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(54) Title: A TOP CHARGING APPARATUS FOR CHARGING MATERIAL IN A BLAST FURNACE AND A METHOD FOR OPENING AND CLOSING A BOTTOM OPENING OF A HOPPER OF A BLAST FURNACE TOP CHARGING APPARATUS

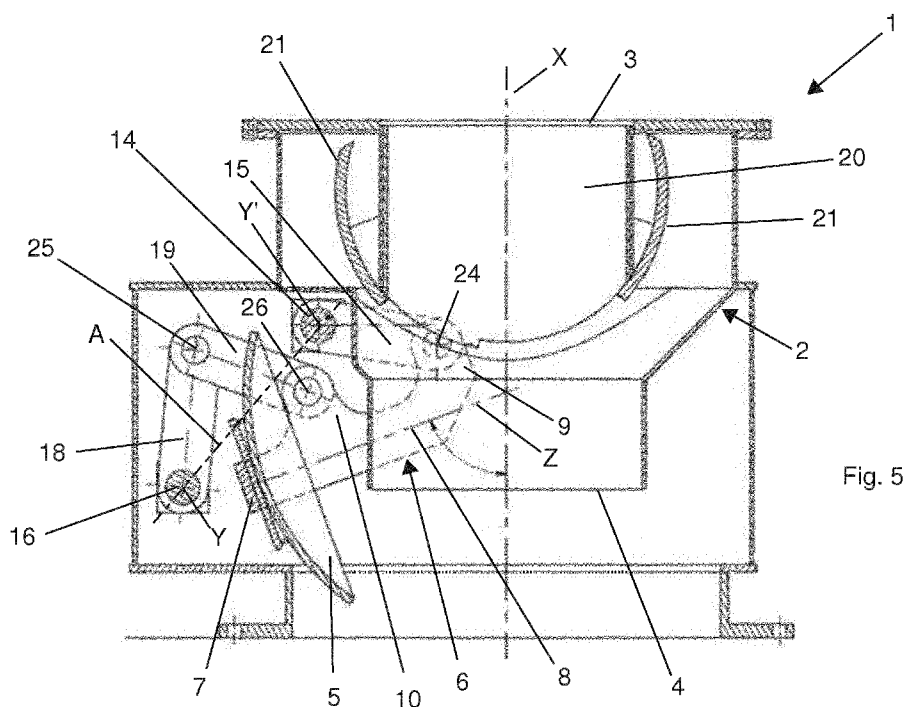


Fig. 5

(57) Abstract: A top charging apparatus (1) for charging material in a blast furnace comprising a material hopper (2) having a top opening (3) and a bottom opening (4) defining a longitudinal axis (X); a closing/opening device for closing or opening said bottom opening (4); wherein said closing/opening device comprises a seal valve (5); at least one handling lever (6), connected to said seal valve (5), for moving the seal valve (5) from a closing position to a maximum opening position, or vice versa; a first rotation shaft (14), connected to at least one first part of the handling lever (6), for actuating said handling lever (6); a second rotation shaft (16), connected to at least one second part of the handling lever (6), for actuating said handling lever (6); wherein the first rotation shaft (14) and the second rotation shaft (16) have axes of rotation (Y, Y') arranged parallel from one another and perpendicular to a first plane



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containing the longitudinal axis (X); and wherein the seal valve (5) in said maximum opening position intersects a second plane (A), defined by the axes of rotation (Y, Y') of first rotation shaft (14) and second rotation shaft (16), in an intermediate position between said axes of rotation.

**A TOP CHARGING APPARATUS FOR CHARGING MATERIAL IN A BLAST FURNACE
AND A METHOD FOR OPENING AND CLOSING A BOTTOM OPENING OF A
HOPPER OF A BLAST FURNACE TOP CHARGING APPARATUS**

Field of the invention

- 5 The present invention relates to a top charging apparatus for charging material in a blast furnace, provided with an opening/closing device for closing or opening the bottom opening of a material hopper.

Background art

- 10 Various devices for closing or opening a seal valve of a material hopper are known from the prior art.

- For example, a known device includes a shut-off flap valve or furnace mouth flap valve, which is used to control the charging of a blast furnace with coke and burden material. For the purpose, the device includes a flap plate which, for the purpose of closing or opening the opening of the material hopper arranged above the mouth of a blast furnace, is movable into an open position and into a closed position. In order to move the flap plate into the desired position, a drive mechanism is usually in articulated connection at the flap rim, by which it is ensured that, in the open position, the flap plate leaves the flow opening substantially completely clear. In the process, however, the flap plate is pivoted out relatively far away from the opening, so that the mouth of the blast furnace has to be correspondingly dimensioned in order to avoid a collision of the flap plate with loose material.

- A further known device avoids this disadvantage by means of a flap plate in articulated connection with two pivot arms which are mounted so that they can pivot about pivot axes that extend parallel to one another. It is ensured therein that, when the flap plate moves from the closed position to the open position and vice-versa, the rim regions of the flap plate move along oppositely directed arcuate paths. The movement of the flap plate obtained in that manner brings about a movement of the flap plate on a trajectory close to the bottom opening, as a result of which the charging system of the blast furnace can be of more compact construction overall. Guiding the flap plate along the arcuate paths brings about, in the region of the opening, a relative movement between the rim region of the flap

plate and the sealing seat provided for the flap plate at the bottom opening. Especially when the sealing region of the flap plate is in contact with the sealing seat of the bottom opening, a relative movement parallel to the plane of the opening is damaging and can result in premature wear of the sealing provisions.

- 5 Thus, the need is felt to provide a top charging apparatus which allows to overcome the aforesaid drawbacks.

Summary of the invention

It is an object of the present invention to provide a top charging apparatus provided with an opening/closing device for opening or closing the opening of the
10 hopper, said device being extremely compact both in open position and partially open position of the seal valve.

It is another object of the invention to provide an opening/closing device capable of considerably reducing wear at the sealing surfaces.

It is another object of the invention to provide a method for closing/opening a
15 bottom opening of a hopper of said top charging apparatus.

Thus, the present invention achieves the above objects by providing a top charging apparatus for charging material in a blast furnace which comprises a material hopper, having a top opening and a bottom opening defining a longitudinal axis X; and a closing/opening device for closing or opening said
20 bottom opening; wherein said closing/opening device comprises:

- a seal valve;
- at least one handling lever, connected to said seal valve, for moving the seal valve from a closing position to a maximum opening position, or vice versa;
- a first rotation shaft, connected to at least one first part of the handling lever, for
25 actuating said handling lever;
- a second rotation shaft, connected to at least one second part of the handling lever, for actuating said handling lever;

wherein the first rotation shaft and the second rotation shaft have axes of rotation Y, Y' parallel from one another and perpendicular to a first plane containing the
30 longitudinal axis X;

and wherein the seal valve in said maximum opening position intersects a second plane A, defined by the axes of rotation Y, Y' of first rotation shaft and second

rotation shaft, in an intermediate position between said two axes of rotation Y, Y'.

The closing/opening device also comprises:

- a first actuator for actuating said first rotation shaft so as to transmit a linear movement to said at least one handling lever and, thus, to said seal valve; and

5 - a second actuator for actuating said second rotation shaft so as to transmit a pivoting movement to said at least one handling lever and, thus, to said seal valve.

Another aspect of the invention refers to a method for opening the bottom opening of the hopper of said top charging apparatus, the method comprising the following steps:

10 - providing the seal valve in a closing position in which the bottom opening is closed by said seal valve;

- actuating the handling lever by means of the first rotation shaft for transmitting a linear movement downwards to said seal valve until reaching an intermediate position in which the seal valve is substantially placed parallel to and spaced apart

15 from said bottom opening;

- actuating the handling lever by means of the second rotation shaft for transmitting a pivoting movement to said seal valve until reaching a maximum opening position in which the bottom opening is completely clear.

A further aspect of the invention refers to a method for closing the bottom opening

20 of the hopper of said top charging apparatus, the method comprising the following steps:

- providing the seal valve in said maximum opening position in which the bottom opening is completely clear;

25 - actuating the handling lever by means of the second rotation shaft for transmitting a pivoting movement to said seal valve until reaching an intermediate position in which the seal valve is substantially placed parallel to and spaced apart from said bottom opening;

30 - actuating the handling lever by means of the first rotation shaft for transmitting a linear movement upwards to said seal valve until reaching a closing position in which the bottom opening is closed by said seal valve.

Advantageously, according to the invention, the sealing system can comprise a material gate and a seal valve with a sealing disc.

The seal valve is used to pressurize the part below and/or above the sealing disc (i.e. the pressure below or above the disc is higher than the pressure above or below the disc). Any equipment that should be pressurized (for example material bunker) or a blast furnace can be placed below the seal valve.

- 5 The seal valve arrangement is setup with two particular geometrical constraints:
- the seal valve moves down, when the sealing effect is to be stopped, substantially parallel to the bottom opening. The advantage is that there is minimum wear at the sealing surfaces compared to only rotational movements;
 - the seal valve rotates and simultaneously laterally moves up with a movement
- 10 similar to a spherical movement. The advantage compared to only rotational movement is that the total height (seal valve including disc in open / partly opened position) is minimum.

A further advantage is that dust could fall down from the disc (as compared to horizontal moving discs).

- 15 Advantageously the first actuator ensures a linear, substantially vertical, movement of the seal valve, whereas the second actuator ensures a pivoting movement of said seal valve.

In the case of linear actuators, the stroke of the first actuator is advantageously shorter than the stroke of the second actuator. Alternatively, rotating actuators can

20 be used.

The whole mechanism is designed to limit the freedom of movements.

Both actuators are relatively strong actuators, because they are designed to ensure opening at high differential pressure. Sealing force is provided by both said actuators.

- 25 Mechanical stops can be provided to stop movements of the components at the correct position. Such mechanical stops can have various designs and can have adjustment possibility.

Both actuators can be electrical, hydraulic or pneumatic.

The dependent claims describe preferred embodiments of the invention.

30 Brief description of the drawings

Further features and advantages of the invention will be more apparent in light of the detailed description of preferred, but not exclusive, embodiments of a top

charging apparatus, disclosed by way of a non-limiting example, with the aid of the accompanying drawings in which:

Figures 1a and 1b depict perspective views of an apparatus according to the invention;

5 Figure 2 depicts a first side view of the apparatus of Figure 1;

Figure 3 depicts a second side view of the apparatus of Figure 1;

Figure 4 depicts a top view of the apparatus of Figure 1;

Figures 5 depicts a cross section view of the apparatus of Figure 1 in an operating position;

10 Figures 6a and 6b depict side views of parts of the apparatus in two operating positions;

Figures 7a and 7b depict side views of parts of the apparatus in two operating positions.

The same reference numerals in the drawings identify the same elements or
15 components.

Detailed description of preferred embodiments of the invention

With reference to the figures, there is depicted a top charging apparatus according to the invention, indicated by the numeral reference 1 as a whole, suitable for charging material in a blast furnace.

20 In all its embodiments the top charging apparatus 1 comprises:

- a material hopper 2 having a top opening 3 and a bottom opening 4 defining a longitudinal axis X;

- a closing/opening device for closing or opening said bottom opening 4.

Optionally the upper part of the hopper 2 includes a material inlet zone 20 (Figure
25 5) between the top opening 3 and a material control valve 21, placed between said top opening 3 and the bottom opening 4. The material control valve 21 is preferably a gate valve comprising two arcuate parts sliding over one another. Dedicated actuator 30 and linkage 31 are provided to move the arcuate parts of the control valve 21 from a closing position to an opening position (Figures 1b, 2).

30 Advantageously the closing/opening device for closing or opening the bottom opening 4 comprises:

- a seal valve 5;

- at least one handling lever 6, connected to the seal valve 5, for moving the seal valve 5 from a closing position to a maximum opening position, or from the closing position to an intermediate opening position, and vice versa;
- a rotation shaft 14, connected to at least one first part of the handling lever 6, for actuating said handling lever 6;
- a rotation shaft 16, connected to at least one second part of the handling lever 6, for actuating said handling lever 6.

Said intermediate opening position is placed between the closing position and maximum opening position.

10 The closing/opening device also comprises:

- a first actuator 11 for actuating the first rotation shaft 14 so as to transmit a linear movement to said at least one handling lever 6 and, thus, to said seal valve 5; and
- a second actuator 12 for actuating the second rotation shaft 16 so as to transmit a pivoting movement to said at least one handling lever 6 and, thus, to said seal valve 5.

The rotation shaft 14 and the rotation shaft 16 have a respective axis of rotation Y, Y'. These two axes of rotation Y, Y' are arranged always parallel from one another and perpendicular to a plane containing the longitudinal axis X. The axes of rotation Y, Y' lie completely, and thus define, a further plane A.

20 In a preferred solution the two parallel axes of rotation Y, Y' are arranged in fixed positions. Said fixed positions are at a same side of the top charging apparatus comprising the maximum opening position of the seal valve 5. Alternatively, at least one of the two rotation shafts 14, 16 and, thus, the respective axis of rotation Y, Y' are not arranged in a fixed position. For example, at least one of the two rotation shafts 14, 16 can move along a sliding rail or along a linear or curvilinear path defined within slots provided on the end support structures 40, 41 (Figure 2) of said at least one rotation shaft. Also in this latter case, the positions of the two rotation shafts 14, 16 are at a same side of the top charging apparatus comprising the maximum opening position of the seal valve 5.

30 Preferably the further plane A is inclined by an acute angle higher than 30°, for example in the range of 30-45°, with respect to the plane containing the longitudinal axis X and orthogonal to the sheet of Figure 5.

Advantageously the seal valve 5 in the maximum opening position intersects the further plane A, containing the two axes of rotation Y, Y', in an intermediate position between said two axes of rotation Y, Y'.

Optionally both the rotation shaft 14 and the rotation shaft 16 are placed radially outside of the bottom opening 4, preferably having a diameter lower than 1,5 meter.

Preferably the handling lever 6 has a base 7 fixed to the seal valve 5, in particular fixed to the external bottom of the seal valve 5, and two side arms 8 arranged at opposite sides with respect to the hopper 2. The two side arms 8 protrude from the ends of the base 7.

In a variant the closing/opening device is provided with:

- a first linkage, connecting the rotation shaft 14 to a first end 9 of the two side arms 8, for transmitting a linear movement to the seal valve 5;
- and a second linkage, connecting the rotation shaft 16 to a second end 10 of the two side arms 8, for transmitting a pivoting movement to said seal valve 5.

There are provided a first actuator 11 for actuating the rotation shaft 14 so as to transmit a linear movement to the seal valve 5, and a second actuator 12 for actuating the rotation shaft 16 so as to transmit a pivoting movement to said seal valve 5.

The second end 10 of the two side arms 8 is proximal to the base 7, whereas the first end 9 of the two side arms 8 is distal from the base 7.

Preferably the handling lever 6 has an U-shape, the base 7 of the U-shape being fixed to the seal valve 5 and the two side arms 8 having a F-shape or a C-shape.

In a variant the two side arms 8, parallel to each other, are arranged on planes transverse, for example orthogonal, to the plane of the base 7 of the U-shape. In particular, the two side arms 8 are symmetrically arranged with respect to a plane orthogonal to an longitudinal axis defined by the base 7.

Preferably, the base 7 of the U-shape has an inner surface fixed to a lower outer surface of the seal valve 5.

Optionally the seal valve 5 has a sealing disc which is intended for closing or opening the bottom opening 4 of the material hopper 2 and is arranged above the throat of a blast furnace. As a result of opening the sealing disc, loose material,

especially ores and burden material, is directed into the throat of the blast furnace through the bottom opening 4 (Figures 5, 7b). In the closed position, the bottom opening 4 is closed off in gas-tight manner by the sealing disc (Figures 1-3). For the gas-tight closure of the bottom opening 4 there is provided at the rim of the bottom opening 4 a sealing seat (not shown) having sealing elements. On the rim of the sealing disc there is provided a corresponding circumferential sealing surface (not shown), which in the closed position of the seal valve 5 cooperates with the sealing seat to provide sealing.

Preferably the first linkage comprises

- 10 - a pair of first levers 15, each first lever 15 being rigidly fixed at a first end thereof to the rotation shaft 14 and hinged at a second end thereof to the first end 9 of a respective side arm 8;

whereby, when the first actuator 11 actuates the rotation shaft 14, the first levers 15 rotate so that a linear movement upwards or downwards is transmitted to the handling lever 6 and, thus, to the seal valve 5.

Optionally the rotation angle of rotation shaft 14 and first levers 15 has a maximum value of 10°.

Each first lever 15 is hinged at the second end thereof to the first end 9 of the respective side arm 8 by means of a respective pin 24.

- 20 Preferably the second linkage comprises

- a pair of second levers 18, each second lever 18 being rigidly fixed at a first end thereof to the rotation shaft 16;

- and a pair of third levers 19, each third lever 19 being hinged at a first end thereof to a second end of a respective second lever 18 and hinged at a second end thereof to the second end 10 of a respective side arm 8;

whereby, when the second actuator 12 actuates the rotation shaft 16, the second levers 18 rotate so that, by means of the third levers 19, a pivoting movement is transmitted to the handling lever 6 and, thus, to the seal valve 5.

Optionally the rotation angle of rotation shaft 16 and second levers 18 has a maximum value of 90°.

Each third lever 19 is hinged at the first end thereof to the second end of a respective second lever 18 by means of a respective pin 25, and is hinged at the

second end thereof to the second end 10 of the respective side arm 8 by means of a respective pin 26.

In a first embodiment the first actuator 11 and the second actuator 12 are linear actuators. Advantageously the first actuator 11 has a first stroke shorter than a
5 second stroke of the second actuator 12. Preferably the first actuator 11 has a first stroke having a maximum value of 100 mm, whereas the second actuator 12 has a second stroke having a maximum value of 700 mm.

Preferably in said first embodiment there are provided:

- a first connecting lever 13 fixed at a first end thereof to the first actuator 11 and
10 rigidly fixed at a second end thereof to the rotation shaft 14;
- and a second connecting lever 17 fixed at a first end thereof to the second actuator 12 and at a second end thereof to the rotation shaft 16.

For example, the first actuator 11 can have a rod 22 connected to the connecting lever 13 by means a pin 23, whereas the second actuator 12 can have a rod 27
15 connected to the connecting lever 17 by means a pin 28 (Figures 6a, 6b).

When the rod 22 moves the pin 23 (Figures 6a, 6b), the connecting lever 13 rotates about the axis of the rotation shaft 14 and transmits a rotation to the same rotation shaft 14. The first levers 15 rotate together with the rotation shaft 14 so that a linear movement upwards or downwards is transmitted, by means of pins
20 24, to the to the first ends 9 of the side arms 8 and, thus, to the handling lever 6 integrally fixed to the seal valve 5.

When the rod 27 moves the pin 28 (Figures 7a, 7b), the connecting lever 17 rotates about the axis of the rotation shaft 16 and transmits a rotation to the same rotation shaft 16. The second levers 18 rotate together with the rotation shaft 16 so
25 that, by means of the third levers 19 and the pins 25, 26, a pivoting movement is transmitted to the second ends 10 of the side arms 8 and, thus, to the handling lever 6 integrally fixed to the seal valve 5.

During this pivoting movement a further rotation of the first levers 15 occurs by means the pins 24. For example, when the rod 27 is retracted, during this pivoting
30 movement a further rotation downwards of the first levers 15 occurs, as visible from Figure 7a to Figure 7b. This advantageously allows a further reduction of the encumbrance of the seal valve 5 in the opening position.

Analogously, when the rod 27 is extended, during this pivoting movement a further rotation upwards of the first levers 15 occurs.

In a second embodiment (not shown) the first actuator 11 and the second actuator 12 are rotating actuators, for example motors, adapted to transmit the rotation to the rotation shaft 14 and the rotation shaft 16, respectively.

When the motor transmits a rotation to the rotation shaft 14, the first levers 15 rotate together with the rotation shaft 14 so that a linear movement upwards or downwards is transmitted, by means of the pins 24, to the first ends 9 of the side arms 8 and, thus, to the handling lever 6 integrally fixed to the seal valve 5.

When the further motor transmits a rotation to the rotation shaft 16, the second levers 18 rotate together with the rotation shaft 16 so that, by means of the third levers 19 and the pins 25, 26, a pivoting movement is transmitted to the second ends 10 of the side arms 8 and, thus, to the handling lever 6 integrally fixed to the seal valve 5.

Also in this second embodiment, during this pivoting movement a further rotation of the first levers 15 occurs by means the pins 24. For example, when the further motor transmits a rotation to the rotation shaft 16 in a first direction, during this pivoting movement a further rotation downwards of the first levers 15 occurs. Analogously, when the further motor transmits a rotation to the rotation shaft 16 in a second direction, opposite to said first direction, during this pivoting movement a further rotation upwards of the first levers 15 occurs.

In the maximum opening position of the seal valve 5 the inclination angle of the side arms 8 with respect to the longitudinal axis X of the bottom opening 4 is higher than 45°, preferably in the range of 55-90°, for example about 70° (Figure 5). In particular, with reference to Figure 5, this inclination angle is defined between a plane orthogonal to the sheet of Figure 5 and containing the longitudinal axis X and a plane Z containing the axes defined by the two side arms 8, also said plane Z being orthogonal to the sheet of Figure 5.

Therebelow the methods for opening and closing the bottom opening 4 of the hopper 2 of the top charging apparatus are disclosed with reference to Figures from 5 to 7b.

Figure 6a shows the seal valve 5 in the closing position, that means the position in

which the bottom opening 4 is closed off in gas-tight manner by the sealing disc of the seal valve 5.

The method for opening the bottom opening 4 comprises the following steps:

- actuating the first linkage by means of the first actuator 11 for transmitting a linear movement downwards to the seal valve 5 until reaching an intermediate position (Figure 6b, 7a) in which the seal valve 5 is substantially placed parallel to and spaced apart from the bottom opening (not shown in Figure 6b, 7a);
- actuating the second linkage by means of the second actuator 12 for transmitting a pivoting movement to the seal valve 5 until reaching a maximum side opening position (Figure 7b, 5) in which the bottom opening 4 is completely clear (Figure 5).

Instead, starting from the maximum side opening position of Figures 5, 7b, the method for closing the bottom opening 4 comprises the following steps:

- actuating the second linkage by means of the second actuator 12 for transmitting a pivoting movement to the seal valve 5 until reaching the intermediate position (Figure 6b, 7a) in which the seal valve 5 is substantially placed parallel to and spaced apart from the bottom opening 4 (not shown in Figure 6b, 7a);
- actuating the first linkage by means of the first actuator 11 for transmitting a linear movement upwards to the seal valve 5 until reaching a closing position in which the bottom opening 4 is closed off in gas-tight manner by the sealing disc of the seal valve 5.

Claims

1. A top charging apparatus (1) for charging material in a blast furnace comprising a material hopper (2) having a top opening (3) and a bottom opening (4) defining a longitudinal axis (X);
- 5 a closing/opening device for closing or opening said bottom opening (4); wherein said closing/opening device comprises
- a seal valve (5);
 - at least one handling lever (6), connected to said seal valve (5), for moving the seal valve (5) from a closing position to a maximum opening position, or vice versa;
 - 10 - a first rotation shaft (14), connected to at least one first part of the handling lever (6), for actuating said handling lever (6);
 - a second rotation shaft (16), connected to at least one second part of the handling lever (6), for actuating said handling lever (6);
- 15 wherein the first rotation shaft (14) and the second rotation shaft (16) have axes of rotation (Y, Y') arranged parallel from one another and perpendicular to a first plane containing the longitudinal axis (X);
- wherein the seal valve (5) in said maximum opening position intersects a second plane (A), defined by the axes of rotation (Y, Y') of first rotation shaft (14) and
- 20 second rotation shaft (16), in an intermediate position between said axes of rotation (Y, Y');
- and wherein there are provided
- a first actuator (11) for actuating said first rotation shaft (14) so as to transmit a linear movement to said seal valve (5); and
 - 25 - a second actuator (12) for actuating said second rotation shaft (16) so as to transmit a pivoting movement to said seal valve (5).
2. The top charging apparatus according to claim 1, wherein the handling lever (6) has a base (7) fixed to the seal valve (5) and two side arms (8) arranged at opposite sides with respect to the hopper (2); and wherein there are provided
- 30 - a first linkage, connecting the first rotation shaft (14) to a first end (9) of the two side arms (8), for transmitting a linear movement to said seal valve (5);
- and a second linkage, connecting the second rotation shaft (16) to a second end

(10) of the two side arms (8), for transmitting a pivoting movement to said seal valve (5).

3. The top charging apparatus according to claim 2, wherein said first linkage comprises

5 a pair of first levers (15), each first lever (15) being rigidly fixed at a first end thereof to said first rotation shaft (14) and hinged at a second end thereof to the first end (9) of a respective side arm (8);
whereby, when the first actuator (11) actuates the first rotation shaft (14), the first levers (15) rotate so that a linear movement is transmitted to the handling lever (6)
10 and, thus, to the seal valve (5).

4. The top charging apparatus according to claim 3, wherein the rotation angle of the first rotation shaft (14) and the first levers (15) has a maximum value of 10°.

5. The top charging apparatus according to claim 3 or 4, wherein there is provided a first connecting lever (13) fixed at a first end thereof to the first actuator (11) and
15 at a second end thereof to said first rotation shaft (14).

6. The top charging apparatus according to any one of claims from 3 to 5, wherein said second linkage comprises

a pair of second levers (18), each second lever (18) being rigidly fixed at a first end thereof to said second rotation shaft (16);
20 a pair of third levers (19), each third lever (19) being hinged at a first end thereof to a second end of a respective second lever (18) and hinged at a second end thereof to the second end (10) of a respective side arm (8);
whereby, when the second actuator (12) actuates the second rotation shaft (16), the second levers (18) rotate so that, by means of the third levers (19), a pivoting
25 movement is transmitted to the handling lever (6) and, thus, to the seal valve (5).

7. The top charging apparatus according to claim 6, wherein the rotation angle of the second rotation shaft (16) and the second levers (18) has a maximum value of 90°.

8. The top charging apparatus according to claim 6 or 7, wherein there is provided
30 a second connecting lever (17) fixed at a first end thereof to the second actuator (12) and at a second end thereof to said second rotation shaft (16).

9. The top charging apparatus according to any one of the preceding claims,

wherein the first actuator (11) has a first stroke shorter than a second stroke of the second actuator (12), and preferably wherein the first stroke has a maximum value of 100 mm, whereas the second stroke has a maximum value of 700 mm.

10. The top charging apparatus according to any one of the preceding claims,
5 wherein in the maximum opening position of the seal valve (5) an inclination angle of the handling lever (6) with respect to the longitudinal axis (X) is higher than 45°, preferably in the range of 55-90°.

11. The top charging apparatus according to any one of claims from 2 to 10,
10 wherein the handling lever (6) has an U-shape, the base (7) of the U-shape being fixed to the seal valve (5) and the two side arms (8) having a F-shape or a C-shape.

12. The top charging apparatus according to any one of the preceding claims,
wherein said second plane (A), defined by the axes of rotation (Y, Y'), is inclined by an acute angle higher than 30° with respect to the longitudinal axis (X).

15 13. The top charging apparatus according to any one of the preceding claims,
wherein both the first rotation shaft (14) and the second rotation shaft (16) are placed radially outside of the bottom opening (4) preferably having a diameter lower than 1,5 m.

14. The top charging apparatus according to any one of the preceding claims,
20 wherein the first rotation shaft (14) and the second rotation shaft (16) have axes of rotation (Y, Y') arranged in fixed positions, or wherein at least one of the first rotation shaft (14) and the second rotation shaft (16) has the respective axis of rotation (Y, Y') arranged in a movable position.

15. A method for opening a bottom opening (4) of a hopper (2) of a top charging
25 apparatus (1) according to any one of the preceding claims, the method comprising the following steps:

- providing the seal valve (5) in a closing position in which the bottom opening (4) is closed by said seal valve (5);
- actuating the handling lever (6) by means of the first rotation shaft (14) for
30 transmitting a linear movement downwards to said seal valve (5) until reaching an intermediate position in which the seal valve (5) is substantially placed parallel to and spaced apart from said bottom opening (4);

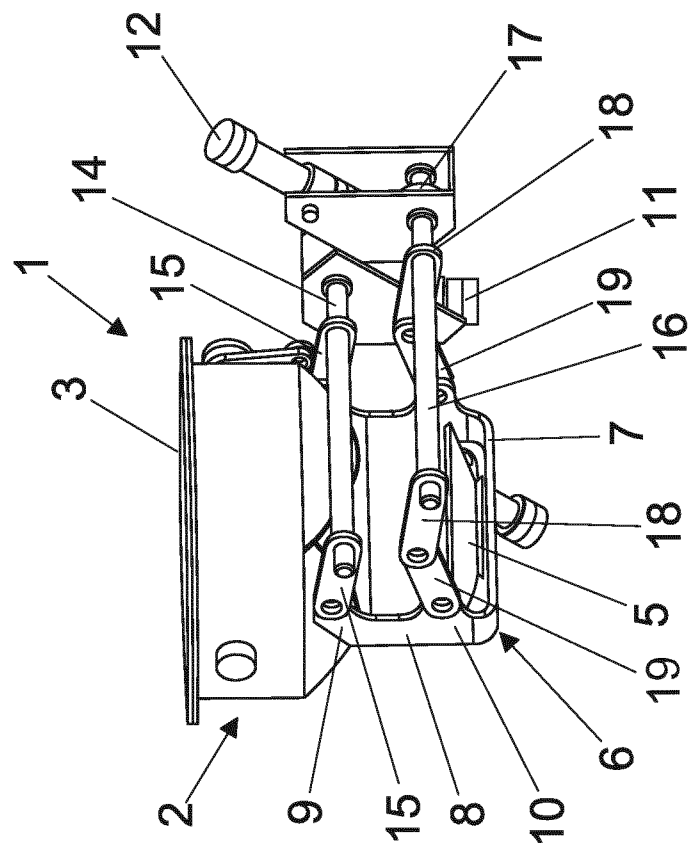
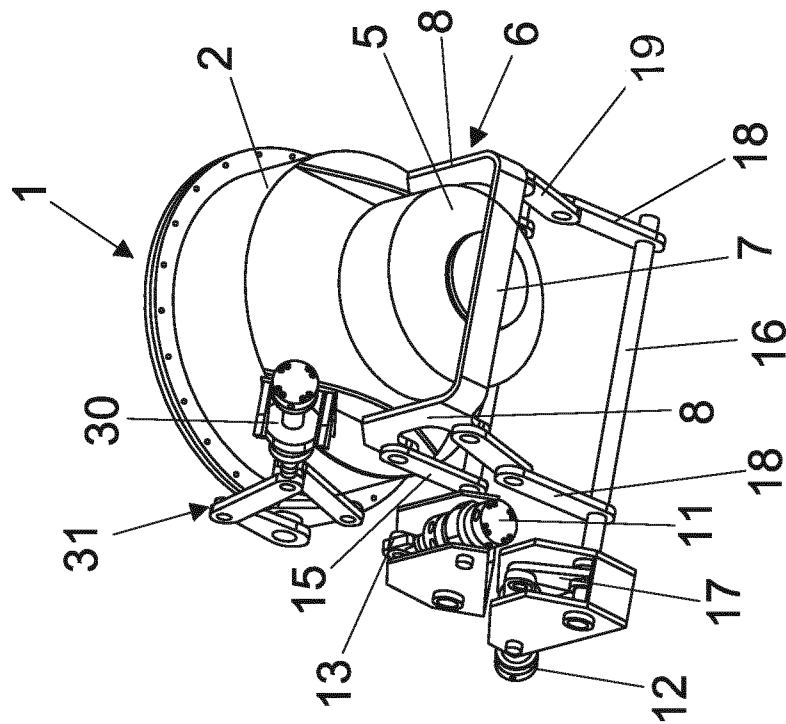
- actuating the handling lever (6) by means of the second rotation shaft (16) for transmitting a pivoting movement to said seal valve (5) until reaching a maximum opening position in which the bottom opening (4) is completely clear.

16. A method for closing a bottom opening (4) of a hopper (2) of a top charging
5 apparatus (1) according to any one of the preceding claims, the method comprising the following steps:

- providing the seal valve (5) in said maximum opening position in which the bottom opening (4) is completely clear;

10 - actuating the handling lever (6) by means of the second rotation shaft (16) for transmitting a pivoting movement to said seal valve (5) until reaching an intermediate position in which the seal valve (5) is substantially placed parallel to and spaced apart from said bottom opening (4);

- actuating the handling lever (6) by means of the first rotation shaft (14) for transmitting a linear movement upwards to said seal valve (5) until reaching a
15 closing position in which the bottom opening (4) is closed by said seal valve (5).



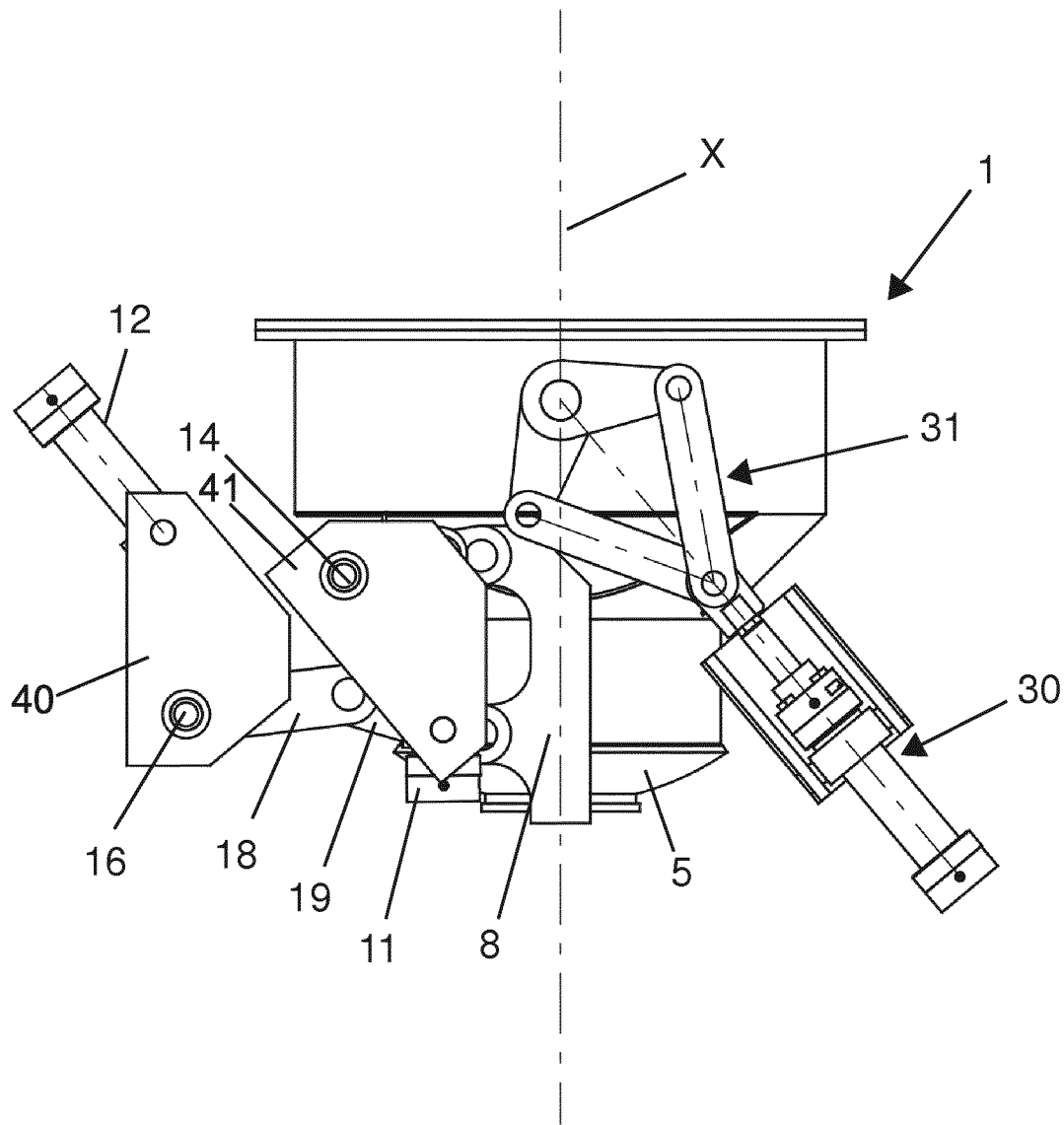
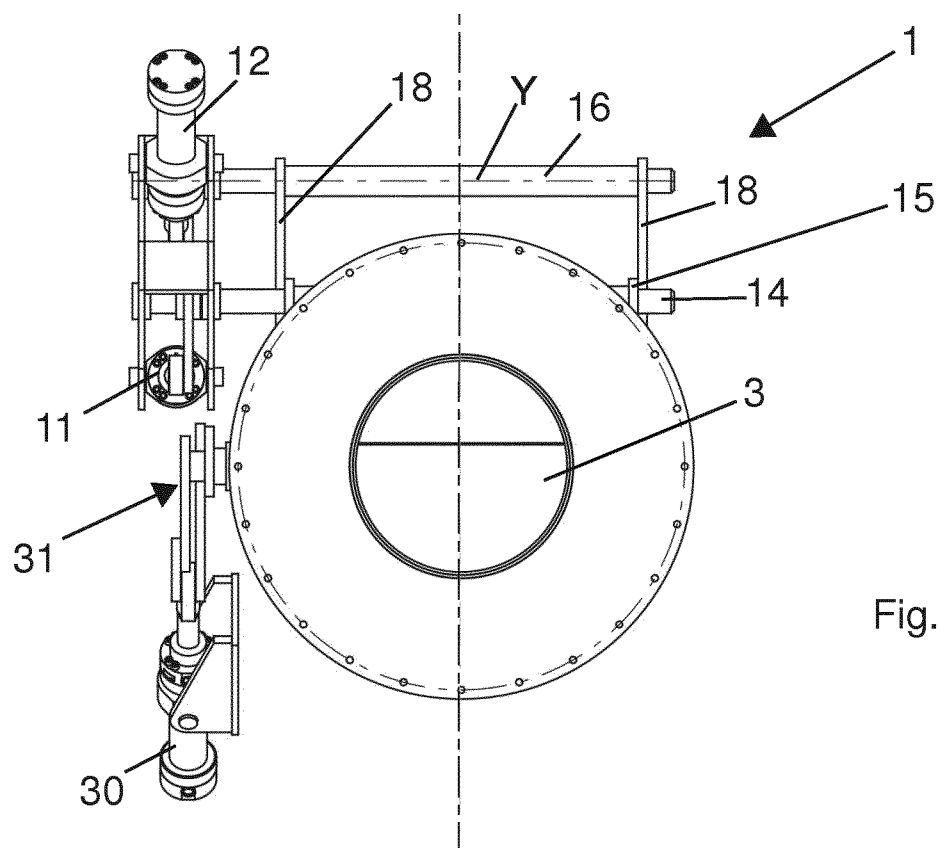
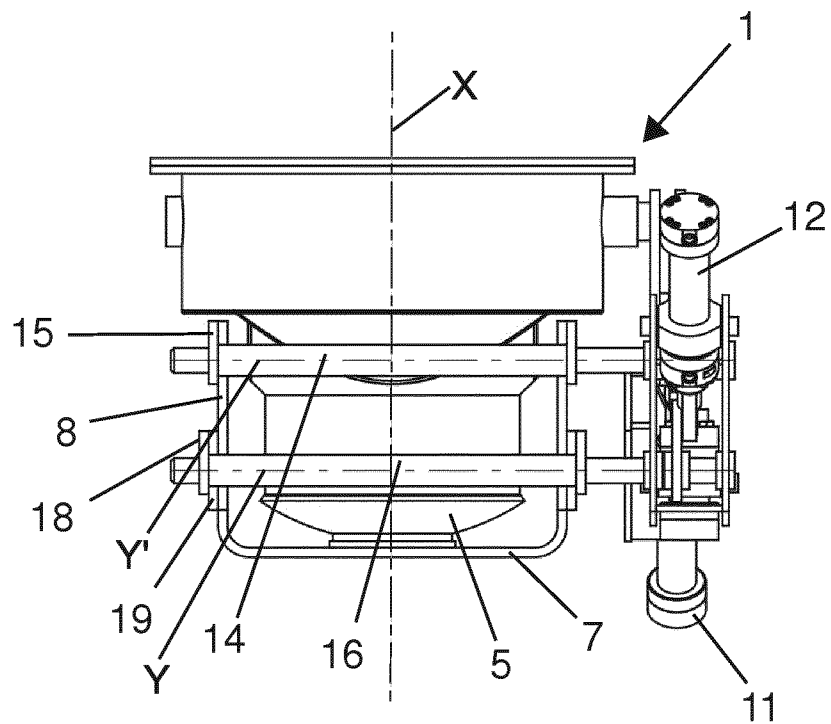
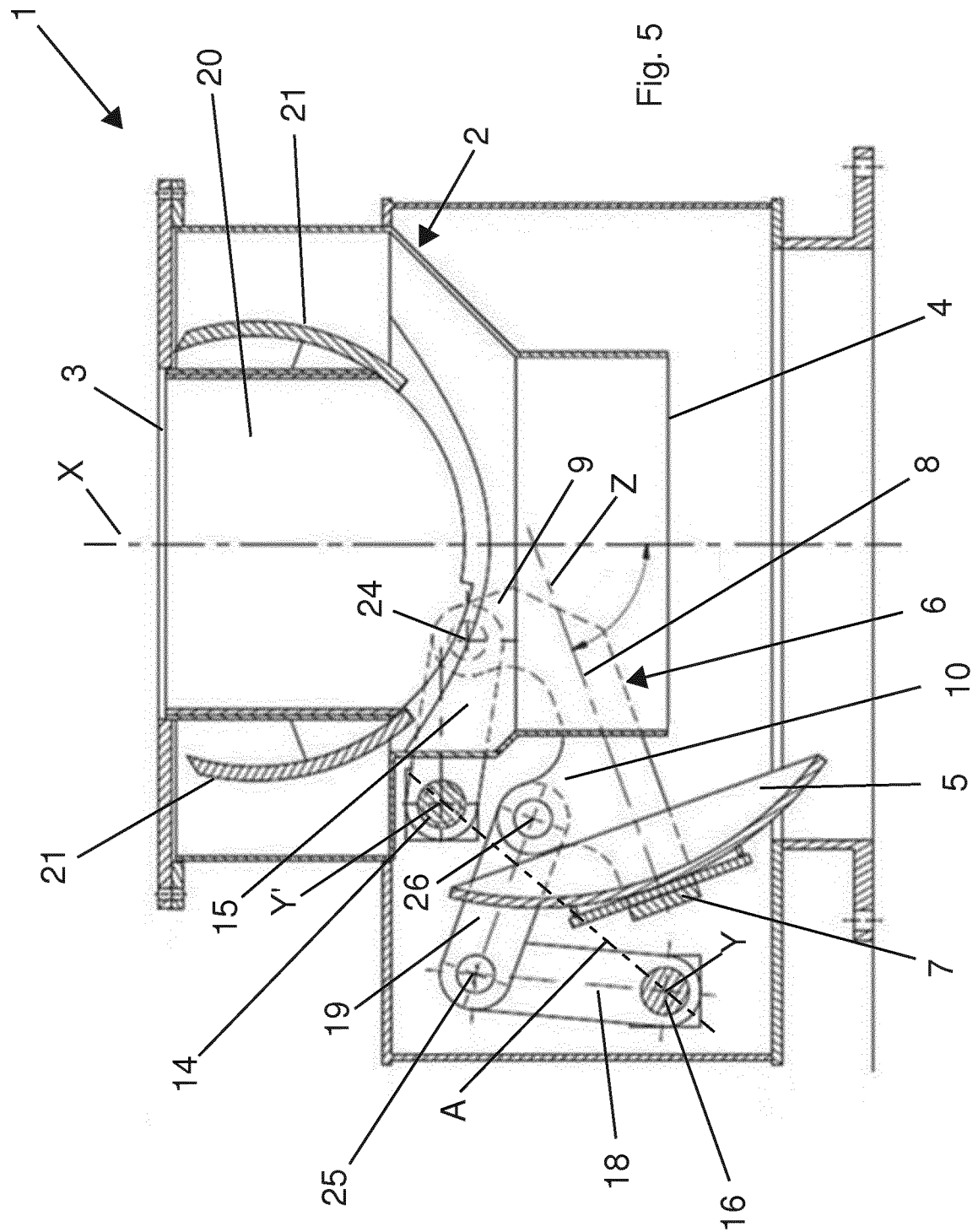


Fig. 2





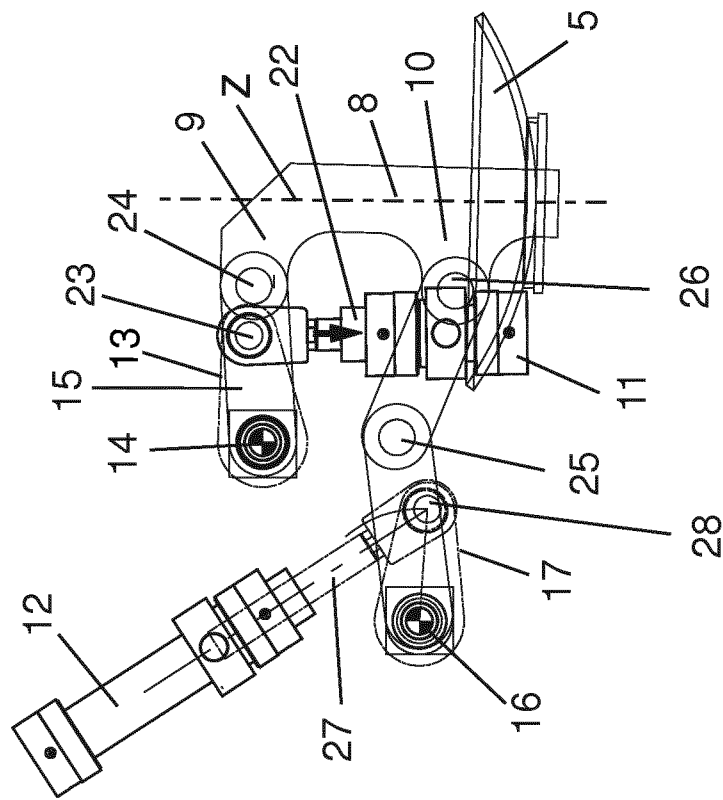


Fig. 6b

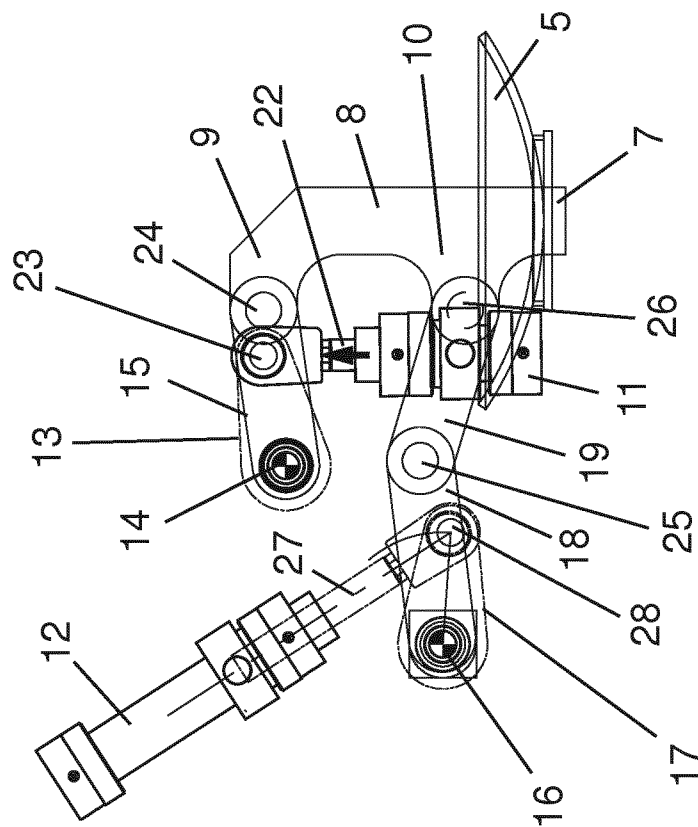


Fig. 6a

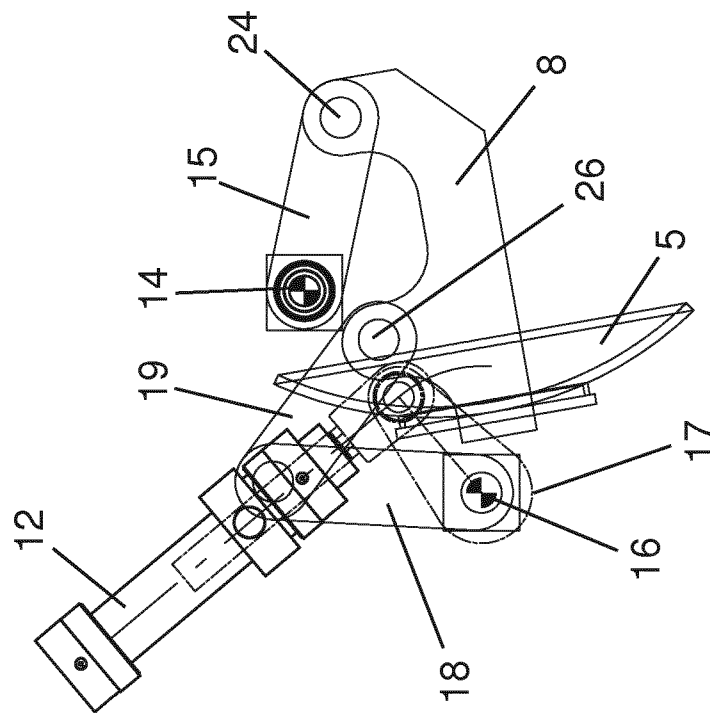


Fig. 7b

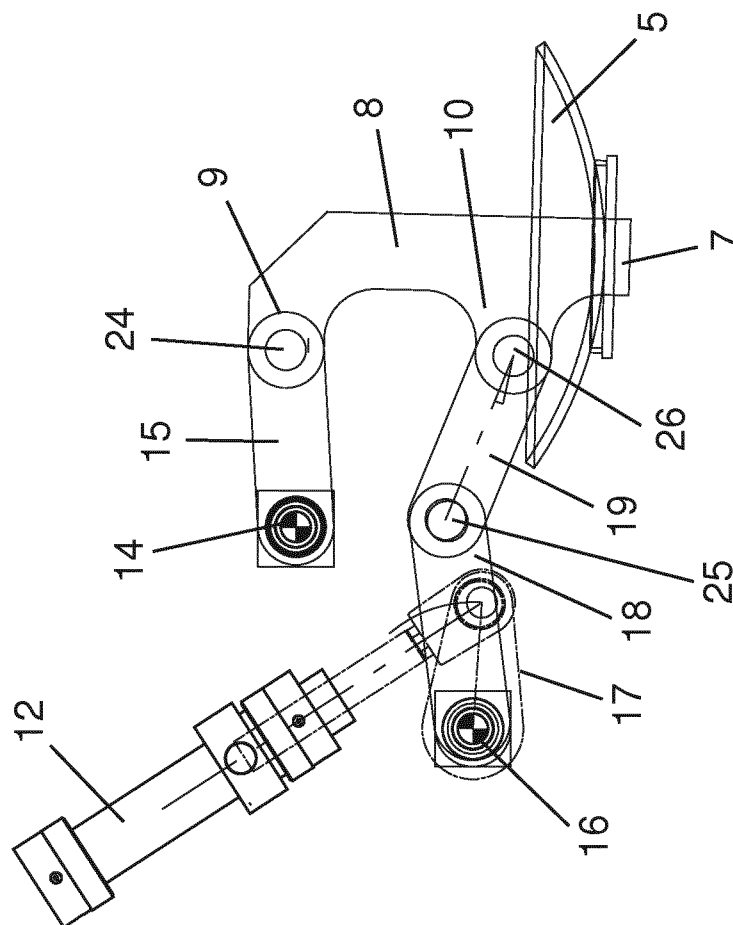


Fig. 7a

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/074507

A. CLASSIFICATION OF SUBJECT MATTER
INV. C21B7/20 F27B1/20
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)
C21B F27B F27D C21C

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.
A	WO 2017/050313 A1 (TDCO GMBH [DE]) 30 March 2017 (2017-03-30) figures 1a-2c	1-16
A	JP H10 339582 A (ISHIKAWAJIMA HARIMA HEAVY IND) 22 December 1998 (1998-12-22) abstract; figure 2	1-16



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

13 November 2019

Date of mailing of the international search report

21/11/2019

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Authorized officer

Peis, Stefano

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/074507

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2017050313 A1	30-03-2017	DE 102015116195 A1 WO 2017050313 A1	30-03-2017 30-03-2017
JP H10339582 A	22-12-1998	NONE	