The feeding channel comprises a bottom floor. The bottom floor includes a plurality of slots.

The feeding assembly includes a feeding rotor. The feeding rotor is configured to rotate in a feeding direction, to push the crops from the feeding channel into the receiver along the feeding path.

The machine comprises a cutting assembly. The cutting assembly is configured to cut the crops passing through the feeding channel.

The cutting assembly includes a plurality of knives. Each knife of the plurality is pivoting around a respective knife rotation point between an extracted position and a retracted position. In the extracted position, each knife is at least partially inserted into a respective slot of the bottom floor to protrude towards the feeding channel. In the retracted position, each knife is retracted below the bottom floor.

In one embodiment, the machine comprises, for each knife of the plurality of knives, a knife protection system. Each knife protection system is configured to retract the respective knife in response to an external force applied to the respective knife. Each knife protection system is configured to retract the respective knife selectively with respect to the other knives of the plurality of knives.

In one embodiment, each knife protection system includes a lever. The lever is configured to rotate around a rotation point. The lever is connected to the respective knife in a driving point.

In one embodiment, each knife protection system includes a absorber element. The absorber element is connected to the lever in a pushing point. The

absorber element is connected to the frame in a locking point. The absorber element is configured to apply an absorption force on the lever to urge the respective knife towards the extracted position.

For each knife protection system, in the extracted position of the knife, the driving point is spaced from the knife rotation point of a first distance.

For each knife protection system, in the extracted position of the knife, the pushing point is spaced from the knife rotation point of a second distance. For each knife protection system, in the retracted position of the knife, the driving point is spaced from the knife rotation point of a third distance. For each knife protection system, in the retracted position of the knife, the pushing point is spaced from the knife rotation point of a fourth distance.

In one embodiment, the second distance is smaller than the first distance. The fact that the second distance is smaller than the first distance provides a (primary) load reduction (reduction of the forces that moves the knife towards the extracted position), because the driving point moves closer to knife rotation point, reducing the lever arm.

Preferably, the fourth distance is smaller than the third distance. The fact that the fourth distance is smaller than the third distance provides a (secondary) load reduction, because the pushing point moves closer to rotation point of the lever, reducing the lever arm of the absorption force.

In one embodiment, for each knife protection system, the driving point, the rotation point and the pushing point are reciprocally spaced, preferably in such a way that a driving segment between the driving point and the rotation point is angularly spaced by an amplification angle from a pushing segment between the pushing point and the rotation point.

In one embodiment, the locking point and the pushing point are spaced with respect to the pushing segment in such a way that an action segment between the locking point and the pushing point is angularly spaced from the pushing segment.

In one embodiment, the action segment is angularly spaced from the pushing segment by a lever angle. The lever angle has a first value, in correspondence

to the extracted position of the respective knife, and a second value, in correspondence of the retracted position of the respective knife.

In one embodiment, the first value of the laver angle is greater than the second value of the lever angle.

The fact that the first value of the laver angle is greater than the second value of the lever angle provides the (secondary) load reduction, because the pushing point moves closer to rotation point of the lever, reducing the lever arm of the absorption force.

Each knife of the plurality has a cutting side, a bottom side and a lateral side.

Each knife of the plurality has a first vertex, between the cutting side and the lateral side, a second vertex, between the cutting side and bottom side and a third vertex, between the bottom side and the lateral side.

Each knife has a front face and a back face.

In one embodiment, the knife rotation point is placed on the second vertex. In one embodiment, the driving point lies on the bottom side of the respective knife.

In one embodiment, the driving point is movable on the respective knife, following a safety trajectory. In one embodiment, each knife comprises a safety guide, defining the correspondent safety trajectory. The safety guide is configured to house the lever for guiding the driving point along the respective safety trajectory.

In one embodiment, each safety guide is on the bottom side of the respective knife.

In one embodiment, each safety guide has a hook profile, surrounding the driving point.

In one embodiment, each lever has a first arm, connected to the respective knife in the driving point. In one embodiment, each lever has a second arm, connected to the absorber element in the pushing point.

In one embodiment, the first arm and the second arm are rigidly connected.

In one embodiment, the front face faces on the first arm. In one embodiment, the back face faces on the second arm.

In one embodiment, for each knife of the plurality, in the retracted position and/or in the extracted position of the knife, the rotation point is between the pushing point and the driving point along a transversal direction, perpendicular to the direction of the absorption force.

In one embodiment, the amplification angle is greater than 45°. In one embodiment, the amplification angle is greater than 30°. In one embodiment, the amplification angle is greater than 15°.

In one embodiment, for each knife protection system, the absorber element is a traction spring. In one embodiment, an elongation of the absorber element is smaller in the extracted position of the knife, than in the retracted position of the knife.

According to an aspect of the present disclosure, it regards a method for recover crops with an agricultural machine.

The method comprises a step of receiving crops into a receiver. The method comprises a step of picking-up corps from a field with a pick-up device.

The method comprises a step of feeding the crops to the receiver throughout a feeding channel, having an inlet, for receiving the crops from the pick-up device, an outlet, opened to the receiver for feeding the crops to the receiver along a feeding path. Preferably, this step of feeding crops is made also with a feeding rotor, that rotates to push the crops into the feeding channel. The feeding channel includes a bottom floor, including a plurality of slots.

In one embodiment, the method comprises a step of cutting the crops passing through the feeding channel with a plurality of knife.

In one embodiment, the method comprises, for each knife of the plurality, a respective step of pivoting around a respective knife rotation point. In the step of pivoting, each knife pivots between an extracted position, where the knife is at least partially inserted into a respective slot of the bottom floor to protrude towards the feeding channel, and a retracted position, where the knife is retracted below (or partially below) the bottom floor.

In one embodiment, the method comprises, for each knife of the plurality, a respective step of protecting the knife with a correspondent knife protection

system. Each knife protection system retracts the respective knife, selectively with respect to the other knives of the plurality of knives, in response to an external force.

Each protecting step includes a step of rotating a lever, connected to the respective knife in a driving point, around a rotating point.

Each protecting step includes a step of urging the respective knife towards the extracted position with an absorber element, connected to a frame in a locking point. The absorber element applies an absorption force on the lever in a pushing point.

In one embodiment, for each knife protection system, as the knife moves from the extracted position towards the retracted position, the driving point approaches to the knife rotation point. In one embodiment, for each knife protection system, as the knife moves from the extracted position towards the retracted position, the pushing point approaches to the knife rotation point.

In one embodiment, for each knife protection system, as the knife moves from the extracted position towards the retracted position, both the driving point and the pushing point approach to the knife rotation point.

In one embodiment, in the protecting step, the driving point, the rotation point and the pushing point are reciprocally spaced. In one embodiment, a driving segment between the driving point and the rotation point is angularly spaced by an amplification angle from a pushing segment between the pushing point and the rotation point.

In one embodiment, the step of knife protecting includes a step of sliding, wherein the driving point moves on the respective knife following a safety trajectory. In one embodiment, the step of knife protecting includes a step of guiding, wherein a respective safety guide of the knife, defining the correspondent safety trajectory, houses the lever for guiding the driving point along the respective safety trajectory.

In one embodiment, the locking point and the pushing point are spaced with respect to the pushing segment in such a way that an action segment between the locking point and the pushing point is angularly spaced from the pushing

segment of a lever angle.

In one embodiment, the lever angle decreases with a rotation of the knife towards the retracted position.

It is here observed that the machine and/or the method according to the present description provides several advantages.

Firstly, it provides a knife protection system that protects individually the plurality of knives. Moreover, it discloses the knife protection system with a specific geometry thanks to which the forces to push or retract the knife down into the floor unit slots will reduce as the knife rotates and retracts into the down position.

Also, it provides a knife protection system having, for each knife, a lever that engages a respective knife hook (safety guide) or encircled zone in order to physically push the respective knife up into the extracted position with forces acting on the bottom side of the cutting knife, in such a way that the upward forces (the force that keep the knife in the extracted position) while increases linearly as the cutting knife rotates towards the extracted position. Moreover, it provides physical contact of the knife protection system with the knife's hook (safety guide) and or encircled zone to provide positive forces to push or retract the knife back down into the drop floor slots into the retracted position.

In addition to that, it provides a knife protection system that reduces the knife retraction forces by the knife trigger engagement roller (driving point) thanks to the effect of: moving closer to the knives rotation point during the cutting knife retraction and reducing linearly the lever arm of the trigger mechanism (lever) as the spring force (absorber element) increases linearly.

Brief description of drawings

This and other features of the invention will become more apparent from the following detailed description of a preferred, non-limiting example embodiment of it, with reference to the accompanying drawings, in which:

- Figure 1 illustrates a baler for providing bales;
- Figures 2A and 2B illustrate a knife protection system with the respective knife in extracted position and in retracted position, respectively;

- Figures 3A and 3B illustrate other views of the knife protection system with the respective knife in extracted position and in retracted position, respectively.
- Figures 4A and 4B illustrate schematic views of the knife protection system of figure 2A and 2B, respectively.

Detailed description of preferred embodiments of the invention

With reference to the accompanying drawings, the numeral 1 denotes an agricultural machine, according to the present disclosure. In particular, the agricultural machine 1 which is illustrated in the accompanying figures is a baler connectable to a tractor for providing round bales.

The machine 1 includes a receiver 11 for receiving crops. In particular, the receiver 11 is defined by a baling chamber. In an embodiment, the receiver 11 includes a first part 11' for housing a first amount of crops, and a second part 11", for housing a second amount of crops. The receiver 11 includes a plurality of rollers 111, delimiting the baling chamber 11 (in particular, delimiting the first part 11' and the second part 11"). The plurality of rollers 111 are configured to rotate the crops housed in the baling chamber, to form the bale. In an embodiment, the rollers 111 of said plurality have a fixed position. The receiver 11 comprises lateral walls; the rollers 111 of said plurality may be fixed to the lateral walls of the receiver 11.

The machine 1 may comprise one or more starter rollers 112. The starter rollers 112 are configured to start a rotation of the crops. In an embodiment, the machine 1 comprise a frame 10; the frame 10 may be fixed or movable; the starter rollers 112 are mounted on said frame 10. Hence, the starter rollers 112, in an embodiment, have a fixed position; in another embodiment, the starter rollers 112 are movable with respect to the rollers 111.

The machine 1 comprises a pick-up device 12, configured for picking-up the crops from a field. The pick-up device 12 includes a pick-up roll.

The machine 1 comprises a feeding assembly 13.

The feeding assembly 13 is configured to guide the crops from the pick-up device 12 to the receiver 11 along a feeding path P. The feeding assembly 13

includes a feeding rotor 132, rotatable about a rotation axis. The feeding assembly 13 includes a feeding channel 131. The feeding channel 131 extends between an inlet 131A and an outlet 131B. The inlet 131A faces the pick-up device 12. The outlet 131B defines an opening in the receiver 11. The feeding rotor 132 is positioned along the feeding channel 131, downstream of the inlet 131A and upstream of the outlet 131B.

The feeding assembly 13 includes a feeding frame 133. The feeding frame 133 defines a (portion of) a top side of the feeding channel 131. The feeding frame 133 is connected to the feeding rotor 132. In an embodiment, the feeding rotor 132 and the feeding frame 133 are separately rotatable about a rotation axis of the feeding rotor 132. In particular, the feeding rotor 132 is rotatable about the rotation axis to advance the crops through the feeding channel 131.

The feeding assembly 13 includes a bottom floor (drop floor) 131C, defining a (portion of) a bottom side of the feeding channel 131. The bottom floor 131C is positioned between the inlet 131A and the outlet 131B of the feeding channel 131. The feeding rotor 132 is positioned above said drop floor device 131C.

In one embodiment, the bottom floor 131C includes a plurality of slots 131C'. The plurality of slots 131C' are mainly elongated along the feeding path P.

The machine 1 comprises a cutting assembly 14. The cutting assembly 14 is configured to cut the crops passing trough the feeding channel 131.

The cutting assembly 14 is associated with the bottom floor 131C, preferably it is connected to it. The cutting assembly comprises a cutting frame 14', connected to the bottom floor 131C.

The cutting assembly 14 comprises a plurality of knives 141.

Each knife 141 is inserted into a respective slot 131C' of the bottom floor 131C. Each knife 141 is movable into the respective slot 131C', preferably the knife is configured to slide into the respective slot 131C'.

In one embodiment, each knife 141 is connected to the cutting frame 14' in a respective knife rotation point 142. The knife rotation point 142 is fixed with respect to the cutting frame 14'. Each knife 141 is pivoting around the respective knife rotation point 142, between an extracted position E, where the

knife 141 is at least partially inserted into a respective slot 131C' of the bottom floor 131C to protrude (project into) towards the feeding channel 131, and a retracted position R, where the knife 141 is retracted below the bottom floor 131C. In one embodiment, each knife 141 is configured to slide into the respective slot 131C' pivoting around the knife rotation point 142.

Each knife 141 has a cutting side 141A, a bottom side 141B, a lateral side 141C. Each knife 141 has a first vertex 141', between the cutting side 141A and the lateral side 141C, a second vertex 141'', between the cutting side 141A and bottom side 141B and a third vertex 141''', between the bottom side 141B and the lateral side 141C. In one embodiment, the knife rotation points 142 is placed on the second vertex 141''.

Each knife comprises has a front face 141F and a back face.

Each knife comprises a safety guide 143. The safety guide 143 is placed on the bottom side 141B of the respective knife 141. In one embodiment, the safety guide 143 has a hook profile.

In one embodiment, for each knife 141 of the plurality of knife 141, the machine 1 comprises a knife protection system 15.

The knife protection system 15 is configured to properly move the respective knife 141, in order to avoid damage of the same. Each knife protection system 15 is configured to retract the respective knife 141 (selectively) in response to an external force FE applied to the respective knife 141. In other words, each knife protection system 15 is configured to allow the lowering of the respective knife 141 from the feeding channel 131 when some object applies the external force FE to the knife 141.

In one embodiment, each knife protection system 15 includes a lever 151.

The lever 151 is rotating around a rotation point 151'. The lever 151 is connected to the respective knife 141 in a driving point DP. The driving point DP can be a contact point between the lever 151 and the respective knife 141. The rotation point 151' is fixed with respect to the cutting frame 14'.

The lever 151 has a first arm 151A and a second arm 151B. The first arm 151A is connected to the respective knife in the driving point DP.

In one embodiment, the driving point DP is on the safety guide 143. The driving point DP is on the bottom side 141B of the respective knife 141.

The first arm 151A faces the front face 141F while the second arm 151B faces the back face of the respective knife 141.

In one embodiment, the knife protection system 15 comprises a knife selector mechanism 154. The knife selector mechanism 154 comprises a plurality of teeth 154', that may be engaged with the lever 151 for selectively select a knife 141 of the plurality.

The teeth 154' of the knife selector mechanism 154 are configured to be coupled with the lever 151, in order to limit the movement of the lever 151.

In particular, the knife protection system is movable between an activated configuration, wherein the lever 151 is free to rotate around the rotation point 151', and a limited configuration, wherein the rotation of the lever 151 is limited by the teeth of the knife selector mechanism 154. The knife selector mechanism 154 allows to selectively activate or deactivate the knife protection system 15 of each knife 141.

Each knife protection system 15 comprises an absorber element 152. The absorber element 152 is connected to the lever 151 in a pushing point PP. The absorber element 152 is connected to the cutting frame 14' in a locking point LP.

The absorber element 152 is configured to apply an absorption force AF on the lever 151 to urge the respective knife 141 towards the extracted position E.

In one embodiment, the absorber element 152 is a traction spring, configured to apply a force directed towards the locking point LP to urge the respective knife 141 towards the extracted position E.

In one embodiment, the absorber element 152 is connected to the second arm 151B of the lever 151.

For the clarity of the present disclosure, the following geometric entity are defined:

- driving segment S1: segment between the driving point DP and the rotation point 151';

- pushing segment S2: segment between the pushing point PP and the rotation point 151';
- action segment S3, segment between the pushing point PP and the locking point LP;
- transversal direction T, perpendicular to the direction of the absorption force AF;
- first distance D1, distance between the driving point DP and the knife rotation point 142 in the extracted position E of the respective knife;
- second distance D2, distance between the driving point DP and the knife rotation point 142 in the retracted position R of the respective knife;
- third distance D3, distance between the pushing point PP and the knife rotation point 142 in the extracted position E of the respective knife;
- fourth distance D4, distance between the pushing point PP and the knife rotation point 142 in the retracted position R of the respective knife;
- amplification angle A1, angle between the driving segment S1 and the pushing segment S2;
- lever angle A2, angle between the pushing segment S2 and the action segment S3.
- first value A2' of the lever angle A2, that is the value of the lever angle with knife 141 in the extracted position E.
- second value A2'' of the lever angle A2, that is the value of the lever angle with knife 141 in the retracted position R.

With reference to the above definitions, in one embodiment, the second distance is smaller than the first distance. In one embodiment, the fourth distance is smaller than the third distance.

In one embodiment, the amplification angle A1 and the lever angle A2 are greater than zero.

In embodiment, the first value A2' of the lever angle A2 is greater than the second value A2" of the lever angle A2.

In one embodiment, the driving point DP is movable along a safety trajectory. The safety trajectory is defined by the safety guide 143. In particular, the first

arm 151A of the lever 151 includes a coupling extremity, engaged in the hook profile.

The coupling extremity slides into the hook profile keeping contact with the bottom side 141B of the respective knife 141. The contact point between the coupling extremity and the bottom side 141B of the knife 141 defines the driving point DP.

In one embodiment, the coupling extremity includes a roller 153, configured to rotates while the coupling extremity slides into the safety guide 143.

In one embodiment, the rotation points 151' is between the pushing point PP and the driving point DP along a transversal direction T (in the retracted position (R) and/or in the extracted position (E) of the knife).

In one embodiment, the amplification angle (A1) is greater than 45°. In one embodiment, the amplification angle (A1) is greater than 30°. In one embodiment, the amplification angle (A1) is greater than 15°.

In one embodiment, the lever angle A2 is variable with the position of the respective knife 141. In particular, the lever 151 and the absorber element 152 are spaced in such a way that the lever angle A2 decrease as the knife 141 moves towards the retracted position R.

In one embodiment, an elongation of the absorber element 152 is smaller in the extracted position E of the knife 141, than in the retracted position R of the knife 141. In fact, the external force FE needed to get a certain elongation increase with the total elongation of the absorber element.

According to an aspect of the present disclosure, it also provides a method for recover crops with an agricultural machine 1.

The method comprises a step of receiving crops into a receiver 11 (such as a bailing chamber). The method comprises a step of picking-up corps from a field with a pick-up device 12.

The method comprises a step of feeding the crops to the receiver 11 throughout a feeding channel 131, having an inlet 131A, for receiving the crops from the pick-up device 12, an outlet 131B, opened to the receiver 11 for feeding the crops to the receiver 11 along a feeding path P.

In one embodiment, the step of feeding crops includes a step of pushing crops, with a feeding rotor 132. In the step of pushing crops, the feeding rotor 132 rotates to push the crops into the feeding channel 131. The feeding channel 131 includes a bottom floor 131C, including a plurality of slots 131C'.

In one embodiment, the method comprises a step of cutting the crops passing through the feeding channel 131 with a plurality of knife 141 (or with a cutting assembly 14).

In one embodiment, the method comprises, for each knife of the plurality 141, a respective step of pivoting around a respective knife rotation point 142. In the step of pivoting, each knife slides into the respective slot of the plurality 131C'.

In the step of pivoting, each knife 141 pivots between an extracted position E, where the knife 141 is at least partially inserted into a respective slot 131C' of the bottom floor 131C to protrude towards the feeding channel 131, and a retracted position R, where the knife is retracted below (or partially below) the bottom floor 131C.

In one embodiment, the method comprises, for each knife of the plurality 141, a respective step of protecting the knife 141 with a correspondent knife protection system 15. Each knife protection system 15 retracts the respective knife 141, selectively with respect to the other knives of the plurality of knives 141, in response to an external force FE.

Each protecting step includes a step of rotating a lever 151, connected to the respective knife in a driving point DP, around a rotating point 151'.

Each protecting step includes a step of urging the respective knife 141 towards the extracted position E with an absorber element 152, connected to a cutting frame 14' in a locking point LP. The absorber element 152 applies an absorption force AF on the lever 151 in a pushing point PP. In one embodiment, in the step of urging, the absorber element 152 is a traction spring, that applies the absorption force AF towards the locking point LP.

In one embodiment, the method comprises a step of approaching, in which, for each knife protection system 15, as the knife 141 moves from the extracted position E towards the retracted position R, the driving point DP approaches to

the knife rotation point 152. In the step of approaching, for each knife protection system, as the knife 141 moves from the extracted position E towards the retracted position R, the pushing point PP approaches to the knife rotation point 142.

In one embodiment, In the step of approaching, for each knife protection system 15, as the knife 141 moves from the extracted position E towards the retracted position R, both the driving point DP and the pushing point PP approach to the knife rotation point 142.

In one embodiment, the step of knife protecting includes a step of sliding, wherein the driving point DP moves on the respective knife following a safety trajectory. In one embodiment, the step of knife protecting includes a step of guiding, wherein a respective safety guide 143 of the knife 141, defining the correspondent safety trajectory, houses the lever 151 for guiding the driving point DP along the respective safety trajectory.

In one embodiment, in the step of protecting, a lever of the absorption force AF with respect to the rotation point 151' decrease as the knife 141 moves towards the retracted position R.

In one embodiment, in the step of guiding, the driving point DP follows the safety trajectory in a bottom side 141B of the knife 141. In particular, in the step of guiding, a coupling extremity of the lever 151 slides into a hook profile (safety guide 143) of the respective knife 141.

In one embodiment, the rotation points 151' remains, along a transversal direction T (in the retracted position (R) and/or in the extracted position (E) of the knife), between the pushing point PP and the driving point DP.

In the following, a description of exemplary embodiments of the machine 1 is provided. According to one aspect of the disclosure, the machine 1 is a baler of the non-stop type with a pre-chamber (first part) 11" and a main chamber (second part) 11', a pickup device 12, a floor unit (bottom floor) 131C and a cutting assembly 14 forming a feeding channel 131 to feed crop into the main chamber 11' and or the pre-chamber 11". The cutting assembly 14 comprises (for each knife of the plurality 141) of a knife protection system 15 in which the

knife 141 pivots around a pivot point (knife rotation point) 142. The cutting assembly 14 comprises a knife trigger mechanism with a lever 151 pivoting around a rotation point 151' tensioned by a spring 152 hooked at the driving point DP and the locking point LP. The cutting assembly 14 comprises a roller 153 attached to the coupling extremity of the lever 151 in the driving point DP engaging the knife in the safety guide 143 to forcefully move the knife 141 in the extracted position E and into a retracted position R. The rotational movement of the knife trigger mechanism (lever 151 and spring 152) in one rotational direction (in the direction towards the retracted position R) results with the roller 153 moving closer to the knives rotation point 142 and to the pushing point PP of the springs moves in a direction closer to the knife rotation point 142.

The knife protection system 15 doubly decreases the forces by means of the spring 152, the lever 151 but also with the roller 153 that moves closer to the knife rotation point 142. On the other hand, when forcefully moving the knife into the extracted position E, the forces are doubly by means of the spring 152, the lever 151 but also with the roller 153 that moves moving further away from the knife rotation point 142, maximizing the knife engagement forces.

In another aspect of the disclosure, the roller 153 are encompassed by the knife's hooking zone defined by a hook type shape enabling the lever 151 (the roller 153) to contact the knife 141 in the hooking zone for moving/ forcing the knife 141 into the extracted position E and/or the retracted position while the lever 151 is always in contact with the knife 141 within the knife's hooking zone (safety guide) 143.

In another aspect of the disclosure, the trigger mechanism (lever 151), its arms (151A, 151B) and the pushing point PP rotate in a direction resulting with the lever arm distance of the pushing point PP with respect to the rotation point 151' being reduced as the trigger mechanism 151 rotates and pushes the knife 336 into the retracted position R. Instead, the lever arm distance of the pushing point PP increases as the trigger mechanism (lever 151) rotates and pushes the knife 141 into the extracted position E.

According to another aspect of the disclosure, during the rotation of the trigger

mechanism 151 through rotation point 151', a first dimensional value ZZ and a second dimensional value YY are directly proportional to each other. In particular, when rotation results in the trigger mechanism 15 pushing the knife in the extracted position E, the first dimensional value ZZ and the second dimensional value YY increase relative to each other. Om the other hand, when rotation results in the trigger mechanism pushing the knife in the retracted position R, the first dimensional value ZZ and the second dimensional value YY decrease relative to each other.

Figure 1 illustrates a section view through the side of the baling machine 1 and shows the machines bottom floor 131C and cutting assembly 14 in the up and working position. The deflector plate mechanism 134 is in the down position to feed crop through the pickup device 12 and through the feeding rotor 133 through the feeding channel 131 and into the main chamber 11'. The scraper mechanism 135 is also in the down and working position for crop feeding into the main chamber 11'.

The cutting assembly 14 includes: the cutting knife 141, the knife's hooking zone (safety guide) 143 in which the cutting unit trigger mechanism (lever 151) with roller 153 engages the knife in the hooking zone and the trigger mechanism spring (absorber element) 152 to provide a force on the knife 141 in the knife's hooking zone 143 to maintain the knife 141 in the extracted position E while grass is being pushed through the knife 141. The trigger mechanism is configured to deactivate the lock in the knife's hooking zone 143 when a peak force (external force FE) from a foreign object is forced through the cutting knives 141 by the feeding rotor 133.

Figure 2A illustrates the cutting assembly 14, the knife 141 and trigger mechanism 151 from the cutting assembly 14. The knife 141 is shown is the extracted position. The trigger mechanism 151 is in a rotated-up position at the largest distance away from the knife's rotation point 142 but crucially it is within the knife's hooking zone 143 for the pushing of the knife up and down. The spring 152 is in a packed configuration.

In this case the knife selector 154 is in an inactive position and therefore the

trigger mechanism 151 is free to rotate around the rotation point 151' into the up and active working position.

As a result, the knife 141 is in the up and working position engaging with the feeding rotor 133 and the incoming crop through the feeding channel 131

Figure 2B illustrates the cutting assembly 14, the knife 141 and trigger mechanism 151 from the cutting assembly 14. The knife 141 is shown is the retracted position R. The trigger mechanism 151 is in a rotated down position closer to the knife's rotation point 142 but crucially it is within the knife's hooking zone 143 for the pushing of the knife 141 up and down. The spring 152 is elongated. The knife selector mechanism 154 is positioned under the knife's trigger mechanism (lever 151) so the teeth 154' of the selector mechanism 154 rotate in order to position different teeth in various positions across the cutting assembly 14 so different combinations of knives may be selected.

In this example in this illustration, the selector mechanism tooth 154' is in position to block the trigger mechanism 151 from rotation which as a result prevents the trigger mechanism 151 from rotation and therefore the knife 141 is blocked from entering into the extracted position E.

CLAIMS

1. An agricultural machine (1), comprising:

- a frame (10);

- a receiver (11), for receiving crops;

- a pick-up device (12), configured for picking-up the crops from a field;

- a feeding assembly (13), including:

a feeding channel (131), having an inlet (131A), for receiving the crops from the pick-up device (12), an outlet (131B), opened to the receiver (11) for feeding the crops to the receiver (11) along a feeding path (P) and a bottom floor (131C), including a plurality of slots (131C');

a feeding rotor (132), rotating in a feeding direction (F), to push the crops from the feeding channel (131) into the receiver (11) along the feeding path (P);

- a cutting assembly (14), which is configured to cut the crops passing through the feeding channel (131) and includes

a plurality of knives (141), each one pivoting around a respective knife rotation point (142), between an extracted position (E), where the knife (141) is at least partially inserted into a respective slot (131C') of the bottom floor (131C) to protrude towards the feeding channel (131), and a retracted position (R), where the knife (141) is retracted below the bottom floor (131C);

for each knife of the plurality (141) of knives, a knife protection system (15), configured to retract the respective knife (141), selectively with respect to the other knives of the plurality (141) of knives, in response to an external force (FE) applied to the respective knife (141),

wherein each knife protection system (15) includes

a lever (151), rotating around a rotation point (151') and connected to the respective knife (141) in a driving point (DP);

an absorber element (152), connected to the lever (151) and to the frame (10) in a pushing point (PP) and in a locking point (LP), respectively, and which is configured to apply an absorption force (AF) on the lever (151) to urge the respective knife (141) towards the extracted position (E),

characterized in that, for each knife protection system (15), in the extracted

position (E) of the knife (141), the driving point (DP) is spaced from the knife rotation point (142) of a first distance, and, in the retracted position (R) of the knife (141), the driving point (DP) is spaced from the knife rotation point (142) of a second distance, wherein the second distance is smaller than the first distance.

2. Agricultural machine (1) according to claim 1, for each knife protection system (15), in the extracted position (E) of the knife (141), the pushing point (PP) is spaced from the knife rotation point (142) of a third distance, and, in the retracted position (R) of the knife (141), the pushing point (PP) is spaced from the knife rotation point (142) of a fourth distance, wherein the fourth distance is smaller than the third distance.

3. Agricultural machine (1) according to claim 1 or 2, wherein, for each knife protection system (15), the driving point (DP), the rotation point (151') and the pushing point (PP) are reciprocally spaced in such a way that a driving segment (S1) between the driving point (DP) and the rotation point (151') is angularly spaced by an amplification angle (A1) from a pushing segment between the pushing point (PP) and the rotation point (151'), wherein the locking point (LP) and the pushing point (PP) are spaced with respect to the pushing segment (S2) in such a way that an action segment (S3) between the locking point (LP) and the pushing point (PP) is angularly spaced from the pushing segment (S2).

4. The agricultural machine (1) according to claim 3, wherein the action segment (S3) is angularly spaced from the pushing segment (S2) by a lever angle (A2) that has a first value (A2'), in correspondence to the extracted position (E) of the respective knife (141), and a second value (A2"), in correspondence of the retracted position (R) of the respective knife (141), and wherein the first value (A2') of the laver angle (A2) is greater than the second value (A2'') of the lever angle (A2).

5. The agricultural machine (1) according to any of the preceding claims, wherein each knife (141) has a cutting side (141A), a bottom side (141B), a lateral side (141C), a first vertex (141'), between the cutting side (141A) and the lateral side (141C), a second vertex (141''), between the cutting side (141A) and

bottom side (141B) and a third vertex (141'''), between the bottom side (141B) and the lateral side (141C) and wherein the knife rotation point (142) is placed on the second vertex (141'') and wherein the driving point (DP) lies on the bottom side (141B) of the respective knife (141).

6. The agricultural machine (1) according to any of the preceding claims, wherein, for each knife protection system (15), the driving point (DP) is movable on the knife (141) following a safety trajectory, and wherein the knife (141) comprises a safety guide (143), defining the correspondent safety trajectory and configured to house the lever (151) for guiding the driving point (DP) along the respective safety trajectory.

7. The agricultural machine (1) according to claim 6, wherein, for each knife protection system (15), the safety guide (143) is on the bottom side (141B) of the respective knife (141).

8. The agricultural machine (1) according to claim 6 or 7, wherein the safety guide (143) has a hook profile, surrounding the driving point (DP).

9. The agricultural machine (1) according to any of the preceding claims, wherein each lever (151) has a first arm (151A), connected to the respective knife (141) in the driving point (DP), and a second arm (151B), connected to the absorber element (152) in the pushing point (PP).

10. The agricultural machine (1) according to claim 9, wherein the first arm (151A) and the second arm (151B) are rigidly connected.

11. The agricultural machine (1) according to claim 9 or 10, wherein each knife has a front face (141F) and a back face, and wherein the front face (141F) faces on the first arm (151A) and the back face faces on the second arm (151B).

12. The agricultural machine (1) according to any of the preceding claims, wherein, in the retracted position (R) and/or in the extracted position (E) of the knife, the rotation point (151') is between the pushing point (PP) and the driving point (DP) along a transversal direction (T), perpendicular to the direction of the absorption force (AF).

13. The agricultural machine (1) according to any of the preceding claims,

wherein the amplification angle (A1) is greater than 45°.

14. The agricultural machine (1) according to any of the preceding claims, wherein, for each knife protection system (15), the absorber element (152) is a traction spring, an elongation of the absorber element (152) being smaller in the extracted position (E) of the knife (141), than in the retracted position (R) of the knife (141).

15. The agricultural machine (1) according to any of the preceding claims, wherein the agricultural machine is a baler or a loading wagon.

16. A method for recover crops with an agricultural machine (1) comprising the following steps:

- receiving crops into a receiver (11);
- picking-up corps from a field with a pick-up device (12);
- feeding the crops to the receiver with a feeding rotor (132) throughout a feeding channel (131), having an inlet (131A), for receiving the crops from the pick-up device (12), an outlet (131B), opened to the receiver (11) for feeding the crops to the receiver (11) along a feeding path (P) and a bottom floor (131C), including a plurality of slots (131C');
- cutting the crops passing through the feeding channel (131) with a plurality of knife (141);
- pivoting of each knife (141) around a respective knife rotation point, between an extracted position (E), where the knife (141) is at least partially inserted into a respective slot (131C') of the bottom floor (131C) to cross the feeding channel (131) transversally with respect to the feeding path (P), and a retracted position (R), where the knife (141) is retracted below the bottom floor (131C);
- protecting each knife (141) with a respective knife protection system (15), wherein the knife protection system (15) retracts the respective knife (141), selectively with respect to the other knives of the plurality (141) of knives, in response to an external force (EF),

wherein the protecting step includes:

- rotating a lever (151), connected to the respective knife (141) in a driving point (DP), around a rotating point (151');

- urging the respective knife (141) towards the extracted position (E), with an absorber element (152), connected to a frame (10) in a locking point (LP) and applying an absorption force (AF) on the lever (151) in a pushing point (PP), characterized in that, for each knife protection system (15), as the knife (141) moves from the extracted position (E) towards the retracted position (R), the driving point (DP) approaches to the knife rotation point (142).

17. The method of claim 16, wherein, for each knife protection system (15), as the knife (141) moves from the extracted position (E) towards the retracted position (R), the pushing point (PP) approaches to the knife rotation point (142).

18. The method of claim 16 or 17, wherein, in the protecting step, the driving point (DP), the rotation point (151') and the pushing point (PP) are reciprocally spaced in such a way that a driving segment (S1) between the driving point (DP) and the rotation point (151') is angularly spaced by an amplification angle (A1) from a pushing segment between the pushing point (PP) and the rotation point (151').

19. The method according to claim 18, wherein the step of knife protecting includes a step of sliding, wherein the driving point (DP) moves on the respective knife (141) following a safety trajectory, and a step of guiding, wherein a respective safety guide (143) of the knife (141), defining the correspondent safety trajectory, houses the lever (151) for guiding the driving point (DP) along the respective safety trajectory.

20. The method according to claim 18 or 19, wherein the locking point (LP) and the pushing point (PP) are spaced with respect to the pushing segment (S2) in such a way that an action segment (S3) between the locking point (LP) and the pushing point (PP) is angularly spaced from the pushing segment (S2) of a lever angle (A2), and wherein, in the step of knife protecting, the lever angle (A2) decreases with a rotation of the knife towards the retracted position (R).

21. The method according to any of the preceding claims from 16 to 20, wherein the agricultural machine is a baler or a loading wagon.

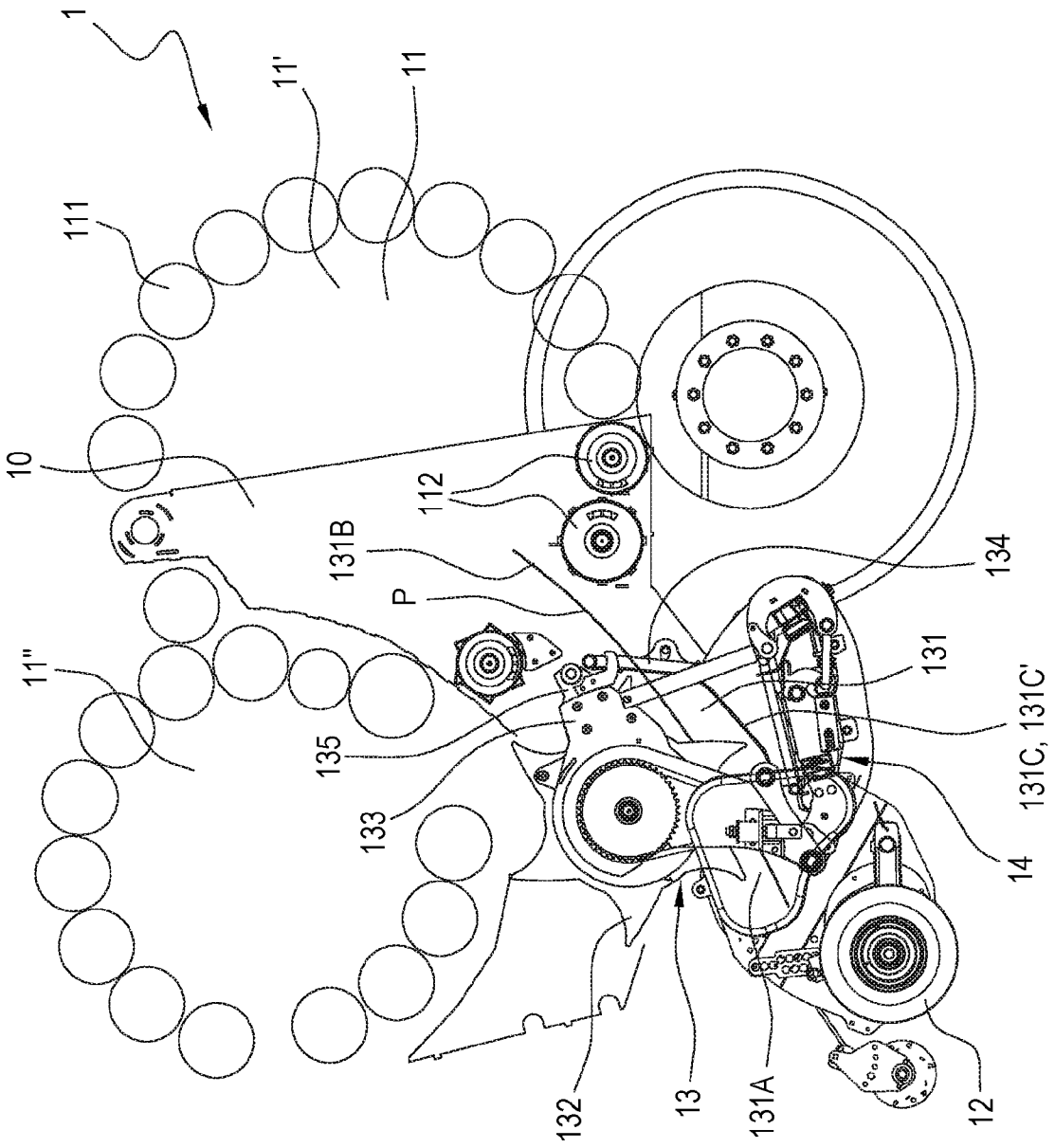

1
11'
11
111
10
112
131B
P
134
11"
131
135
131C, 131C'
133
14
132
13
131A
12

FIG. 1

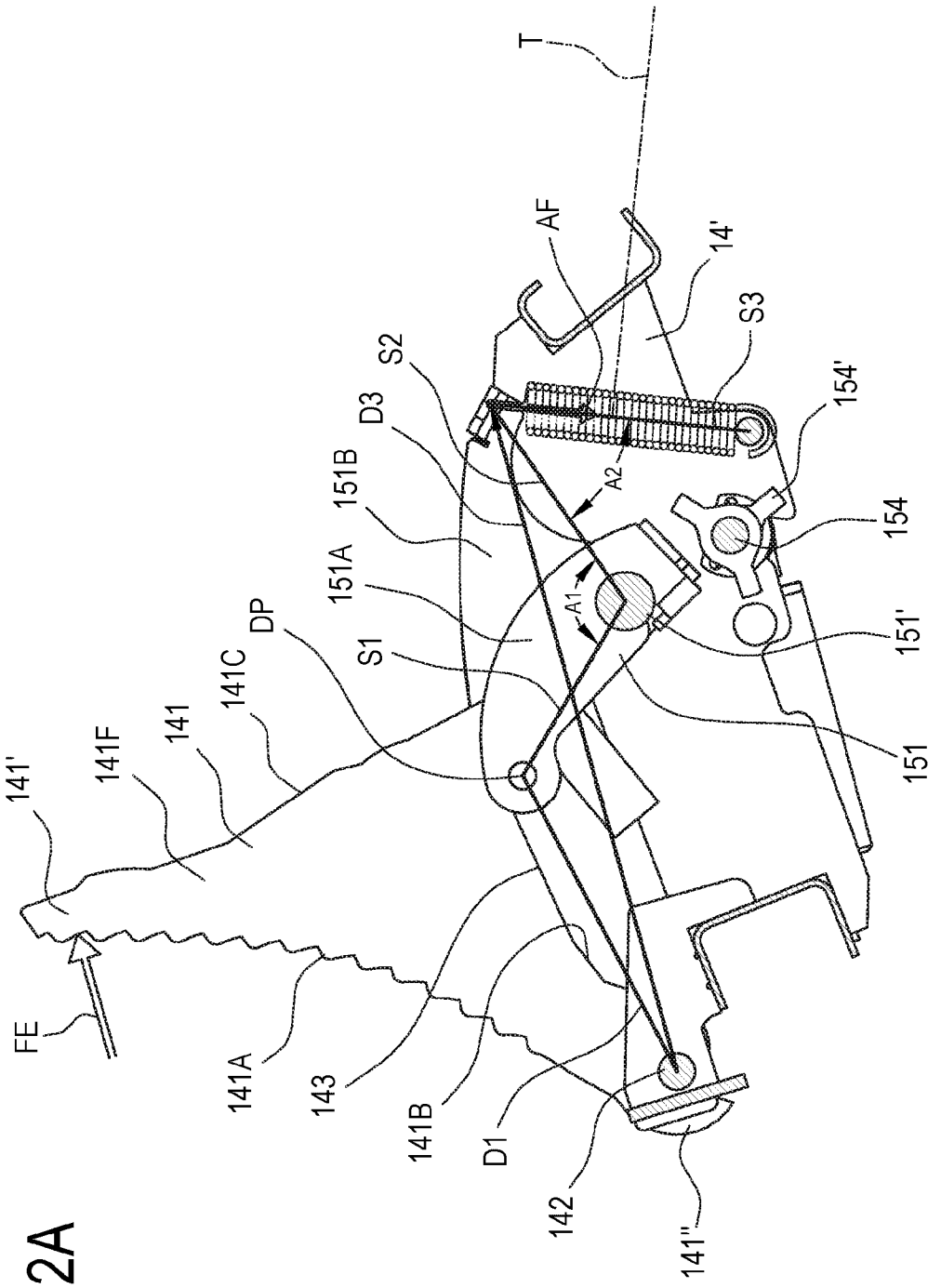

T
AF
14'
S3
S2
D3
154'
151B
A2
154
151A
A1
DP
S1
151'
141C
141
141F
141'
151
FE
141A
143
141B
D1
142
141"

FIG. 2A

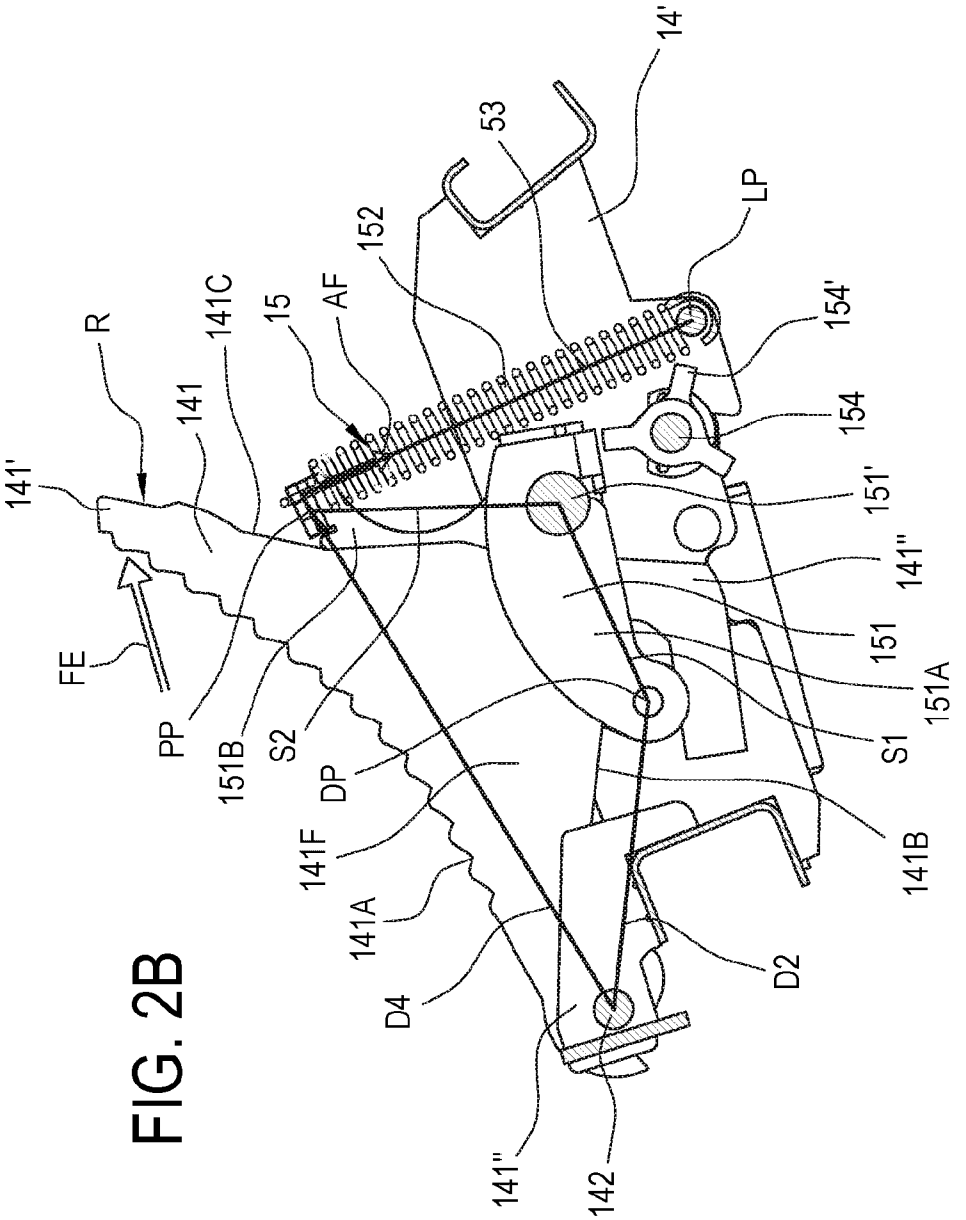

14'
53
LP
152
AF
15
141C
R
141
141'
154'
154
151'
141"
151
151A
S1
141B
D2
FE
PP
151B
S2
DP
141F
141A
D4
141"
142

FIG. 2B

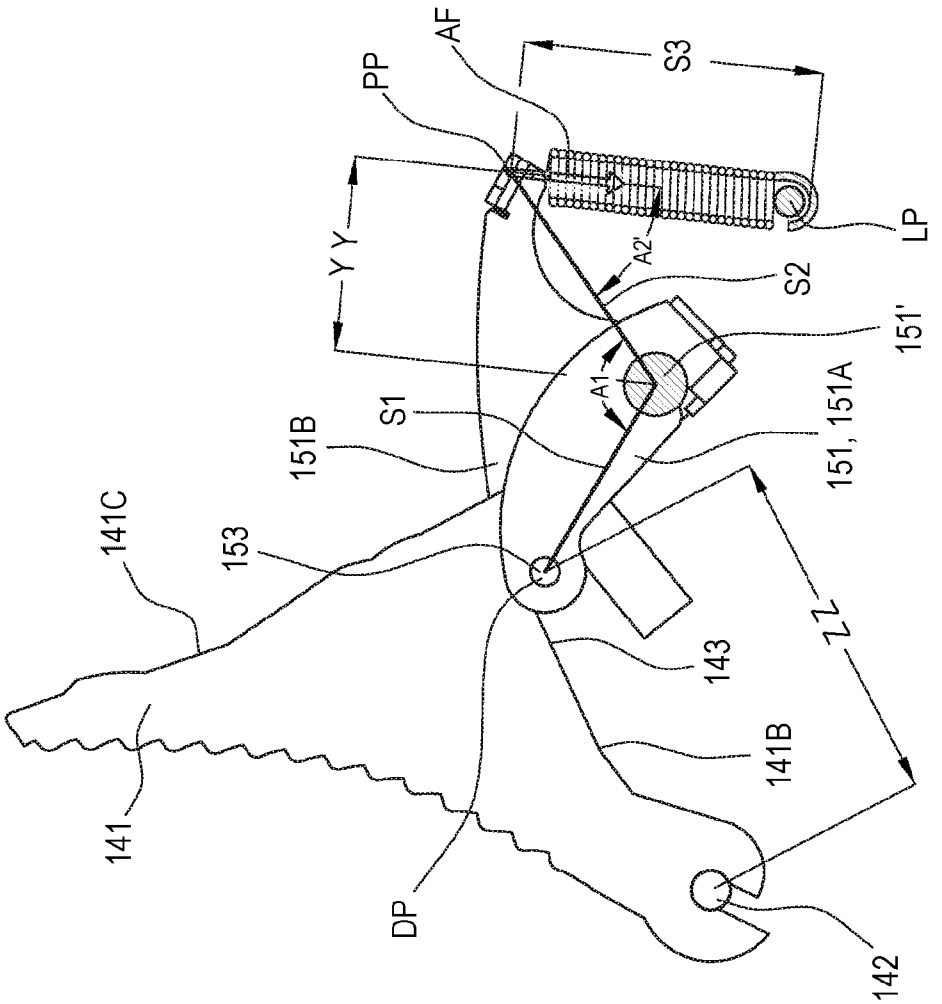

AF
S3
PP
LP
Y Y
A2'
S2
151'
A1
S1
151B
151, 151A
141C
153
143
L1
141B
141
DP
142

FIG. 3A

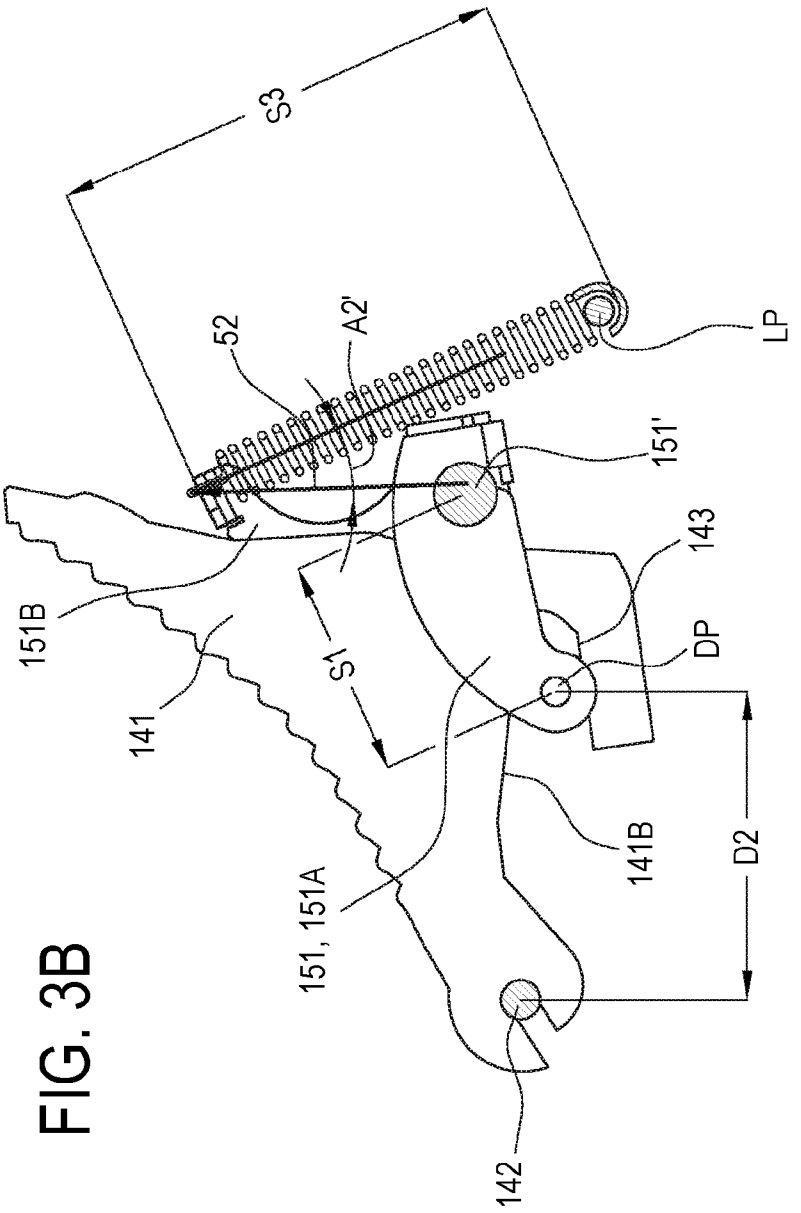


FIG. 3B

FIG. 4B

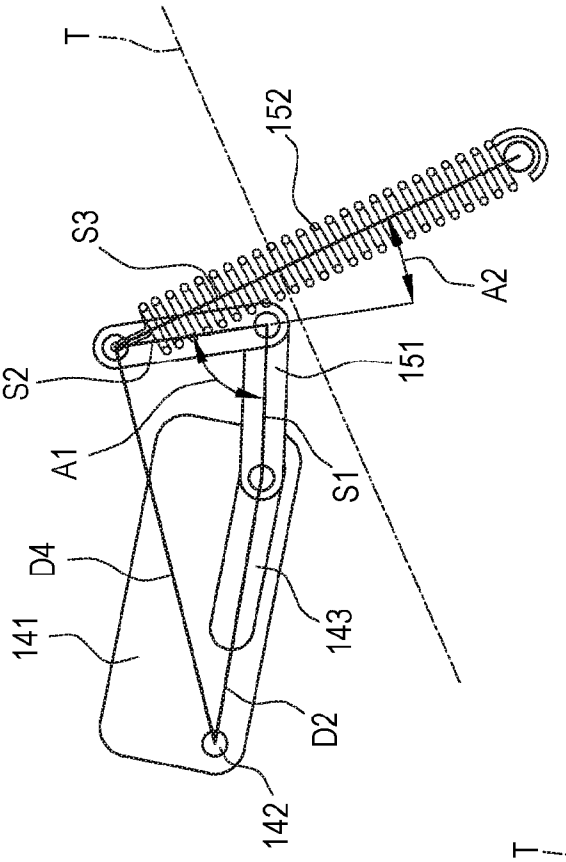

T
152
S3
A2
S2
151
A1
S1
D4
143
141
D2
142

FIG. 4A

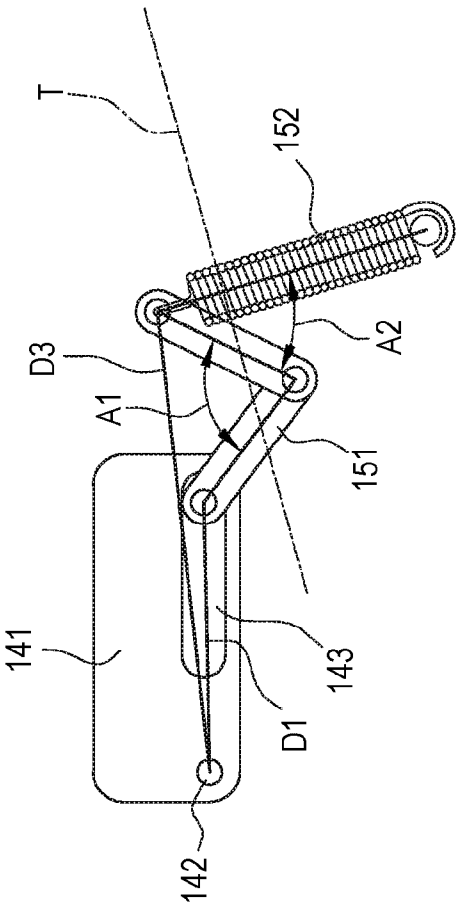
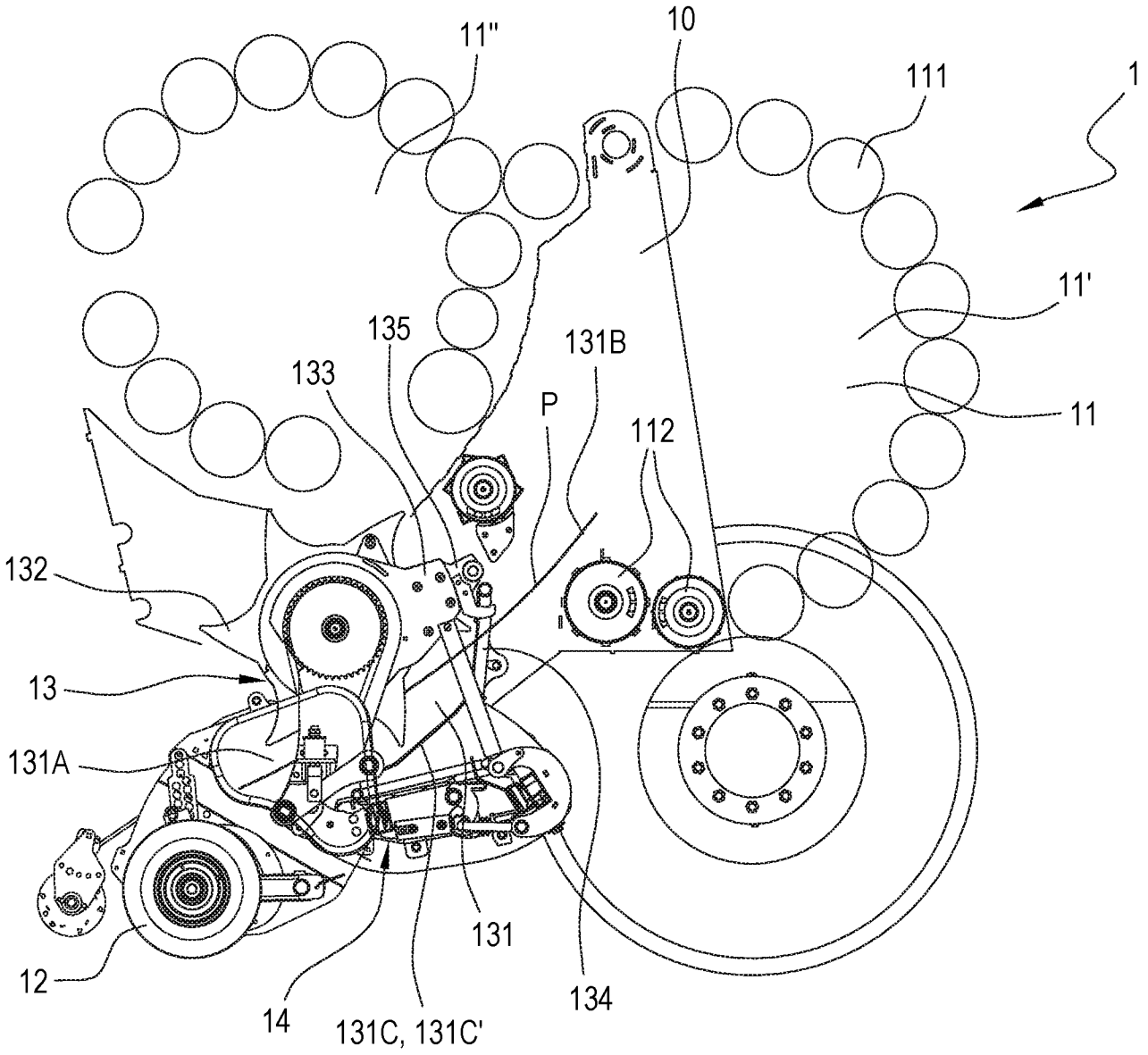

T
152
A2
D3
A1
151
141
143
D1
142

FIG. 1


11"
10
111
1
11'
135
131B
133
P
112
11
132
13
131A
131
12
14
131C, 131C'
134