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(54) Telescopic lift arm for farm vehicles

(57) This invention relates to farm vehicles of the telescopic lift type, equipped with a lift arm fitted with an improved drive mechanism.

The arm according to this invention is of the type comprising a first base section fitted directly to the chassis of a telescopic lift device, a second section which slides inside said first section, and a third section which slides inside said second section, which said arm also acts as support for pressurised hydraulic pipes that connect a pressurised oil generator on board said device to one or more hydraulic jacks fitted at the end of said arm, the reciprocal movements of said three sections being controlled by a hydraulic jack which acts directly between said first and second sections, a system being provided with flexible elements stretched between said first and third sections and tautened by pulleys integral with said second section, which effects the extension and retraction of said third section (4), and is characterised in that it includes:

• a first flexible element (10) which connects a first part (7), integral with said first base section (2), to a part (4a) integral with said third section (4), said first flexible element (10) being tautened by a first pulley (8) integral with said second section (3);

• a second flexible element (11) which connects a second part (12) integral with said first base section (2) to said part (4a), which is integral with said third section (4), said second flexible element (11) being tautened by a second pulley (9) integral with said second section (3):

• a first pipe (14) which follows the same route as said first flexible element (10) from said first part (7), integral with said first section (2), to said part (4a) of said third section (4);

• a second pipe (15) which connects said part (4a), integral with said third section (4), to said at least one jack present on the end of said arm (1);

said first and second flexible elements (10, 11), said first and second pulleys (8, 9) and said first and second pipes (14, 15) being wholly contained inside said first, second and third sections (2, 3, 4).

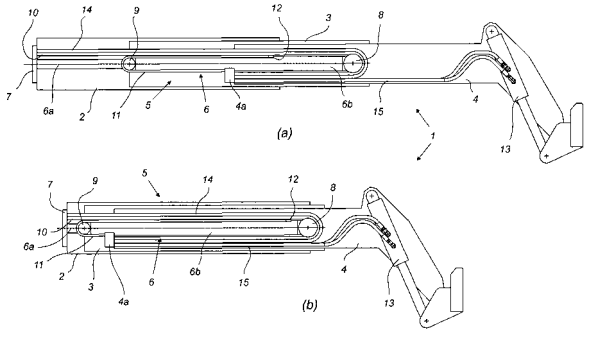

Fig. 2

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Description

[0001] This invention relates to farm vehicles of the telescopic lift type, equipped with a lift arm fitted with an improved drive mechanism.

[0002] According to the prior art, telescopic lift arms usually consist of three reciprocally sliding sections. In practice, there is a first base section fitted directly to the machine chassis, the height of said first base section being adjustable. A second and third section are telescopically fitted to said first base section, and guides are installed so that they can slide reciprocally. In practice, the second section slides inside the first base section, and the third section slides inside the second section. The extension and retraction mechanism is usually made with a system of flexible elements, such as cables or chains driven by a hydraulic jack with one end connected to the first base section and the other end to the second section. A first pulley is fitted at the end of the jack integral with the second section; during extension of the jack, said pulley tautens a first cable or chain with one end attached to a baseplate of the first section and the other end to the base of the third section. When the jack rod is extracted by the pressure of the oil in the cylinder, the second section is also extracted because it is integral with the jack. The first pulley moves away from the baseplate, and the first cable or chain is consequently tautened and extracts the third section.

[0003] Retraction is performed with a second cable or chain which is tautened by a second pulley fitted at the base of the second section, said cable or chain being attached at one end to the base of the third section and at the other end close to the end of the first section. When the jack rod retracts, the second section also retracts because it is integral with the jack. The second pulley tautens the second cable or chain, which causes the third section to retract.

[0004] There are also hydraulic pipes inside the arm that feed the jacks at the end of the third section. Said pipes must consequently follow the lengthening and shortening of the arm.

[0005] The mechanism described has mainly been embodied by chains, but they all present the drawback of having at least one branch which is not contained inside the arm when the arm is extended.

[0006] The same problem occurs for at least some branches of said hydraulic pipes that feed the jacks positioned at the end of the third section.

[0007] This constitutes a considerable limitation on the functionality of the arm, because damage to the chains or pipes following accidental knocks is always possible.

[0008] This drawback has been solved by a cable-operated extension/retraction system, which allows both the cables and the hydraulic pipes to be maintained inside the arm.

[0009] In the cable mechanisms according to the prior art, the cables are connected to the various arm sections via terminals which allow the cable tension to be regulated. However, the positions in which said terminals are located are difficult to access, and often require removal of the arm. This obviously leads to high maintenance costs and lengthy machine stoppages.

[0010] A cable or chain system of this type is suitable to constitute a sub-assembly which can be pre-assembled at the bench and then inserted en bloc in the arm. However, the embodiments according to the prior art do not allow complete pre-assembly of the pipes, because the connections have to be made after the extension/retraction device is fitted, which leads to higher manufacturing costs.

[0011] A specific drawback of cables is that it is very difficult to check their condition; this check must be performed with special ultrasound machines, because the inner strands are not visible. Moreover, as lifting machinery is involved, these operations are particularly important because cable breakage can seriously endanger people in the vicinity of the lifting gear while it is operating.

[0012] A further drawback, also specific to cables, is that they are not very suitable for use with pulleys of small diameter, as required by this specific application, due to the small transverse dimensions of the arm in which they are inserted. Cables therefore undergo excessive stress and consequently have a short life, unless a number of parallel cables with a smaller diameter are used, so that the pulley diameter is acceptable in relation to the said reduced cable diameter. However, this solution increases the complexity of the system, with a consequent increase in both manufacturing and maintenance costs.

[0013] A further drawback of the telescopic arms according to the prior art is that they bend under load, thus in practice limiting the maximum effective lifting height, which is therefore significantly lower than the nominal value.

[0014] This invention eliminates said drawbacks by offering an original arrangement of chains and pipes, as claimed in claim 1, designed to maintain said chains and pipes inside the arm whatever its configuration, and to allow pre-assembly of the entire arm control unit and its subsequent insertion in the arm without any further hydraulic connections, thus achieving a significant reduction in assembly costs.

[0015] The invention also includes a particular arrangement of the chain regulation devices, which makes them suitable to be operated from the outside, with no need to remove the arm.

[0016] Finally, the arm will be given a slight upward curvature so that when the arm bends downwards due to the load, it will return to a straight configuration.

[0017] The first consequence using chains instead of cables is greater safety during use and lower maintenance costs, as maintenance becomes much easier. Further advantages in terms of maintenance also result from the fact that the chain regulation devices are accessible directly from the outside.

[0018] Finally, the arm to which said upward curvature is given presents some advantages in lifting operations,

especially an increase in the maximum obtainable height.

[0019] The invention will now be described in detail according to a preferred embodiment, by way of example but not of limitation, with reference to the annexed figures, wherein:

- figure 1 shows a telescopic lift device equipped with a lift arm according to the invention;
- figures 2 (a, b) schematically illustrate the lift arm and the internal mechanisms;
- figure 3 shows the extension/retraction mechanism;
- figures 4 and 5 (a, b) show details of the connection of the chains and hydraulic pipes;

[0020] Fig. 1 shows a work vehicle fitted with an extensible lift arm according to the invention. Said lift arm (1) is illustrated schematically in figs. 2 (a, b), which show the internal drive mechanism.

[0021] Said arm (1) comprises a first base section (2), inside which runs a second section (3) and, in sequence, a third section (4), guides of known type designed to guide said reciprocal sliding being fitted.

[0022] Inside said arm (1) is inserted an extension/retraction mechanism (5) which comprises:

- a dual-action hydraulic jack (6) comprising a rod (6a), fixed to a plate (7), integral with said first base section (2), and a tube (6b) integral with second section (3) of arm (1);
- a first pulley (8) fitted at a first end of tube (6b) of said jack (6);
- a second pulley (9) fitted at a second end of tube (6b) of said jack (6);
- a first chain (10) connected by its first end to said plate (7), which winds onto said first pulley (8) and is connected by its second end to a first block (4a) integral with the base of third section (4);
- a second chain (11), connected by its first end to a second block (12) integral with said first section (2), which winds onto said second pulley (9) and is connected by its second end to said first block (4a) at the base of third section (4), namely at the point where said first chain (10) is connected.

[0023] Said second block (12) is located inside third section (4), but is stationary in relation to first section (2). The way in which said second block is held stationary will be described below. The function of first block (4a) will also be illustrated.

[0024] Arm (1) according to the invention is shown in the extended configuration in fig. 2a and in the retracted configuration in fig. 2b.

[0025] The extension/retraction mechanism operates as follows.

[0026] Starting with the fully retracted arm configuration, in which rod (6a) of jack (6) is also retracted, the exit of rod (6a) causes the advance of tube (6b) of jack (6), and consequently of second section (3) which is integral with it.

[0027] The advance of tube (6b) of jack (6) also causes the advance of first pulley (8) integral with it, and consequently the advance of the second end of the first chain (10) which, being fixed to first block (4a) which is integral with the base of third section (4), causes it to advance.

[0028] The retraction of arm (1) is always effected by jack (6) which, by causing rod (6a) to retract, also causes the retraction of second section (3) into first section (2).

[0029] The retraction of tube (6b) of jack (6) also causes the retraction of the second pulley (9) integral with it, consequently tautening the second chain (11) and causing the retraction of the second end of second chain (11) which, being fixed to first block (4a) of third section (4), causes it to retract.

[0030] Inside arm (1) there are also hydraulic pipes which have the function of conveying pressurised oil to a hydraulic jack (13) present on the front end of the third section (4), which said pipes are obliged to follow the lengthening and shortening of arm (1).

[0031] For this purpose a first pipe (14) runs parallel to first chain (10), starting from plate (7) and leading to first block (4a) at the base of third section (4), while a second pipe (15) connects said first block (4a) to jack (13).

[0032] The first pipe (14) follows the movements of the first chain (10), and winds onto first pulley (8) with it, while the second pipe (15) moves en bloc with third section (4).

[0033] As shown in fig. 2, the part of first chain (10) and first pipe (14) which lies between plate (7) and first pulley (8) when the arm is retracted always remains stationary in relation to first section (2).

[0034] This occurs spontaneously for first chain (10) and first pipe (14), because they are fixed to plate (7), whereas in the case of second chain (11) it is effected by means of a rigid element (16) (fig. 3) which connects the second block (12) that fixes the second chain (11) to plate (7).

[0035] The elements contained within broken line (17) shown in fig. 3 constitute the complete extension/retraction mechanism (5). Said mechanism (5) can therefore be wholly assembled at the bench and then inserted into arm (1), as it is sufficient to fit plate (7) at the base of first section (2) and first block (4a) at the base of third section (4), and connect the end of second pipe (15) to hydraulic jack (13).

[0036] The extension/retraction mechanism (5) is illustrated schematically in fig. 3 to illustrate its operation. A single extension chain (10) and a single retraction chain (11) are shown. There could obviously also be a larger number of said chains, depending on the loads. There could also be a larger number of hydraulic pipes, depending on requirements.

[0037] According to a preferred form of embodiment of the invention, rigid element (16) could be shaped in such a way as to house the fixed branches of first chain (10) and first pipe (14), and to provide temporary support for jack (6), to aid manipulation during pre-assembly and

insertion into arm (1). Figs. 5 (a, b) show a possible form of said element (16).

[0038] Fig. 4 shows the first block (4a) attached to the base of third section (4). As seen in fig. 4, the first and second chains (10) and (11) are attached to said first block (4a). The block also acts as union between first pipe (14) and second pipe (15) via a U-connector (18).

[0039] As can clearly be seen in fig. 2, the first block (4a) is in a position inaccessible from the outside in each configuration of arm (1). Moreover, in view of its complexity, it would be difficult to perform operations on it even if it were made accessible by making a suitable opening in one or more sections of arm (1). For this reason, chains (10) and (11) are secured rigidly to first block (4a), and the tension of the chains is regulated by acting on the other end, specifically on plate (7) (fig. 5a) for the first chain (10) and the second block (12) (fig. 5b) for the second chain (11).

[0040] As plate (7) is perfectly accessible from the outside, it is sufficient to act on a first regulator (19) connected to first chain (10). However, the second block (12) is inside arm (1); a window (20) has therefore been opened in the side of third section (4) so that it can be accessed. As third section (4) slides in relation to second block (12), in order to access second block (12) the arm must be slid until window (20) coincides with second block (12).

[0041] In practice, second block (12) is also inside second section (3); an access window must therefore also be opened in the second section (3), in such a position as to coincide with window (20) when the latter coincides with second block (12).

[0042] When access to second block (12) has been obtained, the chain tension can be regulated by acting on a second regulator (21), connected to second chain (11), which is identical to said first regulator (19) connected to first chain (10).

[0043] The regulation can be performed by acting on threaded pins or tie-bars (19a) and (21a) respectively, and the tension to which chains (10) and (11) are subjected can be seen from the flattening of Belleville washers (19b) and (21 b) respectively. Belleville washers (19b) and (21 b) give a visual indication of the tension of chains (10) and (11), but do not indicate the lengthening of the chains caused by wear. This can be done by installing indicators on the rod of tie-bars (19a) and (21a). The tension of chains (10) and (11) is regulated from time to time to take up any slack caused by lengthening of the chains. This means that while Belleville washers (19b) and (21 b) are restored to the same deformation value from time to time, the regulation nuts will be screwed further and further onto pins (19a) and (21 a); the position of the nuts in relation to said indicators on the rod of pins (19a) and (21a) will therefore give the value of the lengthening undergone by the chains as a result of wear.

[0044] Said indicators could be constituted by coloured rings on pins (19a) and (21a) which, for example, could be painted on. In this way the unpainted length that protrudes from the nuts corresponds exactly to the lengthening of the chains.

[0045] According to a preferred form of embodiment of the invention, a slightly upward curve will be given to arm (1). Thus when a load is applied to the end of the arm, it will deform the arm so that it approaches a straight shape.

[0046] In practice, it has been found that the curvature should be such as to take up a downward bend of approx. 30 centimetres in the end of a 10-metre long arm. In other words, the arm must deviate from the straight by 30 mm for each metre of length.

[0047] Said curvature is obviously too small to be shown in a drawing and, is therefore not illustrated.

[0048] The invention is described according to a preferred form of embodiment. One skilled in the art could devise numerous other embodiments, all of which fall into the ambit of protection of the following claims.

Claims

1. Arm for lifting and manipulation of loads, of the type comprising a first base section fitted directly to the chassis of a telescopic lift device, a second section which slides inside said first section, and a third section which slides inside said second section, which said arm also acts as support for pressurised hydraulic pipes that connect a pressurised oil generator on board said device to one or more hydraulic jacks fitted at the end of said arm, the reciprocal movements of said three sections being controlled by a hydraulic jack which acts directly between said first and second sections, a system being provided with flexible elements stretched between said first and third sections and tautened by pulleys integral with said second section, which effects the extension and retraction of said third section (4), **characterised in that** it includes:

    - a first flexible element (10) which connects a first part (7), integral with said first base section (2), to a part (4a) integral with said third section (4), said first flexible element (10) being tautened by a first pulley (8) integral with said second section (3);
    - a second flexible element (11) which connects a second part (12) integral with said first base section (2) to said part (4a), which is integral with said third section (4), said second flexible element (11) being tautened by a second pulley (9) integral with said second section (3);
    - a first pipe (14) which follows the same route as said first flexible element (10) from said first part (7), integral with said first section (2), to said part (4a) of said third section (4);
    - a second pipe (15) which connects said part (4a), integral with said third section (4), to said at least one jack present on the end of said arm

(1);

said first and second flexible elements (10, 11), said first and second pulleys (8, 9) and said first and second pipes (14, 15) being wholly contained inside said first, second and third sections (2, 3, 4).

2. Arm for lifting and manipulation of loads, as claimed in claim 1, **characterised in that** it includes means designed to regulate the tension of said flexible elements (10) and (11) positioned at the points of connection between said flexible elements (10) and (11) and said parts (7) and (12), which are integral with said first base section (2).

3. Arm for lifting and manipulation of loads, as claimed in claim 2, **characterised in that** said means (19) and (21) designed to regulate the tension of said flexible elements (10) and (11) comprise tie-bars (19a) and (21 a), connected to said flexible elements (10) and (11), said tie-bars (19a) and (21 a) causing the deformation of elastic means, and said deformation being related to the tension applied to said flexible elements (10) and (11).

4. Arm for lifting and manipulation of loads, as claimed in claim 3, **characterised in that** said elastic means comprise Belleville washers (19b) and (21 b).

5. Arm for lifting and manipulation of loads, as claimed in claim 3, **characterised in that** indicators are provided on the rod of said tie-bars (19a) and (21a) designed to indicate the axial movements undergone by said tie-bars (19a) and (21 a) in relation to said parts (7) and (12), which are integral with said first base section (2), during successive adjustments of said flexible elements (10) and (11).

6. Arm for lifting and manipulation of loads, as claimed in claim 5, **characterised in that** said indicators on the rod of said tie-bars (19a) and (21 a) comprise rings marked on pins (19a) and (21a).

7. Arm for lifting and manipulation of loads, as claimed in at least one of claims 2 to 6, **characterised in that** said means (19) and (21) designed to regulate the tension of said flexible elements (10) and (11) are accessible from the outside.

8. Arm for lifting and manipulation of loads, as claimed in claim 7, **characterised in that** it includes windows (20) in said second and third sections (3) and (4) designed to allow access from the outside to said regulation means (21) of said second flexible element (11).

9. Arm for lifting and manipulation of loads, as claimed in claim 1, **characterised in that** said second part (12), integral with said first base section (2), is fitted at the end of a rigid element (16) designed to maintain a constant distance between said first part (7) and said second part (12).

10. Arm for lifting and manipulation of loads, as claimed in claim 9, **characterised in that** said rigid element (16) is shaped to house the parts of said first flexible element (10) and said first pipe (14) which remain stationary in relation to said first base section (2) during the relative sliding of said first, second and third sections (2, 3, 4).

11. Arm for lifting and manipulation of loads, as claimed in claim 1, **characterised in that** said part (4a), integral with said third section (4), comprises a block to which the ends of said flexible elements (10) and (11) are attached.

12. Arm for lifting and manipulation of loads, as claimed in claim 1, **characterised in that** said part (4a), integral with said third section (4), comprises a block to which said first and second hydraulic pipes (14) and (15) are connected, a channel that places said first pipe (14) in communication with said second pipe (15) being fitted.

13. Arm for lifting and manipulation of loads, as claimed in claim 12, **characterised in that** said channel which places said first pipe (14) in communication with said second pipe (15) comprises an U-shaped union (18) fitted on said block (4a).

14. Arm for lifting and manipulation of loads, as claimed in at least one of claims 1 to 13, **characterised in that** said arm (1) has an upward curvature.

15. Arm for lifting and manipulation of loads, as claimed in claim 14, **characterised in that** said curvature is such that said arm (1) deviates from the straight by 30 mm for each metre of length.

16. Arm for lifting and manipulation of loads, as claimed in at least one of claims 1 to 15, **characterised in that** said first and second flexible elements (10) and (11) are chains.

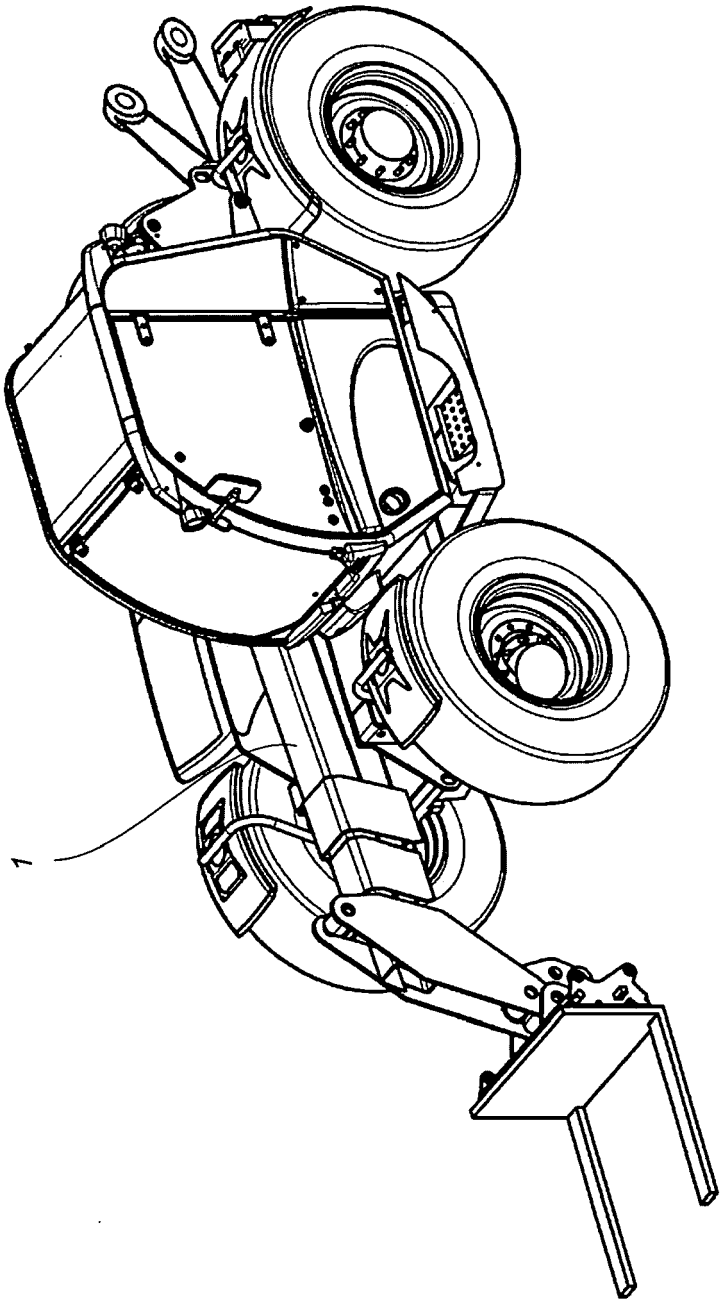
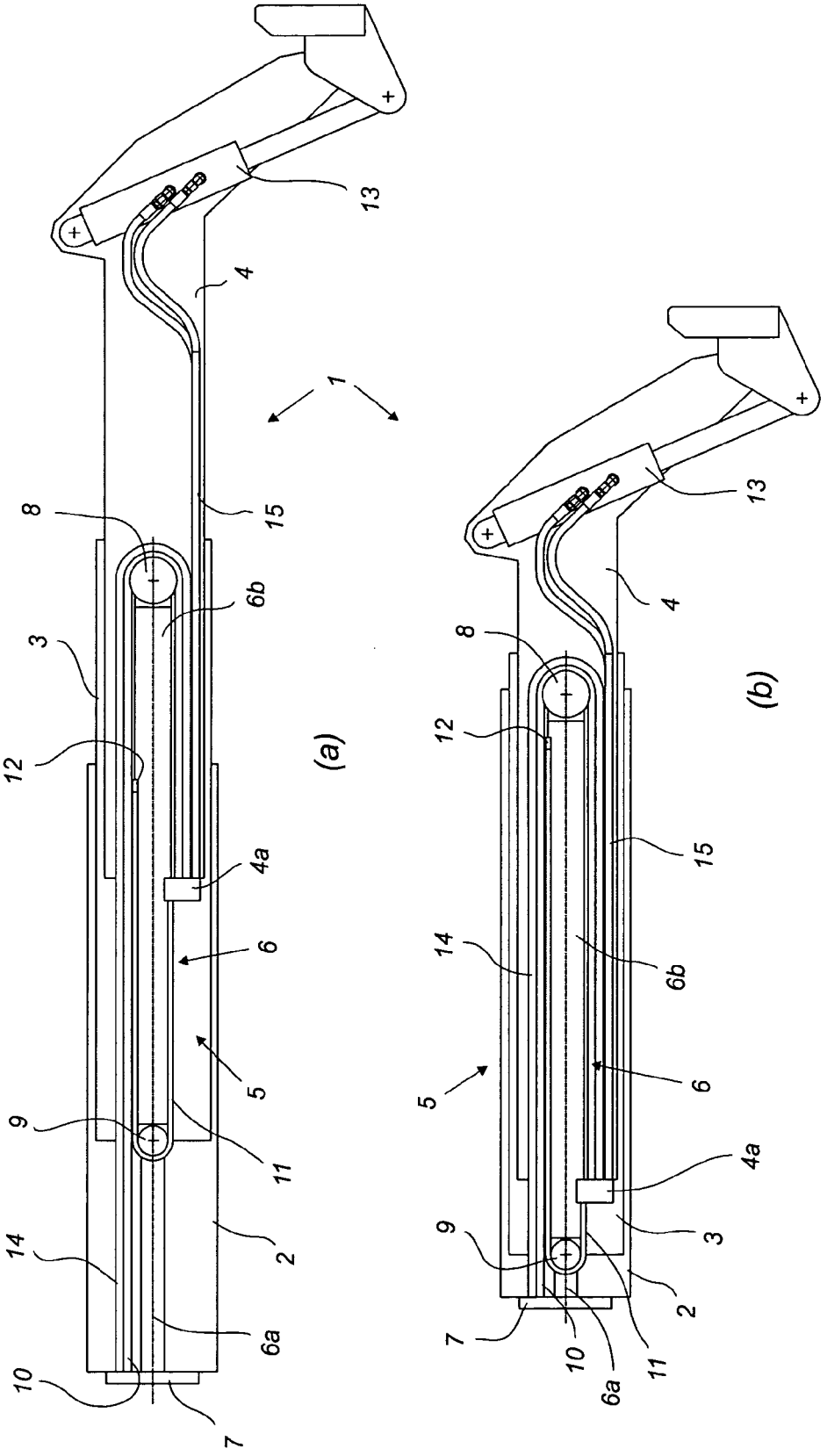


Fig. 1


13
4
1
8
15
6b
3
12
4a
6
5
9
11
14
2
6a
10
7
(a)
13
4
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12
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6b
5
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4a
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2
7
10
6a
11
(b)

Fig. 2

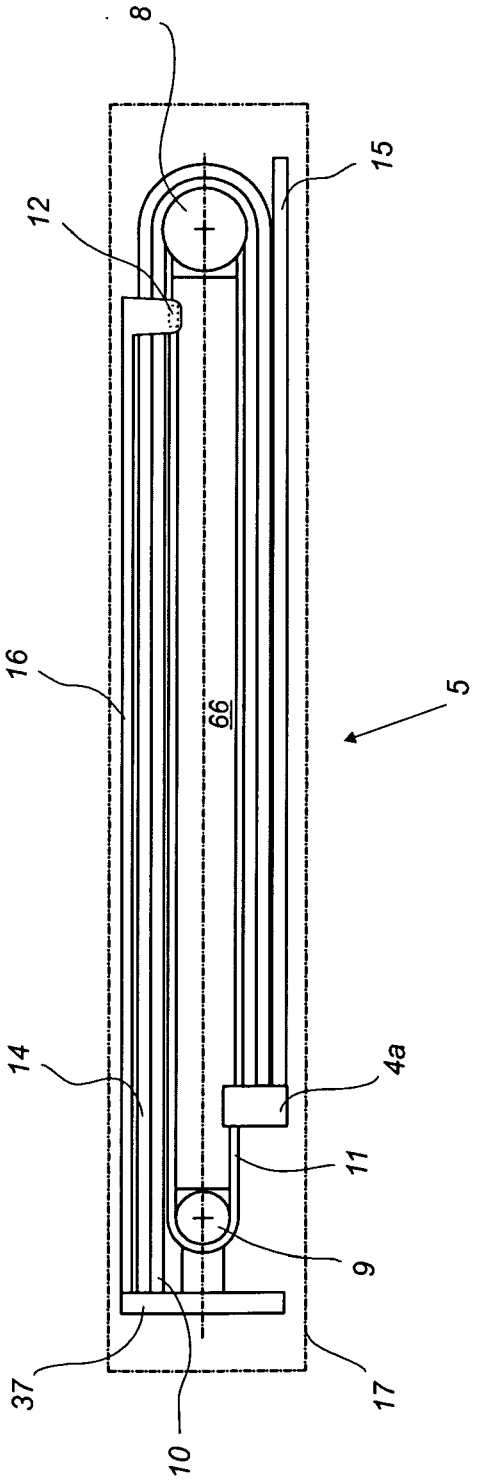


Fig. 3

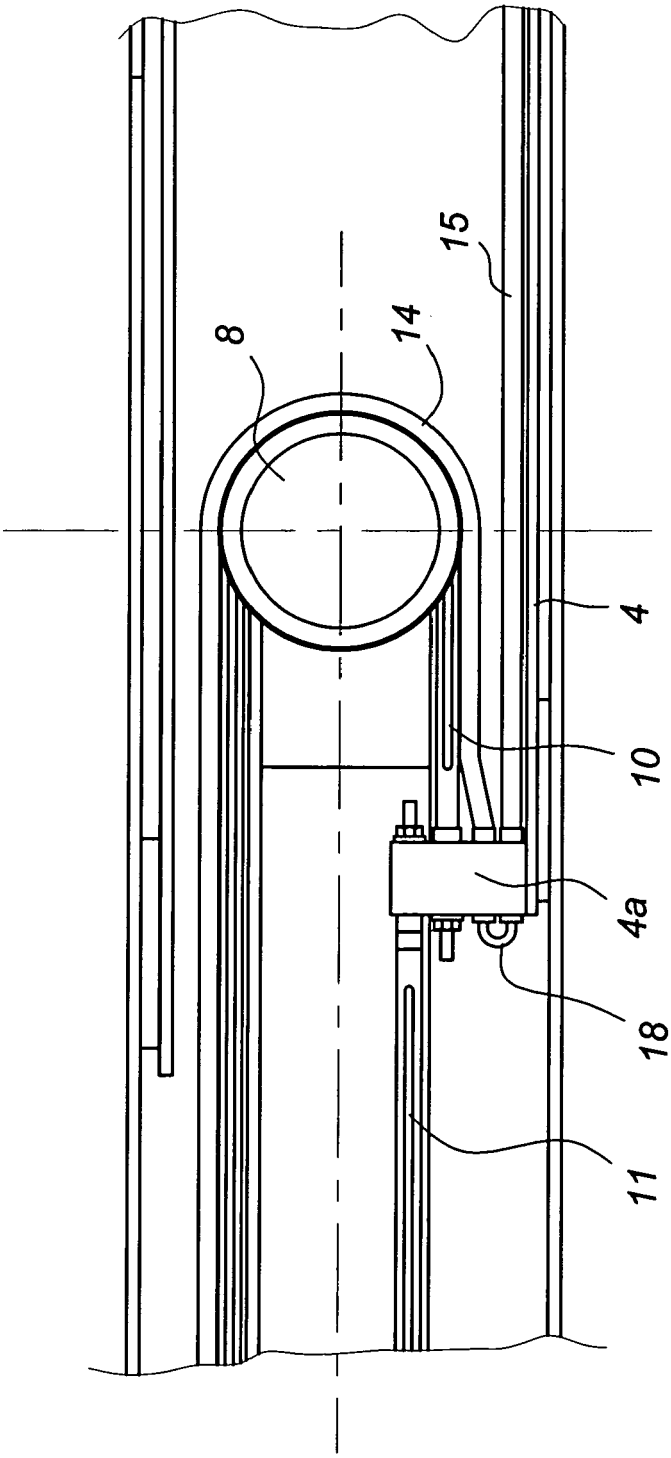
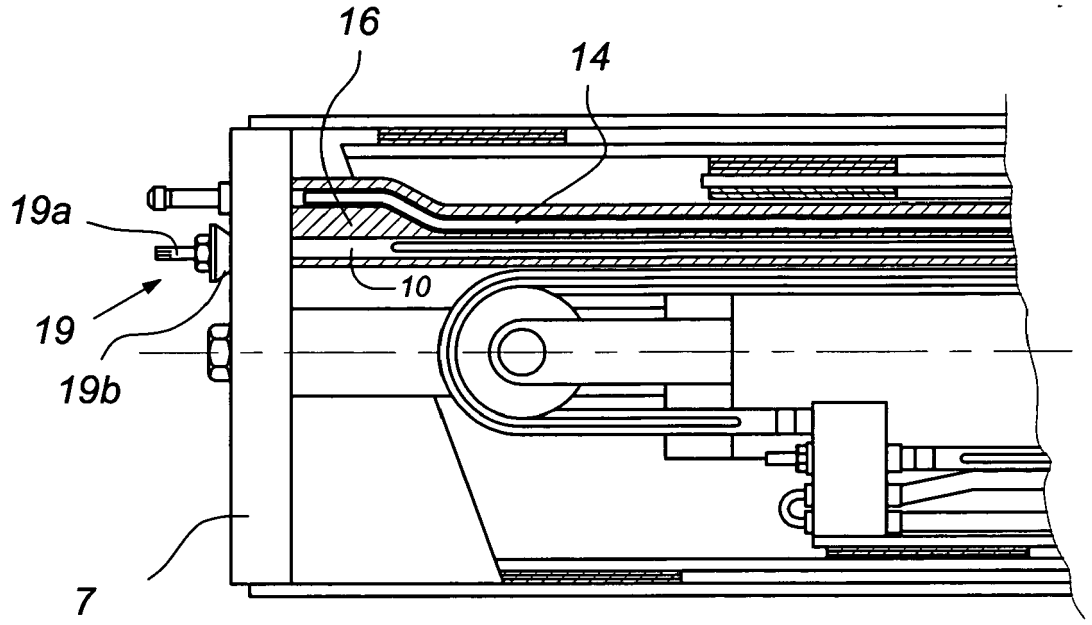
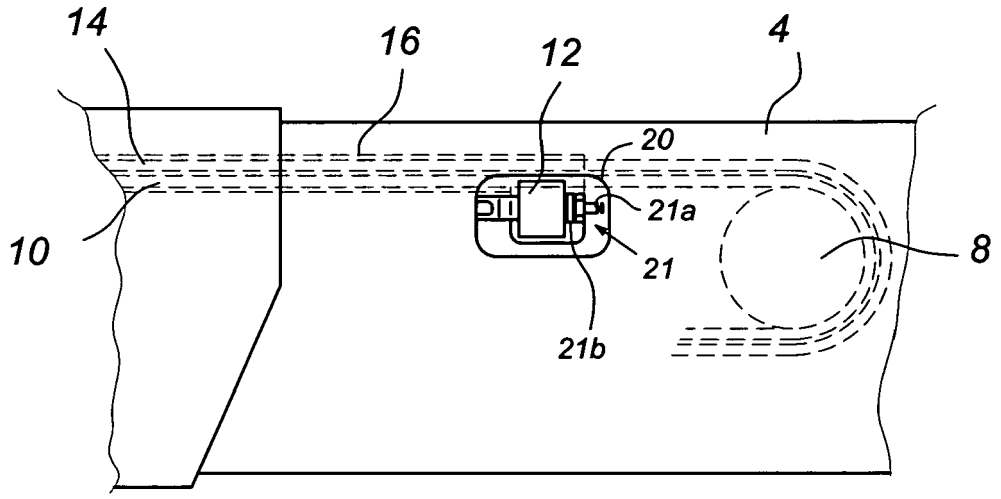


Fig. 4



(a)



(b)

Fig. 5