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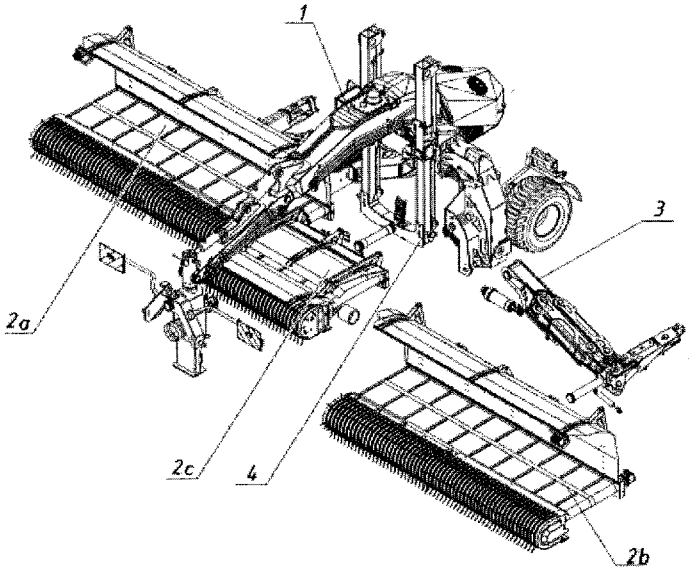


Fig. 1

(57) Abstract: The subject of the invention is a hopper hay rake for the harvesting of straw, in particular from legumes, used in precision agriculture. The hay rake according to the invention is characterized in that the frame (1) in the rear part is connected with the running wheels by movable rocker arms (9), where between the rocker arms (9) and the frame (1) hydraulic actuators S3 (22) are installed, whereas the frame (1) consists of at least two profiles (11, 12), where the profile of frame I (11) is connected in a swinging manner with the profile of frame II (12), and between the profile of frame I (11) and the profile of frame II (12) a hydraulic actuator S2 (21) is installed, whereas a system of guides (19) of a lift (4) is installed to the profile of the frame I (11), with a working unit (2c) installed on the lift (4), forming the middle pick-up and belt section, and on both sides of the hay rake working units (2a and 2b) are installed forming the side pick-up and belt sections, which are connected with the frame (1) by a system of actuated arms (3).

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Hopper hay rake for the harvesting of straw, in particular from legumes

The subject of the invention is a hopper hay rake for the harvesting of straw, in particular from legumes, used in precision agriculture, in particular in the collecting of hay from previously mowed agricultural grassland and forming a haystack from previously collected hay.

Prior art includes many devices used for the raking of bulky agricultural produce (including hay, partly dried green forage, stem plants etc.) from the area of the field and forming them into longitudinal windrows. These include rakes, which can include rotary rakes (single- and multi-section), as well as rake-tedders.

A disadvantage of the rakes known from the prior art, e.g. rotary rakes, is the compacting of collected material, which is placed in a haystack during the shifting process, as a consequence of which the compacted material dries in an uneven fashion, and the entire process takes longer.

Pick-up belt rakes are also known, in which the plants are picked up from the surface and then transported by the belt to the edge of the device, at the side of which a windrow is formed. The pick-up belt rakes include both single section and multi-section rakes, including two- or three-section ones. These rakes may be equipped with classical or belt-and-finger pick-ups, and the working width of the machine depends on both the number of sections and the width of working units.

A patent application from the Industrial Institute of Agricultural Machinery registered under the number of P.419096 demonstrates a rake attached to an agricultural tractor, containing a load-bearing frame supported on one side on a running chassis, and on the other side on the tractor by a hitch, having a pick-up and a transverse belt, which form a pick-up belt section, correspondingly left and right, where the pick-up belt sections are attached to the load-bearing frame in a sliding manner, which enables the smooth changes of their position transverse to the machine's direction of travel.

A disadvantage related to the use of solutions known from the prior art is the limited possibility of adjusting the clearance between the ground and the working units of the rakes, as well as the limited possibilities of controlling the individual sections of the rake, in particular in case of three-section rakes. In known solutions the middle section is generally a fixed element of the rake, which may only be removed under workshop conditions (without the possibility of adjusting the height). In case of solutions with a moving middle section the

working unit is raised with rods. However the use of rods causes some dependency between the raising height and the rod height, which has an adverse impact on the length of the entire equipment.

The solution according to the invention eliminates the problems and disadvantages known from the state of the art.

The essence of the invention, which is a hopper hay rake for the harvesting of straw, in particular from legumes, consists of the hay rake frame in the rear part being connected with the running wheels by movable rocker arms, where between the rocker arms and the frame hydraulic actuators S3 are installed, whereas the frame consists of at least two profiles, where the profile of frame I is connected in a swinging manner with the profile of frame II, and between the profile of frame I and the profile of frame II the hydraulic actuator S2 is installed, whereas a system of guides of a lift is installed to the profile of the frame I, with a working unit installed on the lift, forming the middle pick-up and belt section, and on both sides of the hay rake working units are installed forming the side pick-up and belt sections, which are connected with the frame by a system of actuated arms.

It is advantageous when the system of each of working unit folding arms forms a scissor mechanism consisting of an arm profile, a scissor unit, a rotating holder and a clamping ring for unit rotation, where the scissor system is formed by at least two rods in the form of channel sections working in a common kinematic system, in which system the movement is performed with the use of hydraulic actuators S6, attached between the rod rotation attachment points, and the scissor system is attached to the rotating holder, whereas on the second side of the rotating holder the clamping ring for unit rotation is installed in a rotating manner, which is rotated with the actuator S7 attached to the rotating holder, whereas between the arm profile and the frame a telescoping actuator S5 is installed.

It is particularly advantageous when the scissor mechanisms for folding the arms are connected with the frame by legs, advantageously connected to the frame with temporary fasteners.

It is additionally advantageous when each of the working sections consists independently of a pick-up system and a belt conveyor system, where each of the systems has a separate load-bearing frame and is equipped with a separate drive system, advantageously with working speed adjustment.

Moreover it is advantageous when the system for attaching the finger pick-up to the belt conveyor consists of a fastening pin, which is fastened on the belt conveyor and of a fastening sleeve, which is fastened on the pick-up, where after sliding one element into the second a hinge mechanism is created.

It is also advantageous, when the finger pick-up of the working unit has a drum driven by a hydraulic motor and connected with it by a clutch, where on the drum ball bearings are installed, on which crosspieces are set, and each crosspiece is a union of a tube and a rod,

whereas a spring fingers unit is placed on the crosspieces of the pick-up, operating in accordance with the shape of a guiding cam, advantageously consisting of two pieces.

It is also advantageous when the side working units are installed on rollers, which enable the rotation of the working unit, driven by an actuator S8, with the actuator being attached to the clamping ring for unit rotation.

It is also advantageous when the middle working unit is set on a roller which is symmetrically placed in relation to the lift, whereas the system is protected against excessive rotation of the working unit by limiters with dampening rubber stops.

It is especially advantageous when the lift is installed on a lift guide, resting on rollers, where the play in the telescope is adjusted with the thickness of an plastic plate insert with sliding properties, and the more precise adjustment of the insert pressure is performed in the four corners by four pressure screws corresponding to these corners.

It is also advantageous when a guard is attached to the frame of any of the belt conveyors, the guard most advantageously consisting of two guarding plates and following bars connected with the belt frame by the actuator S4.

It is also advantageous when underneath of the working units a system of rollers is attached, which forms a system of two pairs of rocker arms, connected to each other on one axis, where the rocker arm I has a roller which acts as the axis of rotation for both rocker arms, whereas the rocker arm II has a sleeve which is set on the roller of the rocker arm I which enables the rotation of the rocker arm I in relation to the rocker arm II, whereas the roller of the rocker arm I is placed in a moving manner in the clamping ring, which is bolted to the frame of the belt conveyor.

Moreover it is advantageous when in the front part of the frame a load-bearing pillar is installed, most advantageously with a support plate, and it is also advantageous when in the front part of the frame a three-point hitch beam is installed, whereas it is particularly advantageous when the load-bearing pillar, the three-point hitch beam and the support plate are connected to each other with a turn-plate.

It is additionally advantageous when to the profile of the frame I a load-bearing tray is bolted on, with a central point of the entire hydraulic system located on the tray, whereas it is particularly advantageous when moving guards of the hydraulic system elements are attached to the profile of the frame I.

It is also advantageous when elements of the hydraulic control system are placed within the frame, and it is also advantageous when the hydraulic oil tank forms an integral part of the frame.

It is moreover advantageous when in the zone of the belt conveyors of any of the working sections a harvest volume monitoring device is installed, whereas it is both advantageous when the harvest volume monitoring device is a lidar, as well as it is advantageous when the harvest volume monitoring device is an optical system which contains a camera and an infrared multi-point illuminator, connected to the hay rake's location recording system and to

a data recorder, whereas the drive systems of the working units are equipped with speed adjusters, which are connected to the optical system by a system of controllers.

The use of the solution presented in the invention enables, among others, the following technical and utility effects:

- the ability to adjust the clearance between the ground and the working units, which enables obtaining a high clearance when the hay rake is working on the headland, while keeping the working units in a horizontal position,

- ensuring high efficiency of the process while maintaining optimum external dimensions of the hay rake,

- the possibility of the hay rake operating in various configurations, with the use of various working sections, which helps the operator to perform works in unfavourable spatial configurations of grassland and increases flexibility in the planning of methods of performing future agrotechnical treatments, e.g. the possibility of simultaneous operation of three sections, ejecting the hay to one or the another side of the hay rake, or to both sides, as well as in the second case, when the system assumes the possibility of operating of two sections collecting the hay inside the machine with raised, non-working middle section, without having to remove it.

- removing the risk of sod damage by the operation of the working units due to the use of a hydraulic unit to relieve the working units instead of springs,

- increased operation efficiency while maintaining quality of the collected material, including high cleanliness of the harvest and better partial drying

- obtaining high cleanliness of the harvest and better partially dried hay.

The hay rake according to the invention, in the example implementation, which is not limiting, was presented on drawings, where on Fig. 1 the main sub-systems of the machine are presented in a perspective view. On Fig. 2 the structure of the frame is presented with the running chassis in a general view, whereas on Fig. 3 individual elements of the frame were presented, in particular elements which enable it to articulate. On Fig. 4 the position of individual elements during the adjustment of clearance in operating conditions and while on headlands. The construction of the operating unit forming a single pick-up and belt section was presented on Fig. 5, whereas the construction of the pick-up was presented on Fig. 6 and the construction of the belt conveyor was presented on Fig. 7. On Fig. 8 a view of the belt conveyor with guards in, respectively, open position and closed position was shown. The system of the following mechanism's rollers is presented on Fig. 9. On Fig. 10 versions of the hay rake operation depending on the used working units are presented. The elements of the arms used to raise and fold the working units are presented on Fig. 11, whereas on Fig. 12 the stages of raising the working units are presented, respectively in rear and right side views.

Hay rake according to the invention, that is an overshot hay rake for the harvesting of straw, in particular from legumes, in an example implementation is a half-suspended device, attached to the tractor using a three-point hitch, category 3.

The main elements of the hay rake include the system of the load-bearing frame (1), to which three working units (2) are attached, including working units (2a and 2b) forming side pick-up and belt sections, which are attached to the frame (1) by scissor mechanisms for folding the arms (3) and the a working unit (2c), forming the middle pick-up and belt section, which is attached to the frame (1) by a lift (4) system.

The load-bearing structure of the hay rake is formed by an articulated frame (1), which is composed of two moving rocker arms (9), two legs (10), frame I profile (11) and frame II profile (12), load-bearing pillar (13), turn-plate (14), support plate (15) and three-point hitch beam (16). Legs (10) are connected with the frame (1) with temporary fasteners, which enables their removal and allows to easily break up the machine, e.g. for servicing purposes or for shipment in a container, without having to perform a complete disassembly of all parts.

In the rear part of the frame (1) to the frame I profile (11) a load-bearing tray (17) is bolted on, with a central point of the entire hydraulic system (5) located on the tray (17) which is covered by a guard (18) of the hydraulic system (5), with the guard (18) being attached to the frame I profile (11) with hinges, which allows it to be easily raised and lowered, providing easy access to the elements of the hydraulic system (5).

Two lift guides (19) are bolted to the frame I profile (11), with the guides used in the operation of the lift mechanism (4).

Frame (1) provides a load-bearing function for the working units (2), hydraulic system (5), electric control system (6), brakes (7), warning signs and lighting. In the frame (1) the hydraulic oil tank is also located, which is an integral part of the frame (1) at that — the tank fills the natural space in the frame profile.

The frame (1) articulation mechanism consists of: moving rocker arms (9), on which running wheels supporting the frame (1) in the rear part are attached, two-part frame profile divided into frame I profile (11) and frame II profile (12), where the frame profile is articulated, load-bearing pillar (13) keeping the front part of frame (1) in a vertical position and three-point hitch beam (16) and support plate (15), which acts as a support for frame (1) and maintains a fixed height of the frame (1) suspension point in the front part. The load-bearing pillar (13), beam (16) and support plate (15) are connected to each other with a turn-plate (14), allowing them to rotate in respect to each other. The layout of individual elements of the frame folding mechanism is interconnected, creating a coordinated and coupled kinematic system.

The use of a frame folding mechanism achieves a high ground clearance of the working units (2), which is a condition for the correct operation of the hay rake e.g. when working on the headland, and for the ability to keep the working units (2) in a horizontal position. The entire system is powered by hydraulic actuators named S1 (20), S2 (21), S3 (22) whereas the actuators S3 (22) form a pair and are coupled in a system. The actuators S1 (20), S2 (21), S3

(22) are activated simultaneously, which enables the adjustment of ground clearance by raising or lowering of working units (2).

In an example solution the hay rake according to the invention is equipped with two side working units (2a and 2b), which form side sections with a working width of 4 m and with a single working unit (2c), forming the middle pick-up and belt section, with a working width of 2 m. The working units (2a, 2b and 2c) are intended to pick up the hay, and then to transport it to a specific location. Individual working units (2a, 2b and 2c) form the working sections of the machine, which differ in size and placement, while maintaining all the elements of the working unit (2), where in an example implementation each of the working sections (2) of the hay rake consists of a finger pick-up (24) and a slat belt conveyor (23), whereas the drive units are equipped with speed adjusters, which enable the adjustment of the conveyor's (23) speed independently of the rotational speed of the pick-up (24). A guard (25) and a system of rollers (26) for adjusting the operating height of the given unit are attached to the frame of the conveyor (23). In each work unit (2) the finger pick-up (24) and the belt conveyor (23) have a modular construction, that is, they have separate load-bearing frames, which means that the finger pick-up (24) structure is an independent element, which may be easily removed, e.g. for servicing or in case of damage — for replacement of the entire subsystem. The system for attaching the finger pick-up (24) to the belt conveyor (23) consists of a fastening pin (27), which is fastened on the belt conveyor (23) and of a fastening sleeve (28), which is fastened on the pick-up (24), where after sliding one element into the second a hinge mechanism is created. Additionally the pick-up (24) is fastened to the belt conveyor (23) with bolts, which protects the system from unwanted disconnection.

The finger pick-up (24) has a drum (29), which is powered by a hydraulic motor (30) and is connected to it by a clutch (31). On the drum (29) ball bearings are installed, on which crosspieces are set. Each crosspiece is a union of a tube (32) and a rod (33), which ensures increased strength during the hay rake's operation while reducing the mass of the pick-up (24). The crosspiece holder (34), which is used to set the angle of the crosspiece and is set by the guiding cam (35) has a protective pin (36) which protects it against destructive overload in case of unanticipated operation.

On the crosspieces of the pick-up (24) there is a unit (set) of spring fingers (37), which operate in accordance with the shape of the guiding cam (35). The guiding cam (35) consists of two parts, which enables its easy replacement when damaged. In the bottom zone of the pick-up (24) a slide limiter (38) is mounted, which protects the working unit (2) against the pick-up (24) hitting the ground.

When the adjacent sections reach their minimal range, individual sections contact each other. In the contact zone of individual working units (2) a pick-up bumper (39) is located, which ensures that the distance between the sections is maintained.

The slat belt conveyor (23) is composed of the belt (40) with two rows of slats, to which the caching plates (41) may be bolted in order to ensure that the belt (40) more efficiently catches hay, e.g. in the form of dried, light, not compacted hay. In the structure of the conveyor (23) a pair of belt tensioners (42) is installed, which are located opposite to the hydraulic motor. The

belt tensioners (42) were designed in such a manner as to ensure they can be accessed from the side of the belt conveyor (23), which enables the adjustment of the belt tension without removing the pick-up (24).

Two pairs of rollers (26) are bolted to the frame (43) of the belt conveyor (23), along with bumpers (44) which restrict the operating range of the rollers (26), which protects the belt (40) against being damaged when the ground is followed by the roller (26).

On the frame (43) of the belt conveyor (23) holders (45) for attaching of guards (25) are also installed, and a scraper (46) in the form of a bar with a cutter blade installed along the drive roller (47) of the belt (40), which removes any fouling from drive rollers.

The guard (25) is installed to the frame (43) of the belt conveyor (23), composed of two guard plates (48 and 49), following bars (50) and the actuator S4 (60) with an appropriate stroke, which causes the movement of the guard (25) over the required range. The guards (25) are used to keep the hay on the belt (40) and may be used as a base for the installation of other elements and devices, e.g. measuring devices for monitoring the harvest volume. In the example implementation on the guard (25) a lidar (8) is installed, enabling the measurement of harvest volume at a given section of the field.

In the bottom zone of the working units (2) a system of rollers (26) is attached, which forms a system of two pairs of rocker arms (61 and 62), connected to each other on one axis. The rocker arm I (61) has a roller which acts as the axis of rotation for both rocker arms, whereas the rocker arm II (62) has a sleeve which is set on the roller of the rocker arm I (61). This solution enables the rocker arm I (61) to rotate in relation to the rocker arm II (62), which enables adjusting the angle between the rockers, which directly translates to the height of the rollers' (26) position above the ground, which enables the adjustment of the operating height of the working unit (2). Maintaining the set angle between the rocker arms is made possible by the fastening pin (63), which passes through the lug of the rocker arm II (62) and setting plates (64). The setting plates (64) are installed on the sockets of the roller of the rocker arm I (61), which results in the setting plates (64) being locked before moving in relation to the rocker arm I (61). The entire system is bolted together with the cover 65 from the front of the rocker arm II (61) roller.

The roller of the rocker arm I (61) is placed in a moving manner in the clamping ring 66, which is bolted to the frame (43) of the belt conveyor (23), which enables the free following of the terrain during the operation of the working unit (2), despite irregularities present on grasslands.

On the ends of both rocker arms there is a wheel hub (66), with running rollers (67) attached to the hub (66).

The hay rake according to the invention has three working units (2), where two working units (2a and 2b) form side sections and are attached to frame (1) on especially designed moving, folding arms (3), whereas the working unit (2c) forms the middle section and is mounted on the lift (4).

The hay rake according to the invention may operate in various working configurations. In the first case the system of the designed working units 2 assumes the possibility of simultaneous operation of all three sections, whereas depending on the needs it is possible to place the entire hay on the right side of the hay rake or on the left side of the hay rake, it is also possible to partially spread the hay on both sides of the hay rake. In the second case it is possible to turn off the middle section and to simultaneously operate both side sections, whereas it is possible to both partially spread the collected hay on both sides of the hay rake, and it is also possible — in case of a raised, non-operational middle section — to collect the hay inside the machine, without having to remove the working unit (2c). Setting a manual mode it is possible to individually set individual working units, so that the hay is placed in haystacks in accordance with the preferences of the hay rake's user (operator).

The design of the frame (1) enables the collection of hay in the middle zone of the device, since the clearance's area is large enough to enable free flow of a large volume of material collected by working units (2). This solution helps the operator to perform works in unfavourable spatial configurations of grassland and increases flexibility in the planning of methods of performing future agrotechnical treatments

Each of the arms (3) consists of an arm profile (70), scissor unit (72), rotating holder (74) and a clamping ring (75) for unit rotation. Arm profile (70) enables raising the entire arm (3) together with the working unit (2) to a vertical position using a telescoping actuator S5 (71) attached to the frame (1) of the device. The scissor unit (72) is formed by two rods in the form of channel sections working in a common kinematic system. In this system the movement is performed with the use of hydraulic actuators S6 (73) attached between the rod rotation attachment points. This enables lowering the height of the entire arm (articulating the arm) and moving the working unit (2) more towards the front part of the frame (1), between the front and rear support, causing a more advantageous distribution of forces on the supports, and therefore, an advantageous distribution of the centre of gravity of the entire device. On one side of the rotating holder (74) the scissor unit (72) is attached, and on the second side the clamping ring for unit rotation (75) is installed in a rotating manner, which is rotated with the actuator S7 (76), with the actuator (76) being attached to the rotating holder (74). The clamping ring for unit rotation (75) holds the working unit (2), which is installed on a roller (77) enabling the rotation of the working unit (2) and driven by the actuator S8 (78), with the actuator (78) being attached to the clamping ring for unit rotation (75). The clamping ring for unit rotation (75) was designed in such a manner that the roller (77) is locked against any movement, and yet is easily removable.

The procedure of folding the arms for transport occurs in three stages.

In the first stage the guards (25) are folded, this movement is caused by the actuator S4 (60).

In the second stage the arm profile (70) with the entire arm (3) and the working unit (2) are raised on the telescoping actuator S5 (71) to a vertical position. Also the working unit (2) is placed parallel to the arm (3) by another actuator S8 (78).

In the third stage the scissors (72) are folded by a rotating movement of the rods being in a common system. This movement is powered by the actuator S6 (73). Simultaneously in the third stage the clamping ring for unit rotation (75) rotates, powered by the actuator S7 (76).

Each of the arms (3) after folding has a catch hook (79), which is adjustable, and an arm locking hook (80), protecting the arms (3) from unfolding accidentally.

The working unit (2c) forming the middle section of the hay rake is attached to the frame (1) by a lift (4) system, which raises the working unit (2c) removing it from operation completely and ensuring appropriate clearance for the receiving of the hay collected from side sections of the working units (2).

If the working unit (2c) is to operate as a part of the entire machine, the lift (4) lowers the working unit (2c), including the middle section to operate as a part of the entire system.

The lift (4) works in the lift guide (19) resting on rollers (81), and the play in the telescope is adjusted with the thickness of an plastic plate insert with sliding properties. A more precise adjustment of the insert pressure is performed in the four corners by four pressure screws (82) corresponding to these corners.

The working unit (2c) is set on a roller which is symmetrically placed in relation to the lift (4), whereas the system is protected against excessive rotation of the working unit (2) by limiters (83) with dampening rubber stops. After folding the middle section and removing it from operation, to secure the middle section from any movements in relation to the hay rake locking latches (84) were used.

The hydraulic system of the hay rake consists of actuators powered from the tractor's hydraulic system and from three hydraulic pumps to power the motors used to power the working units (2). Moreover, the hydraulic system of the hay rake according to the invention enables the relieving of the working units, since it's disadvantageous to have relatively heavy working units exerting excessive ground pressure. Working units in operating condition should not damage the sod at the grassland. The hydraulics of the relieving system is based on cartridge solenoid valves, cartridge throttles and hydraulic accumulators. The direct function of the springs in the hydraulic relieving system is performed by a telescoping actuator. Before commencing the operation it moves into a "floating" mode, that is, the actuator yields to the forces of gravity and is passive, and the mass of the arm causes the natural lowering of the working unit 2 and collapsing of the actuator. The hydraulic system starts to gradually, periodically pump oil into the actuator. As a result of partial pressure created in the actuator, the force of the pressure exerted by the working unit 2 on the surface decreases, since some of this force is taken over by the telescoping actuator S5 (71) by the pressure acting within it. The degree of charging of the actuator, and thus of additional load is adjusted with hydraulic cartridge throttles.

The central point of the hydraulic system is the rear part of the hay rake, in which control elements are installed, and from where the entire system of conduits and hoses is distributed to the remaining elements of the machine.

Claims

1. Hopper hay rake for the harvesting of straw, in particular from legumes, containing a frame with a running wheel system and a pick-up and belt system, equipped with a hydraulic system and electrical control system, characterized in that the frame (1) in the rear part is connected with the running wheels by movable rocker arms (9), where between the rocker arms (9) and the frame (1) hydraulic actuators S3 (22) are installed, whereas the frame (1) consists of at least two profiles (11, 12), where the profile of frame I (11) is connected in a swinging manner with the profile of frame II (12), and between the profile of frame I (11) and the profile of frame II (12) a hydraulic actuator S2 (21) is installed, whereas a system of guides (19) of a lift (4) is installed to the profile of the frame I (11), with a working unit (2c) installed on the lift (4), forming the middle pick-up and belt section, and on both sides of the hay rake working units (2a and 2b) are installed forming the side pick-up and belt sections, which are connected with the frame (1) by a system of actuated arms (3).
2. A hay rake in accordance with claim 1, characterized in that the system of each of working unit (2a and 2b) folding arms (3) forms a scissor mechanism consisting of an arm profile (70), a scissor unit (72), a rotating holder (74) and a clamping ring for unit rotation (75), where the scissor system (72) is formed by at least two rods in the form of channel sections working in a common kinematic system, in which system the movement is performed with the use of hydraulic actuators S6 (73), attached between the rod rotation attachment points, and the scissor system (72) is attached to the rotating holder (74), whereas on the second side of the rotating holder (74) the clamping ring for unit rotation (75) is installed in a rotating manner, which is rotated with the actuator S7 (76) attached to the rotating holder (74), whereas between the arm profile (70) and the frame (1) a telescoping actuator S5 (71) is installed.
3. A hay rake in accordance with claim 1 or claim 2, characterized in that the scissor mechanisms for folding the arms (3) are connected with the frame (1) by legs (10), advantageously connected to the frame (1) with temporary fasteners.
4. A hay rake in accordance with claim 1 or claim 2, characterized in that each of the working sections (2a, 2b, 2c) consists independently of a pick-up (24) system and a belt conveyor (23) system, where each of the systems has a separate load-bearing frame and is equipped with a separate drive system, advantageously with working speed adjustment.
5. A hay rake in accordance with claim 1 or claim 4, characterized in that the system for attaching the finger pick-up (24) to the belt conveyor (23) consists of a fastening pin

(27), which is fastened on the belt conveyor (23) and of a fastening sleeve (28), which is fastened on the pick-up (24), where after sliding one element into the second a hinge mechanism is created.

6. A hay rake in accordance with claim 1 or claim 4, characterized in that the finger pick-up (24) of the working unit (2) has a drum (29) driven by a hydraulic motor (30) and connected with it by a clutch (31), where on the drum (29) ball bearings are installed, on which crosspieces are set, and each crosspiece is a union of a tube (32) and a rod (33), whereas a spring fingers unit (37) is placed on the crosspieces of the pick-up (24), operating in accordance with the shape of a guiding cam (35), advantageously consisting of two pieces.
7. A hay rake in accordance with claim 1 or claim 4, characterized in that the side working units (2a and 2b) are installed on rollers (77), which enable the rotation of the working unit (2), driven by an actuator S8 (78), with the actuator (78) being attached to the clamping ring for unit rotation (75).
8. A hay rake in accordance with claim 1 or claim 4, characterized in that the middle working unit (2c) is set on a roller which is symmetrically placed in relation to the lift (4), whereas the system is protected against excessive rotation of the working unit (2) by limiters (83) with dampening rubber stops.
9. A hay rake in accordance with claim 1 or claim 8, characterized in that the lift (4) is installed on a lift guide (19), resting on rollers (81), where the play in the telescope is adjusted with the thickness of an plastic plate insert with sliding properties, and the more precise adjustment of the insert pressure is performed in the four corners by four pressure screws (82) corresponding to these corners.
10. A hay rake in accordance with claim 1 or claim 8, characterized in that a guard (25) is attached to the frame (43) of any of the belt conveyors (23), the guard (25) most advantageously consisting of two guarding plates (48 and 49) and following bars (50) connected with the belt frame (43) by an actuator S4 (60).
11. A hay rake in accordance with claim 1 or claim 10, characterized in that underneath the working units (2) a system of rollers (26) is attached, which forms a system of two pairs of rocker arms (61 and 62), connected to each other on one axis, where the rocker arm I (61) has a roller which acts as the axis of rotation for both rocker arms, whereas the rocker arm II (62) has a sleeve which is set on the roller of the rocker arm I (61) which enables the rotation of the rocker arm I (61) in relation to the rocker arm II (62), whereas the roller of the rocker arm I (61) is placed in a moving manner in the clamping ring (66), which is bolted to the frame (44) of the belt conveyor (23).
12. A hay rake in accordance with claim 1 or claim 2, characterized in that in the front part of the frame (1) a load-bearing pillar (13) is installed, most advantageously with a support plate (15).
13. A hay rake in accordance with claim 1 or claim 12, characterized in that in the front part of the frame a three-point hitch beam (16) is installed.
14. A hay rake in accordance with claim 1 or claim 13, characterized in that the load-bearing pillar (13), the three-point hitch beam (16) and the support plate (15) are connected to each other with a turn-plate (14).

15. A hay rake in accordance with claim 1 or claim 2, characterized in that to the frame I profile (11) a load-bearing tray (17) is bolted on, with a central point of the entire hydraulic system (5).
16. A hay rake in accordance with claim 1 or claim 15, characterized in that moving guards (18) of the hydraulic system elements are attached to the profile of the frame I (11),
17. A hay rake in accordance with claim 1 or claim 2, characterized in that the elements of the hydraulic control system are placed within the frame (1).
18. A hay rake in accordance with claim 1 or claim 2, characterized in that the hydraulic oil tank forms an integral part of the frame (1).
19. A hay rake in accordance with claim 1 or claim 2, characterized in that in the zone of the belt conveyors (23) of any of the working sections (2a, 2b, 2c) a harvest volume monitoring device is installed.
20. A hay rake in accordance with claim 1 or claim 19, characterized in that the harvest volume monitoring device is a lidar (8).
21. A hay rake in accordance with claim 1 or claim 19, characterized in that the harvest volume monitoring device is an optical system which contains a camera and an infrared multi-point illuminator, connected to the hay rake's location recording system and to a data recorder, whereas the drive systems of the working units (2a, 2b, 2c) are equipped with speed adjusters, which are connected to the optical system by a system of controllers.

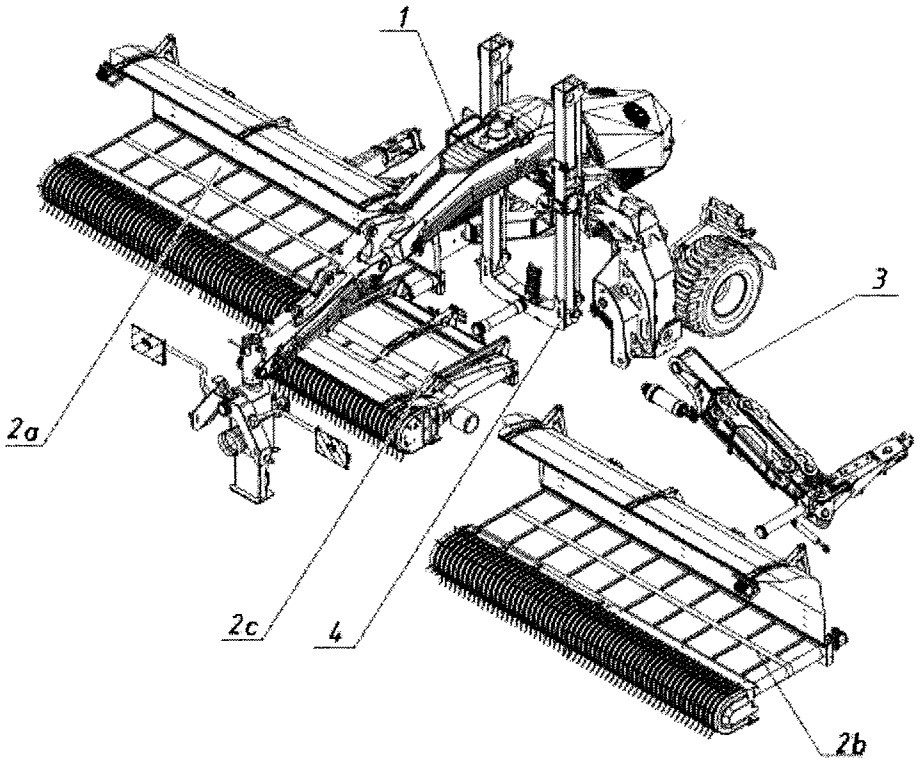


Fig. 1

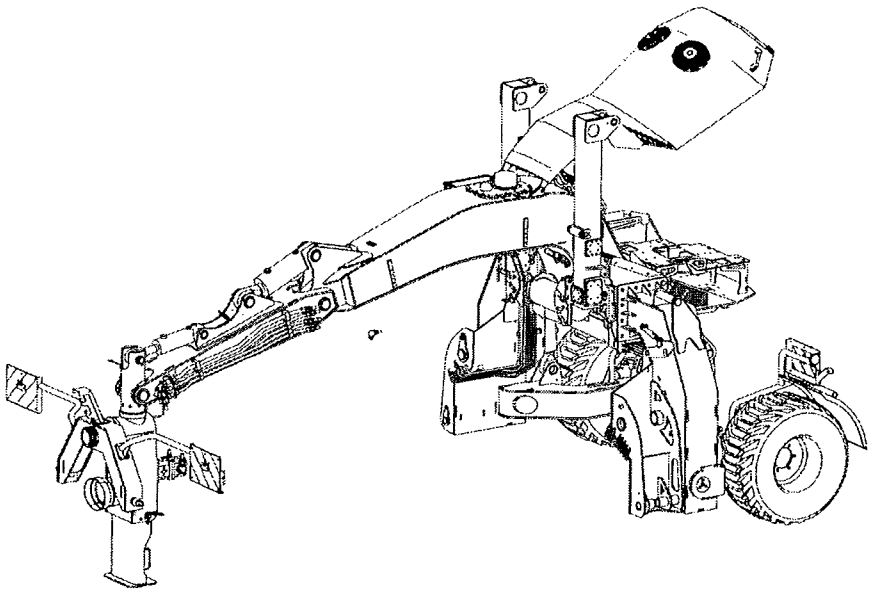


Fig. 2

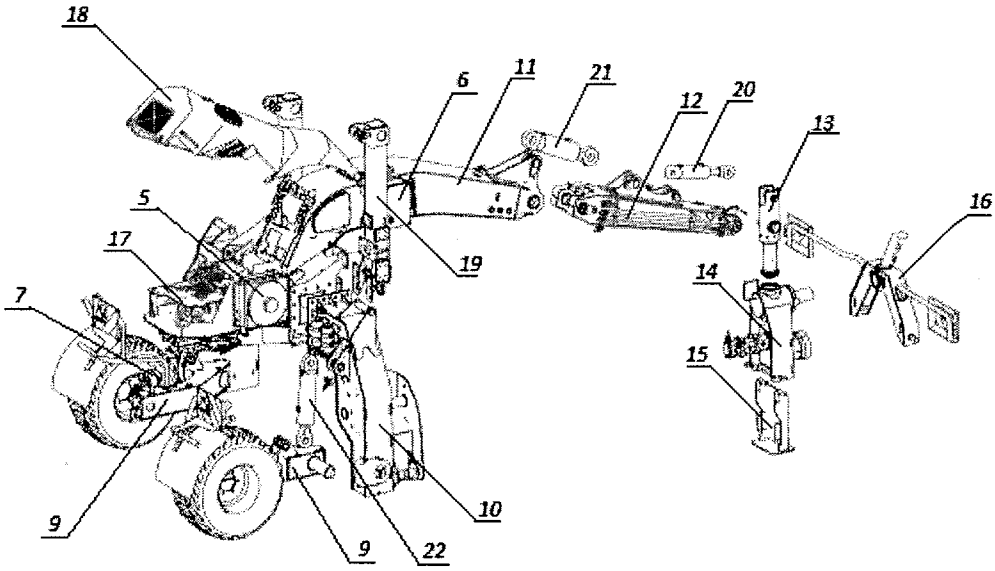
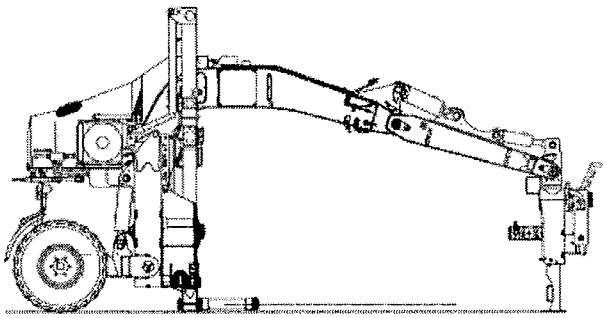


Fig. 3

Work position:
in the field



Work position:
on the headlands

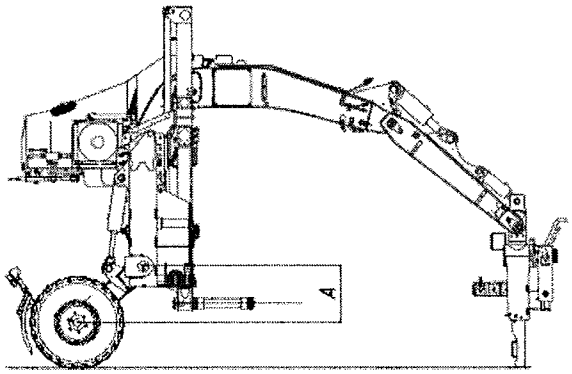


Fig. 4

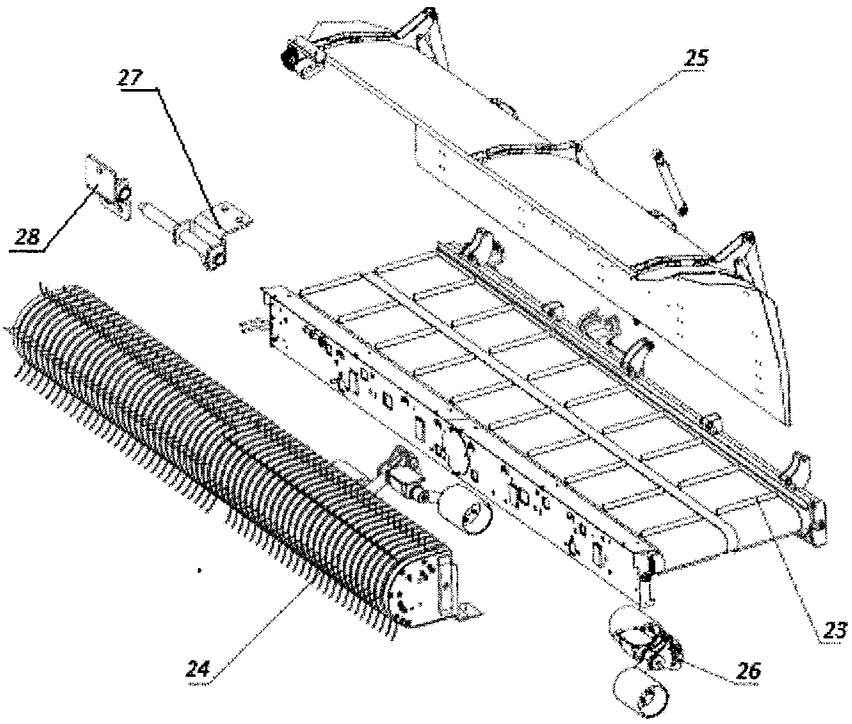


Fig. 5

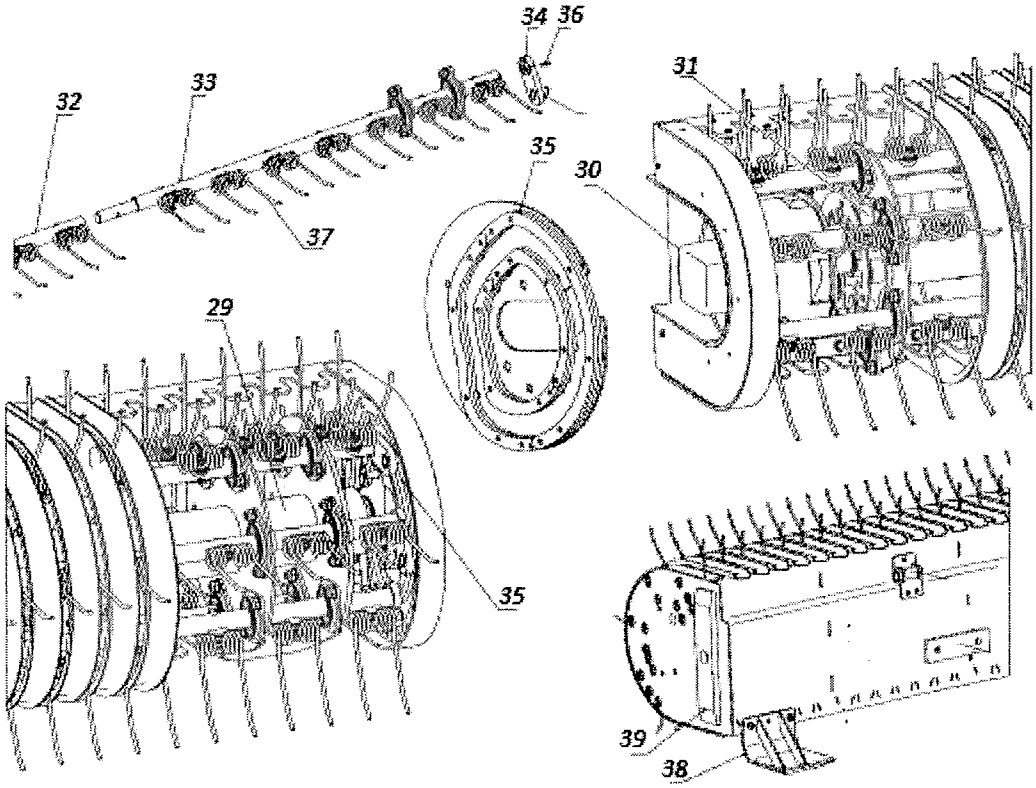


Fig. 6

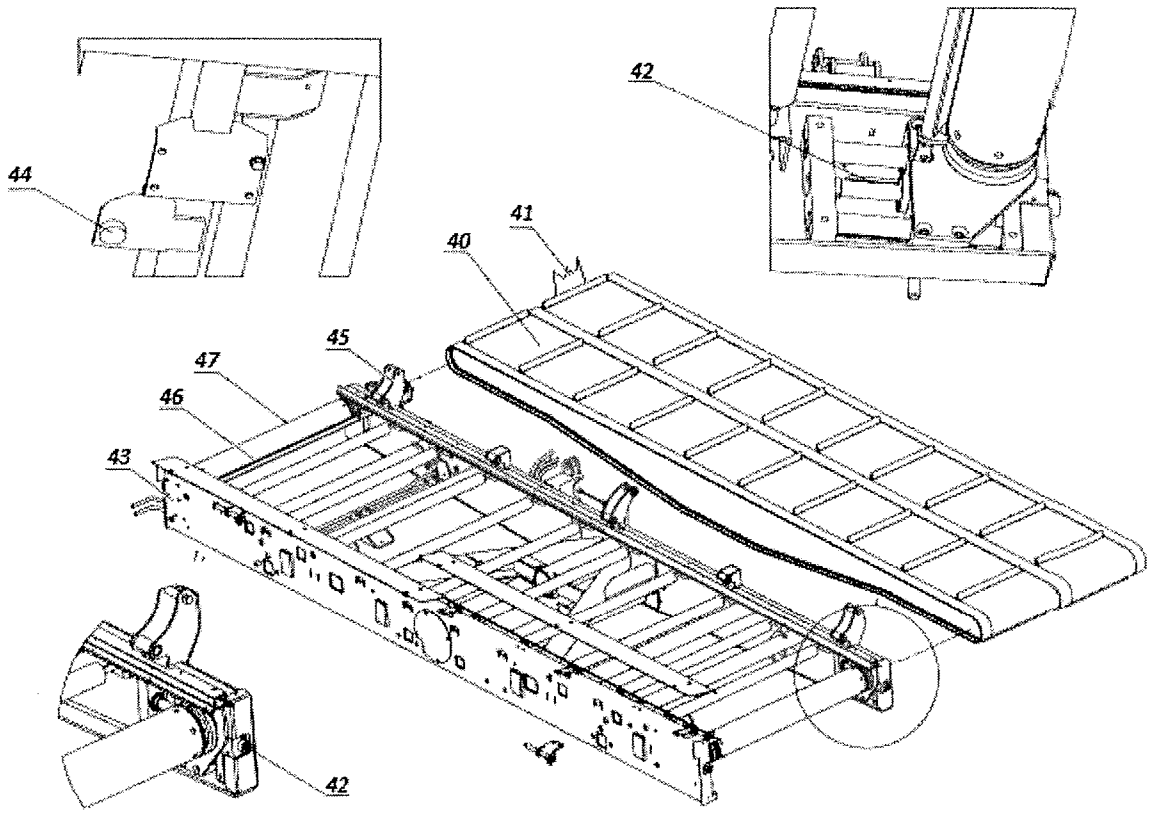


Fig. 7

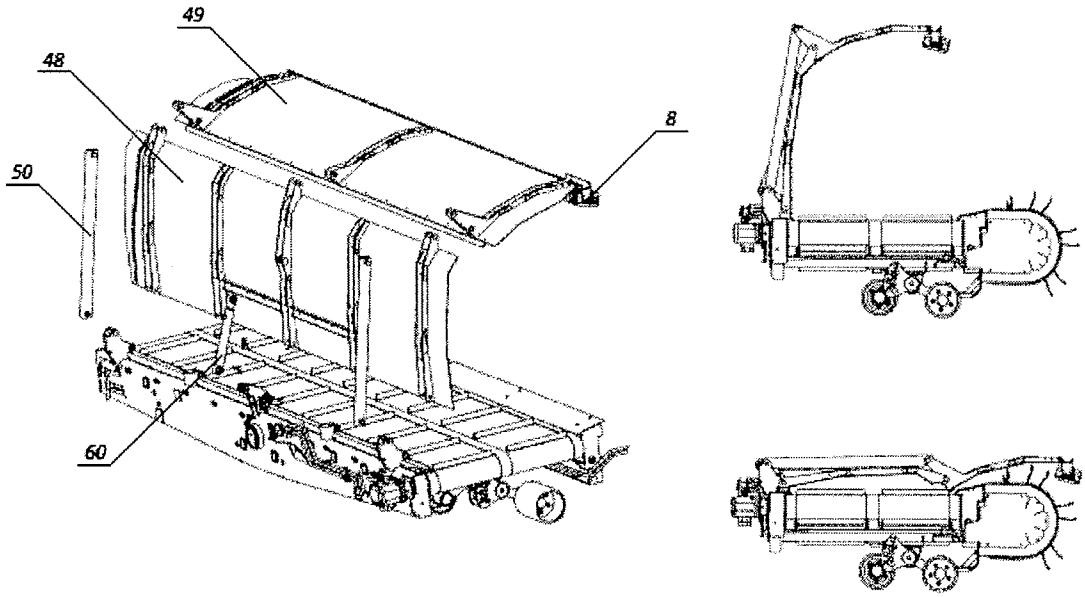


Fig. 8

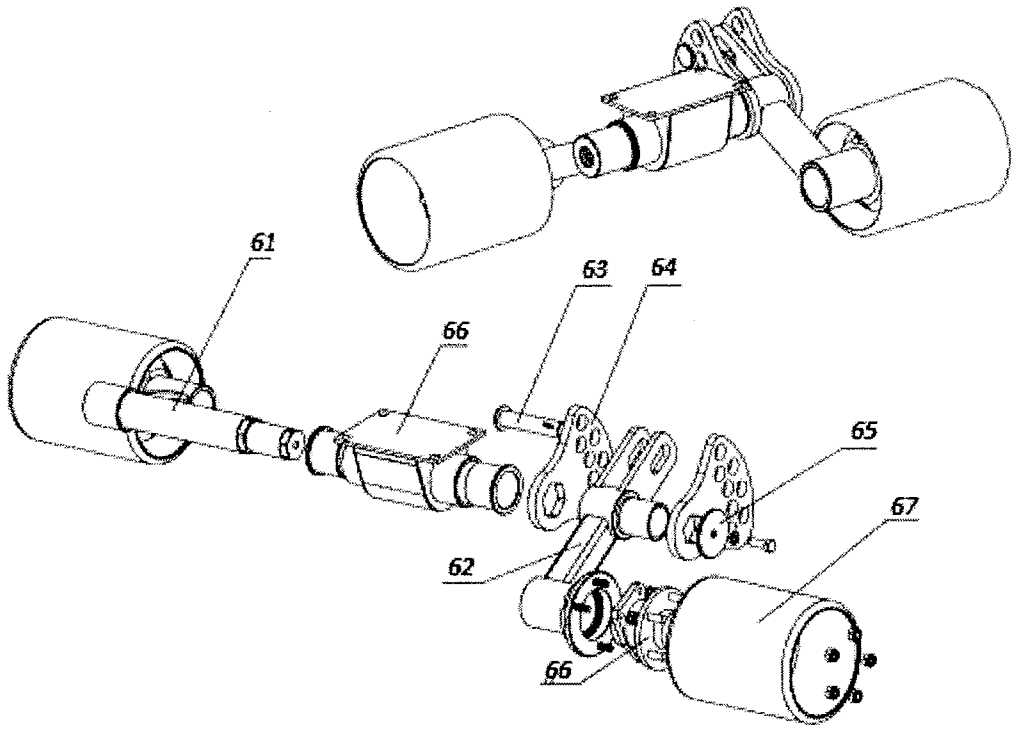

61
63
64
66
65
67
62
66

Fig. 9

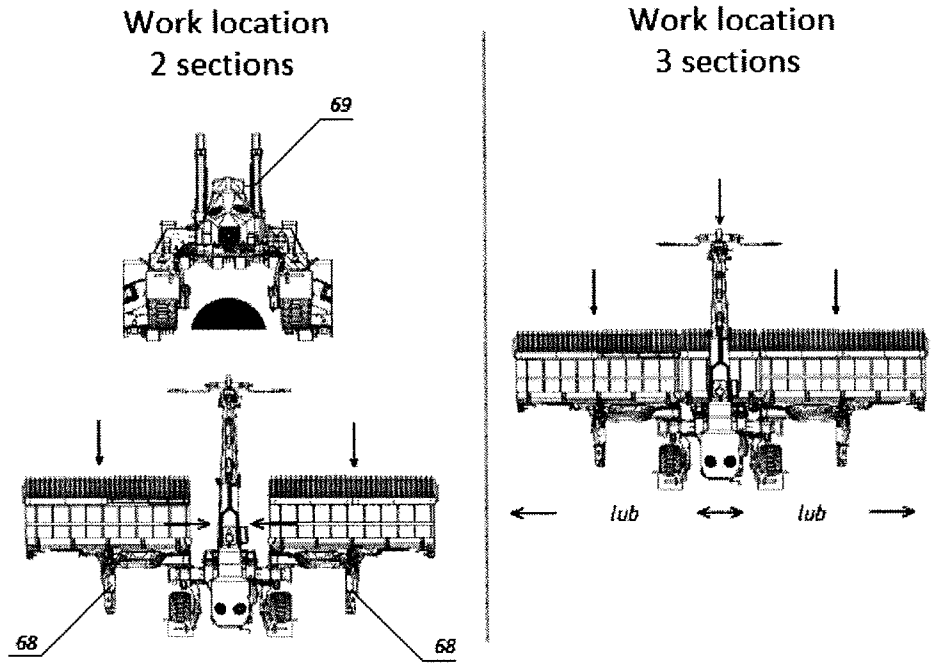

Work location
2 sections
69
68
68
Work location
3 sections
lub
lub

Fig. 10

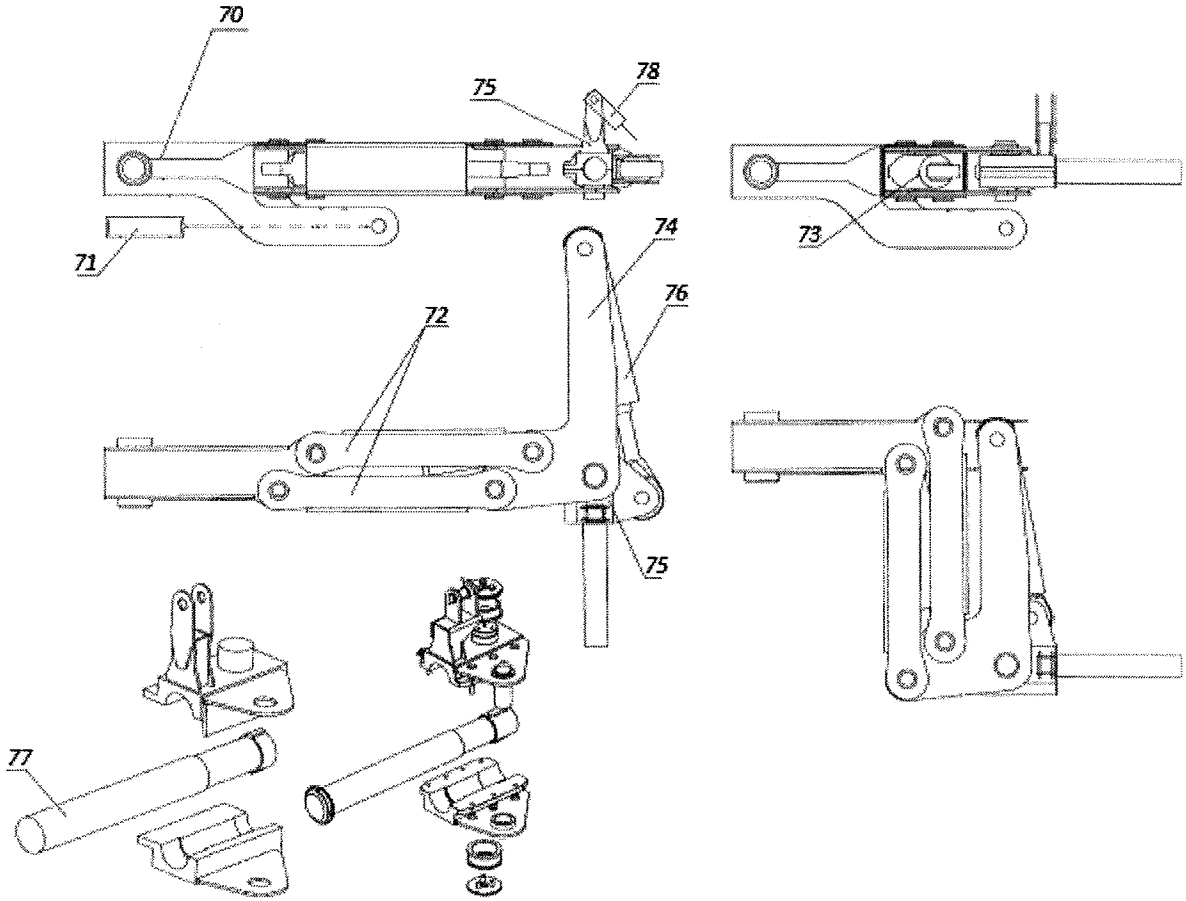


Fig. 11

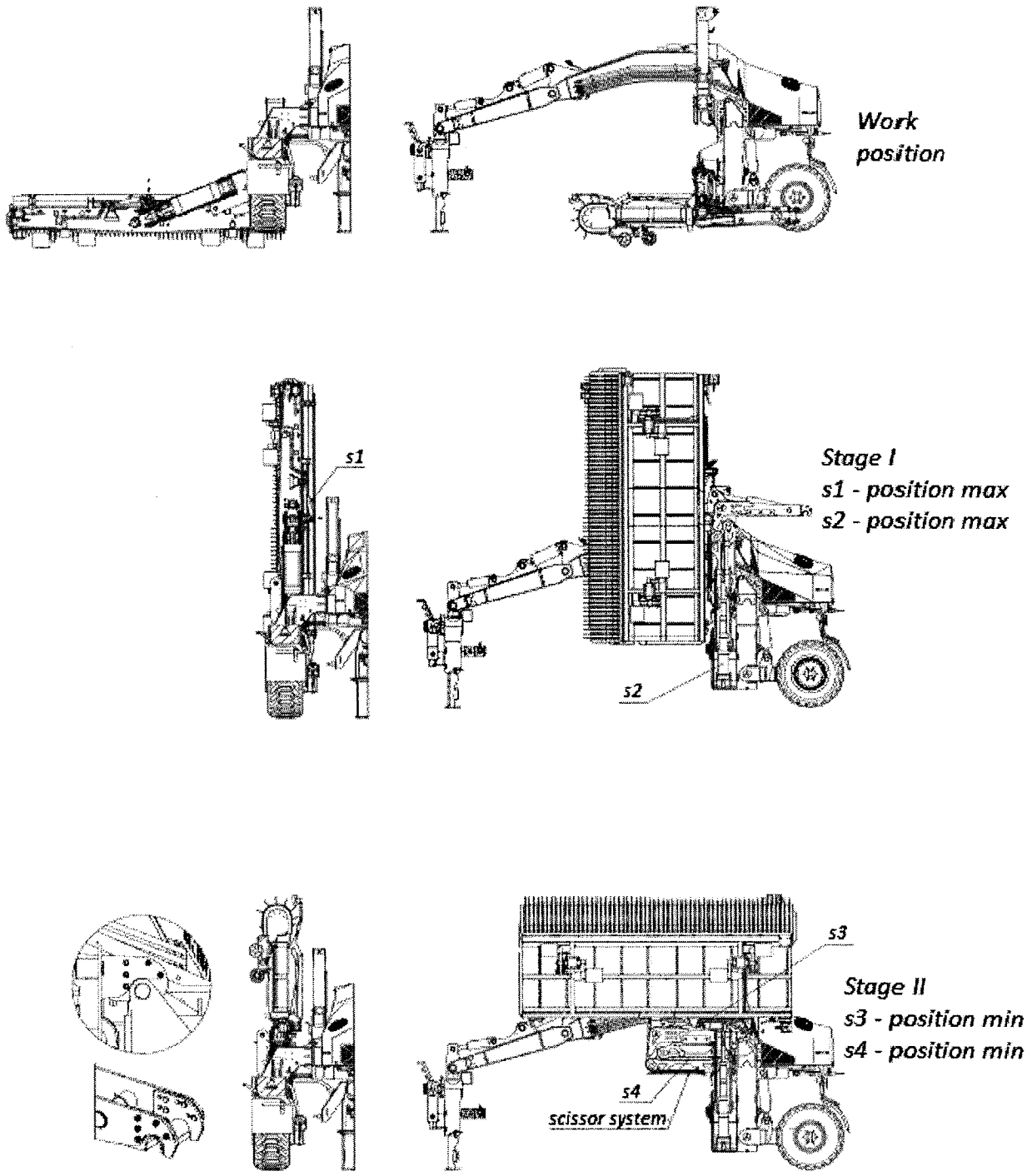

Work position
s1
Stage I
s1 - position max
s2 - position max
s2
s3
Stage II
s3 - position min
s4 - position min
s4
scissor system

Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/PL2020/000043

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01D41/02 A01D90/08 A01F15/07
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01D A01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/020492 A1 (SCHWER MICHAEL [FR] ET AL) 22 January 2015 (2015-01-22)	1,3-21
A	abstract figures 1,7-9 paragraph [0002] paragraphs [0037] - [0040]	2
A	WO 2016/014675 A1 (CNH IND AMERICA LLC [US]) 28 January 2016 (2016-01-28) abstract figures 2-4	1-21
A	GB 1 555 326 A (FMC FOOD MACHINERY EUROPE NV) 7 November 1979 (1979-11-07) the whole document	1-21

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2020	15/09/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Giorgini, Gabriele

1

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INTERNATIONAL SEARCH REPORT

International application No
PCT/PL2020/000043

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 405 556 A2 (CLAAS SAULGAU GMBH [DE]) 7 April 2004 (2004-04-07) the whole document	1-21
A	DE 298 16 837 U1 (KRONE BERNHARD GMBH MASCHF [DE]) 26 November 1998 (1998-11-26) the whole document	1-21

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/PL2020/000043

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015020492 A1	22-01-2015	AR 096740 A1	03-02-2016
		AU 2014203778 A1	05-02-2015
		BR 102014017489 A2	20-10-2015
		CN 104285595 A	21-01-2015
		DK 2839731 T3	09-01-2017
		EP 2839731 A1	25-02-2015
		ES 2603677 T3	28-02-2017
		FR 3008576 A1	23-01-2015
		HU E031271 T2	28-06-2017
		PL 2839731 T3	31-03-2017
		RU 2014129332 A	10-02-2016
		US 2015020492 A1	22-01-2015
		US 2016338259 A1	24-11-2016
WO 2016014675 A1	28-01-2016	CN 107074452 A	18-08-2017
		US 2017208745 A1	27-07-2017
		WO 2016014675 A1	28-01-2016
GB 1555326 A	07-11-1979	NONE	
EP 1405556 A2	07-04-2004	AT 381883 T	15-01-2008
		AT 413092 T	15-11-2008
		DE 10346818 A1	15-04-2004
		EP 1405556 A2	07-04-2004
		EP 1808064 A1	18-07-2007
DE 29816837 U1	26-11-1998	NONE	