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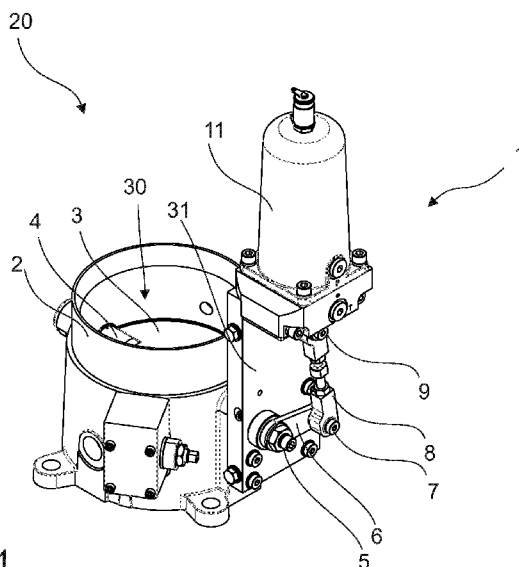


Fig. 1

(57) Abstract: An actuator arrangement (1) for an inlet air valve of a compressor system of a mining machine, the actuator arrangement comprises a linear actuator (11) comprising a movable element (10), operatively connected via a lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) to a shaft (4) of a closing element (3) of the inlet air valve. A linear movement of the movable element (10) of the linear actuator (11) is transmitted via the lever mechanism to a rotation movement of the shaft (4) of the closing element (3) of the inlet air valve, wherein a transmission ratio of the lever mechanism is configured to vary during a movement of the movable element (10) of the linear actuator (11).



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AN ACTUATOR ARRANGEMENT FOR AN INLET AIR VALVE OF A
COMPRESSOR, AN INLET AIR VALVE, AND A MINING MACHINE

5 **TECHNICAL FIELD**

The embodiments disclosed herein relate to an actuator arrangement for an inlet air valve of a compressor of a mobile mining machine, an inlet valve, and a mobile mining machine.

10

BACKGROUND

Various embodiments of mining machines are known. Some embodiments of mobile mining machines may include an air compressor system. The air compressor system may take air in through an air filter and compress the air with an air compressor and deliver the compressed air as working air, such as flushing air for a drilling rig operation.

The intake air may flow through an adjustable inlet air valve, which may be configured to control the amount of air that can flow through the adjustable inlet air valve. By adjusting the adjustable inlet air valve a controller of the compressor system of a mining machine may control the volume of compressed air delivered by the air compressor.

At some situations there is a need for reliable control the intake air valve to open progressively from a closed state to a fully open state.

30 **SUMMARY**

According to a first aspect, there is provided an actuator arrangement for an inlet air valve of a compressor system of a mining machine.

According to an embodiment of the actuator arrangement for an inlet air valve the actuator arrangement comprises a linear actuator comprising a movable

35

element, operatively connected via a lever mechanism to a shaft of a closing element of the inlet air valve, wherein a linear movement of the movable element of the linear actuator is transmitted via the lever mechanism to a rotation movement of the shaft of the closing element of the inlet air valve, wherein a transmission ratio of the lever mechanism is configured to vary during a movement of the movable element of the linear actuator.

10 The technical effect of one or more embodiments is that by the actuator arrangement of the inlet air valve is suitable for different amount of working air needs, for example adaptable with use of different sized drill units, due to a progressive actuating arrangement of the closing element of the inlet air valve.

15 An advantage of the arrangement according to one or more embodiments of the present disclosure is that more stable control of the inlet air valve may be achieved with the actuator arrangement. This enables also more accurate control of the inlet air valve on relatively small flow channel opening values as adjusted with the closing element.

20 The actuator arrangement for an inlet valve is characterized by what is stated in the independent claim.

25 Some other embodiments are characterized by what is stated in the other claims.

 Inventive embodiments are also disclosed in the specification and drawings of this patent application.

30 The inventive content of the patent application may also be defined in other ways than defined in the following claims. The inventive content may also be formed of several separate inventions, especially if the invention is examined in the light of expressed or implicit sub-

35 tasks or in view of obtained benefits or benefit groups. Some of the definitions contained in the following claims may then be unnecessary in view of the separate

inventive ideas. Features of the different embodiments of the invention may, within the scope of the basic inventive idea, be applied to other embodiments.

5 In an example embodiment of the actuator arrangement a linear movement of the movable element of the linear actuator may be transmitted via the lever mechanism to a rotation movement of the shaft of the closing element of the inlet air valve. A transmission ratio of the lever mechanism may be configured to vary
10 during a movement of the movable element of the linear actuator.

In an example embodiment of the actuator arrangement the movement of the linear actuator may be transmitted progressively via the lever mechanism to the
15 closing element of the inlet air valve.

In an example embodiment of the actuator arrangement the shaft of the closing element of the inlet air valve may be rotatable by the lever mechanism at an angle (α) formed between a closing position, and a fully
20 open position of the closing element.

In an example embodiment of the actuator arrangement the transmission ratio of the lever mechanism may be configured to vary during the movement of the movable element of the linear actuator. In an example
25 embodiment the transmission ratio may be a relative movement of the shaft of the closing element of the inlet air valve by a movement of the movable element of the linear actuator. In an example embodiment the transmission ratio may be an amount of rotation of the shaft
30 of the closing element in relation to an amount of movement of the movable element of the linear actuator transmitted to the shaft of the closing element by the lever mechanism. In an example embodiment the transmission ratio of the lever mechanism may be configured
35 to vary during the movement of the movable element of the linear actuator so that in the beginning of the movement of the closing element from the closing

position of the closing element towards fully open position of the closing element the transmission ratio of the lever mechanism may be low. In an example embodiment the transmission ratio of the lever mechanism may be
5 configured to vary during the movement of the movable element of the linear actuator so that in the beginning of the movement of the closing element from the closing position of the closing element towards fully open position of the closing element the transmission ratio of
10 the lever mechanism may be low so that a movement speed of the closing element may have a first, slow, speed. In an example embodiment the transmission ratio of the lever mechanism may be configured to vary during the movement of the movable element of the linear actuator
15 so that the transmission ratio of the lever mechanism may be configured to increase so that the speed of the movement of the closing element may increase during movement of the closing element towards the fully open position.

20 In an example embodiment of the actuator arrangement the rotation of the shaft of the closing element may be configured to change non-linearly by the lever mechanism in relation to the movement of the movable element of the linear actuator.

25 In an example embodiment of the actuator arrangement the linear actuator may be fastened on a frame portion through which a shaft of the closing member may extend, and that the lever mechanism may be arranged on a side of the frame portion that may be a side away from a
30 flow channel.

In an example embodiment of the actuator arrangement the lever mechanism may comprise a first lever. The first lever may comprise a first connecting point and a second connecting point. The first lever may
35 be connected in the first connecting point to the shaft of the closing element of the inlet air valve. The actuating arrangement may further comprise a second lever.

The second lever may comprise a first connecting point and a second connecting point. The first connecting point of the second lever may be connected to the first lever in the second connecting point. The second connecting point may be arranged at a distance from the first connecting point. The second connecting point of the second lever may be connected directly, or via a further lever, to the movable element. The linear movement of the movable element of the linear actuator may be transmitted via the lever mechanism to a rotation movement of the shaft of the closing element.

In an example embodiment of the actuator arrangement a distance between the connecting points of the second lever may be adjustable. In an example embodiment of the actuator arrangement the second lever may be, for example, a turnbuckle type of a lever.

In an example embodiment of the actuator arrangement the lever mechanism may comprise a third lever arranged between the second lever and the movable element of the linear actuator.

In an example embodiment of the actuator arrangement the third lever may be connected in a first connection point to a second connecting point of the second lever and in a second connection point to the movable element of the linear actuator, wherein the second connecting point may be at a distance from the first connecting point.

In an example embodiment of the actuator arrangement a fourth lever may be arranged to connect the third lever to a frame portion, wherein a first connecting point of the fourth lever may be connected to the frame portion, and a second connecting point of the fourth lever may be connected to the third lever between the first connecting point and the second connecting point, wherein the lever mechanism may be a four link mechanism.

In an example embodiment of the actuator arrangement a connection point between the first lever and the second lever may be a movable point in relation to the position of the second connecting point of the first lever. In an example embodiment of the actuator arrangement a connection point between the first lever and the second lever may be a movable point for example, a roll arranged on a second end of the first lever and arranged to move on a path formed on the second lever in relation to the position of the second connecting point of the first lever.

In an example embodiment of the actuator arrangement the linear actuator may be a hydraulic actuator or a pneumatic actuator or an electric actuator or an electro-hydraulic actuator, and may comprise a cylinder and a piston, and a bias element arranged in the actuator for assisting to return the movable element of the linear actuator and the valve element to a closing position.

According to a second aspect, there is provided an inlet air valve. According to an example embodiment the inlet air valve may comprise a valve body, a flow channel through the valve body, a closing element arranged in the flow channel. Said closing element may be arranged movably in the flow channel between at least two positions, a first, closing position, in which the flow channel may be closed, and a second, open position, in which air may flow through the channel. The inlet air valve may comprise an actuator arrangement according to one or more embodiments mentioned above or below or a combination of one or more embodiments mentioned above or below. In an example embodiment of the inlet air valve may be configured to have an integrated design comprising an actuator arrangement and valve in a same assembly.

According to a third aspect, there is provided a mining machine comprising at least one air compressor

system for producing working air, such as flushing air for a drilling rig operation. According to an example embodiment, the mobile mining machine may be provided with the air compressor system of the mining machine may
5 comprise an inlet air valve according to any one of embodiments mentioned above alone or combined with any other above embodiment or embodiments.

In the disclosure a meaning of word "closed" may also mean that some air may be able to flow in the
10 flow channel despite that the closing element may be in a first, "closing" position.

BRIEF DESCRIPTION OF THE DRAWINGS

15

The accompanying drawings, which are included to provide a further understanding of the embodiments and constitute a part of this specification together with the description help to explain the principles of
20 the invention set out in the claims. In the drawings:

Figure 1 is a simplified perspective view of an example embodiment of an inlet air valve with an example embodiment of an actuating arrangement,

Figure 2 is a simplified side view of an example
25 embodiment of the inlet air valve with an example embodiment of an actuating arrangement,

Figure 3 is a simplified side view, of an example embodiment of the inlet air valve with an actuating arrangement, and partly cross-sectional view taken
30 along a line U-U of Figure 2,

Figure 4 is a simplified side view, of an example embodiment of the inlet air valve with an actuating arrangement, and partly cross-sectional view taken
along a line A-A of Figure 3,

Figure 5 is a simplified top view, of an example
35 embodiment of the inlet air valve with an actuating

arrangement, and partly cross-sectional view taken along a line B-B of Figure 3,

Figure 6 is a simplified side view of an example embodiment of the inlet air valve with an example
5 embodiment of an actuating arrangement in a first position, closing position,

Figure 6a is a simplified detail C of Figure 6,

Figure 7 is a simplified side view of an example
10 embodiment of the inlet air valve with example embodiment of an actuating arrangement in a second position, open position,

Figure 7a is a simplified detail D of Figure 7,
15

Figure 8 is a simplified schematical figure of an example embodiment of an air compressor system of a mining machine, and

Figure 9 is a diagram showing examples of opening
20 curves of example embodiments of intake air valves.

In the figures, some embodiments are shown simplified for the sake of clarity. Similar parts are marked with the same reference numbers in the figures.
25

DETAILED DESCRIPTION

According to an aspect, an actuator arrangement for an inlet valve for a compressor device described in this description may be arranged in a mobile mining
30 machine. The machine may be a mine machine, or a construction machine, e.g., a rock drilling rig, a development drill, a tunneling drilling machine, a surface drilling machine, a bolting or reinforcing vehicle, a rock removal machine, a longhole drill rig, an explosive
35 charging machine, a loader, a transport vehicle, a loading or hauling machine, a setting vehicle of gallery

arcs or nets, a concrete spraying machine, a crusher, or a measuring vehicle.

In figure 1 the inlet air valve 20 is for simplicity presented without a cover arrangement for the inlet air valve actuator arrangement.

The inlet air valve 20 may comprise a valve body 2. The inlet air valve 20 may comprise a flow channel 30 arranged through the valve body 2. The inlet air valve 20 may further comprise a closing element 3 arranged in the flow channel 30. The closing element 3 may be arranged movably in the flow channel 30 between at least two positions, a first, closing position, in which the flow channel 30 is closed, and a second, open position, in which air may flow through the channel. In an example embodiment the closing element 4 may be arranged on a shaft 4 that is arranged cross the flow channel 30 and extending through the wall of the flow channel. The inlet air valve 20 may comprise an actuator arrangement 1.

In an example embodiment the inlet air valve 20 may be an adjustable inlet air valve. In an example embodiment the inlet air valve 20 may be an inlet butterfly valve, comprising a disc-like closing element 3. The inlet air valve 20 may be biased by a spring to be in a default state of closed. The actuator arrangement 1 may be disposed to adjust the inlet air valve to open an adjustable amount to change an amount of air that can flow to the air inlet of the air compressor. In example embodiments the inlet air valve 20 may be operated by an electrical, hydraulic, or pneumatic actuator arrangement in communication with the controller. In example embodiments the actuator arrangement 1 may be in electrical communication with the controller. In an example embodiment the compressor system may comprise a pressure sensor 27. The pressure sensor may be a transducer for converting pressure into an electrical signal. The pressure sensor may be in electrical communication with the

controller. The pressure sensor may be located in or near the air compressor. The engine may be an electric engine or a gasoline motor or a hydraulic motor. The air compressor may be a screw air compressor. The air inlet
5 of the air compressor may be an air inlet of the air compressor. The air outlet of the air compressor may be an air outlet of the air compressor. The controller 50 may be a programmable logic controller (PLC). The controller may be in electrical communication with the actuator 21 of the inlet air valve 20. In an example
10 embodiment the actuator arrangement 1 may be the actuator or part of the actuator. The controller 50 may be in electrical communication with the sensors. The controller 50 may be configured to control the operation
15 of the air compressor system.

Figures 1 to 5 illustrates an example embodiment of the inlet air valve 20 comprising an actuator arrangement 1 for an inlet air valve. In an example embodiment the inlet air valve may be a type of a butterfly valve. The closing means may be arranged on a shaft 4 that may be arranged rotatably on a valve body cross the flow channel 30. An end of the shaft 4 may extend through a wall of the valve body defining the flow channel 30. The actuator arrangement 1 may comprise
20 a linear actuator 11 comprising a movable element 10. The movable element 10 of the linear actuator 11 may be operatively connected via a lever mechanism 6, 7, 8, 9 to the shaft 4 of the closing element 3 of the inlet air valve. A linear movement of the movable element 10 of
25 the linear actuator 11 may be transmitted via the lever mechanism 6, 7, 8, 9 to a rotation movement of the shaft 4 of the closing element 3 of the inlet air valve. In an example embodiment a transmission ratio of the lever mechanism is configured to vary during a movement of the
30 movable element 10 of the linear actuator 11. In an example embodiment of figure 1 the inlet air valve is

in a closed state. In an example embodiment of figures 2 to 5 the inlet air valve is in an open state.

In an example embodiment the shaft 4 of the closing element 3 of the inlet air valve is rotatable by the lever mechanism 6, 7, 8, 9 at an angle (α) formed between a closing position, and a fully open position of the closing element 3.

In an example embodiment the lever mechanism 6, 7, 8, 9; 6, 7, 8, 9 comprises a first lever 6. The first lever may comprise a first connecting point 5 and a second connecting point 7. The first lever 6 may be connected in the first connecting point 5 to the shaft 4 of the closing element 3 of the inlet air valve. The actuating arrangement may further comprise a second lever 8, comprising a first connecting point and a second connecting point. The first connecting point of the second lever 8 may be pivotally connected to the first lever 6 in the second connecting point 7 arranged at a distance from the first connection point 5. The second connecting point 9 of the second lever 8 may be pivotally connected directly or via a further lever, to the movable element 10. The linear movement of the movable element 10 of the linear actuator 11 may be transmitted via the lever mechanism 6, 7, 8, 9 to rotation movement of the shaft 4 of the closing element 3.

In an example embodiment a distance between the connecting points 7, 9 of the second lever 8 may be adjustable. The second lever 8 may be, for example, a turnbuckle type of a lever.

The movement of the movable element 10 of the movable element 10 of the linear actuator 11 may be transmitted progressively via the lever mechanism 6, 7, 8, 9 to the shaft 4 of the closing element (3) of the inlet air valve.

In an example embodiment the linear actuator 11 may be fastened on a frame portion 31 through which the shaft 4 of the closing element 3 is extending. The

lever mechanism 6, 7, 8, 9 may be arranged on a side of the frame portion 31 that is away from the flow channel 30.

5 In an example embodiment of figures 6, 6a, 7, 7a the lever mechanism 6, 7, 8, 9, 91, 92 may comprise a third lever 91 arranged between the second lever 8 and the movable element 10 of the linear actuator 11.

10 The third lever 91 may be pivotally connected in a first connection point to a second connecting point 9 of the second lever 8 and pivotally connected in a second connection point to the movable element 10 of the linear actuator 11. The second connecting point may be at a distance from the first connecting point.

15 In an example embodiment a fourth lever 81 may be arranged to connect the third lever 91 to a frame portion 31, wherein a first connecting point of the fourth lever 81 is pivotally connected to the frame 31, and a second connecting point of the fourth lever 81 is connected to the third lever 91 between the first connecting point and the second connecting point. In an example embodiment the lever mechanism is a four link mechanism.

25 In an example embodiment a connection point between the first lever 6 and the second lever 8 may be a movable point in relation to the position of the second connecting point of the first lever. In an example embodiment the movable point may be a roll arranged on a second end of the first lever and arranged to move on a path formed on the second lever.

30 In an example embodiment the linear actuator 11 may be a hydraulic actuator or a pneumatic actuator or an electric actuator or an electro-hydraulic actuator, comprising a cylinder and a piston, and a bias element arranged in the actuator for assisting to return the movable element of the linear actuator and the valve element to a closing position.

The air flows through the filter, through the inlet air valve (when it is open), and into the air compressor. The inlet air valve may be in a default position of closed. A bias element (such as a spring, not illustrated) may hold the inlet air valve closed. The linear actuator 11 may be connected to the inlet air valve and the controller. The linear actuator may respond to current from the controller by extending the linear actuator. The movable element of the linear actuator pushes on the closing element of the inlet air valve which moves the inlet air valve to an open position. The inlet air valve may be adjustable so that the size of the opening of the inlet air valve is proportional to the amount the movable element 10 of the linear actuator 11 pushes on the closing element of the inlet air valve. In an example embodiment the movement of the movable element 10 of the linear actuator 11 may be transmitted progressively via the lever mechanism 6, 7, 8, 9; 6, 7, 8, 9, 91, 92 to the shaft 4 of the closing element 3 of the inlet air valve.

Figure 8 shows an example embodiment of an air compressor system of a mining machine 100. Air flows through the air filter 24 and is filtered by the air filter. The air flows through the inlet air valve 20, which may be configured to control the amount of air that can flow through the adjustable inlet air valve 20. The controller 50 may control how open the adjustable inlet air valve 20 is by providing signal or impulse the actuator arrangement 21. By adjusting the adjustable inlet air valve 20 the controller 50 can control the volume of compressed air delivered by the air compressor 22. This may be called throttling the air compressor system by controlling the opening of the adjustable inlet air valve 20.

The air that flows through the adjustable inlet air valve 20 flows into the air inlet 25 of the air compressor 22 and is compressed by the air compressor,

which delivers a volume of compressed air to the air outlet 26 of the air compressor. The air compressor 22 may be driven by the engine 23. In an example embodiment the air compressor system may be a part of mobile mining machine 100.

Figure 9 is a diagram showing examples of opening curves of example embodiments of intake air valves. In the figure 9 is presented on a vertical axis (Y-axis) a size of an opening of a flow channel converted to circular openings having different diameters in mm. In an example embodiment the flow channel may have a nominal diameter of 150 mm. In an example embodiment a flow area (or a size of an opening of a flow channel) may be converted to circular opening diameters, in figure from 0 mm to 150 mm. On a horizontal axis (X-axis) is presented movement of a moving element of a linear actuator in percentages, 0% to 100%. The percentage is 0% when the moving element is a first position. The percentage increases according to the movement of the movable element of the linear actuator. The percentage is 100% when the moving element is a second position, i.e. in an extended position.

When the percentage of movement of the moving element of the linear actuator increases the opening of the flow channel becomes larger due the movement of the linear actuator transmitted by the lever mechanism to the closing element from closing position towards fully open position of the inlet air valve.

In the prior art version (Prior art) the opening curve seems to be linear. In exemplary embodiments of the different inlet air valve versions (Ver1, Ver2, Ver3) with different actuator arrangements the opening curves seem to be clearly non-linear. Ver1 may be an exemplary embodiment of an inlet air valve as shown in figure 1. Ver2 may be an exemplary embodiment of an inlet air valve as shown in figure 6. Ver3 may be an exemplary embodiment of an inlet air valve comprising

an actuator arrangement in which a connection point between the first lever and the second lever may be a movable point in relation to the position of the second connecting point of the first lever. In an example embodiment the movable point may be a roll arranged on a second end of the first lever and arranged to move on a path formed on the second lever. In an exemplary embodiment of each of exemplary embodiments Ver1, Ver2, or Ver3 the movement of the closing member of the inlet air valve may be slow in the beginning of movement of the closing member from a closing position towards a fully open position. This may enable an accurate control of inlet air valve, also at small flow channel opening values.

In an example embodiment the frame portion 31 may be a plate like element, with an upper wall and a lower wall and a side wall connecting the upper wall to the lower wall. In an example embodiment of the inlet air valve may be configured to have an integrated design comprising an actuator arrangement and valve in a same assembly.

In an example embodiment of a mobile mining machine 100 may comprise at least one at least one air compressor system for producing working air, such as flushing air for a drilling rig operation, wherein the air compressor system of the mining machine comprises an inlet air valve 20 according.

It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in various ways. The invention and its embodiments are thus not limited to the examples described above, instead they may vary within the scope of the claims.

CLAIMS

1. An actuator arrangement (1) for an inlet air valve of a compressor system of a mining machine, the actuator arrangement comprises a linear actuator (11) comprising a movable element (10), operatively connected via a lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) to a shaft (4) of a closing element (3) of the inlet air valve arranged in a flow channel (30), wherein a linear movement of the movable element (10) of the linear actuator (11) is transmitted via the lever mechanism to a rotation movement of the shaft (4) of the closing element (3) of the inlet air valve, wherein a transmission ratio of the lever mechanism is configured to vary during a movement of the movable element (10) of the linear actuator (11), and wherein the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) comprises a first lever (6), comprising a first connecting point (5) and a second connecting point (7), wherein the first lever (6) is connected in the first connecting point (5) to the shaft (4) of the closing element (3) of the inlet air valve, and the actuating arrangement further comprises a second lever (8), comprising a first connecting point and a second connecting point, wherein the first connecting point of the second lever (8) is pivotally connected to the first lever in the second connecting point (7) arranged at a distance from the first connection point (5), wherein the second connecting point (9) of the second lever (8) is pivotally connected directly or via a further lever, to the movable element (10), wherein linear movement of the movable element (10) of the linear actuator is transmitted via the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) to rotation movement of the shaft (4) of the closing element (3), characterized in that a distance between the connecting points (7, 9) of the second lever (8) is adjustable.

2. The arrangement according to claim 1, wherein the movement of the movable element (10) of the linear actuator (11) is transmitted progressively via the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) to the shaft (4) of the closing element (3) of the inlet air valve.

3. The arrangement according to claim 1 or 2, wherein the shaft (4) of the closing element (3) of the inlet air valve is rotatable by the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) at an angle (α) formed between a closing position, and a fully open position of the closing element (3).

4. The arrangement according to any one of claims 1 to 3, wherein the transmission ratio of the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) is configured to vary during the movement of the movable element (10) of the linear actuator (11) so that in the beginning of the movement of the closing element from the closing position of the closing element (3) towards fully open position of the closing element the transmission ratio of the lever mechanism is low so that a movement speed of the closing element (3) has a first, slow, speed, and wherein the transmission ratio of the lever mechanism is configured to increase so that the speed of the movement of the closing element (3) increases during movement of the closing element towards the fully open position.

5. The arrangement according to any one of claims 1 to 4, wherein the rotation of the shaft (4) of the closing element (3) is configured to change non-linearly by the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) in relation to the movement of the movable element (10) of the linear actuator (11).

6. The arrangement according to any one of claims 1 to 5, wherein the linear actuator (11) is fastened on a frame portion (31) through which the shaft (4) of the closing element (3) is extending, and that

the lever mechanism (6, 7, 8, 9; 6, 7, 8, 9, 91, 92) is arranged on a side of the frame portion (31) that is away from the flow channel (30).

7. The arrangement according to any one of
5 claims 1 to 6, wherein the second lever is a turnbuckle type of a lever.

8. The arrangement according to any one of
claims 1 to 7, wherein the lever mechanism (6, 7, 8, 9;
6, 7, 8, 9, 91, 92) comprises a third lever (91) arranged
10 between the second lever (8) and the movable element
(10) of the linear actuator (11).

9. The arrangement according to claim 8,
wherein the third lever (91) is pivotally connected in
a first connection point to a second connecting point
15 (9) of the second lever (8) and pivotally connected in
a second connection point to the movable element (10)
of the linear actuator (11), wherein the second connecting point is at a distance from the first connecting point.

20 10. The arrangement according to claim 8 or 9,
wherein a fourth lever (81) is arranged to connect the
third lever (91) to a frame portion (31), wherein a
first connecting point of the fourth lever (81) is pivotally connected to the frame (31), and a second connecting point of the fourth lever (81) is connected to
25 the third lever between the first connecting point and the second connecting point, wherein the lever mechanism is a four link mechanism.

11. The arrangement according to any one of
30 claims 1 to 10, wherein a connection point between the
first lever (6) and the second lever (8) is a movable point in relation to the position of the second connecting point of the first lever.

12. The arrangement according to any one of
35 claims 1 to 11, wherein the linear actuator (11) is a hydraulic actuator or a pneumatic actuator or an electric actuator or an electro-hydraulic actuator,

comprising a cylinder and a piston, and a bias element arranged in the actuator for assisting to return the movable element of the linear actuator and the valve element to a closing position.

5 13. An inlet air valve (20) comprising a valve body (2), a flow channel (30) through the valve body, a closing element (3) arranged in the flow channel, said closing element is arranged movably in the flow channel between at least two positions, a first, closing posi-
10 tion, in which the flow channel (30) is closed, and a second, open position, in which air may flow through the channel, wherein the inlet air valve comprises a actuator arrangement (1) according to any one of claims 1 to 12.

15 14. A mining machine (100) comprising at least one air compressor system for producing working air, such as flushing air for a drilling rig operation, wherein the air compressor system of the mining machine comprises an inlet air valve (20) according to claim 13.

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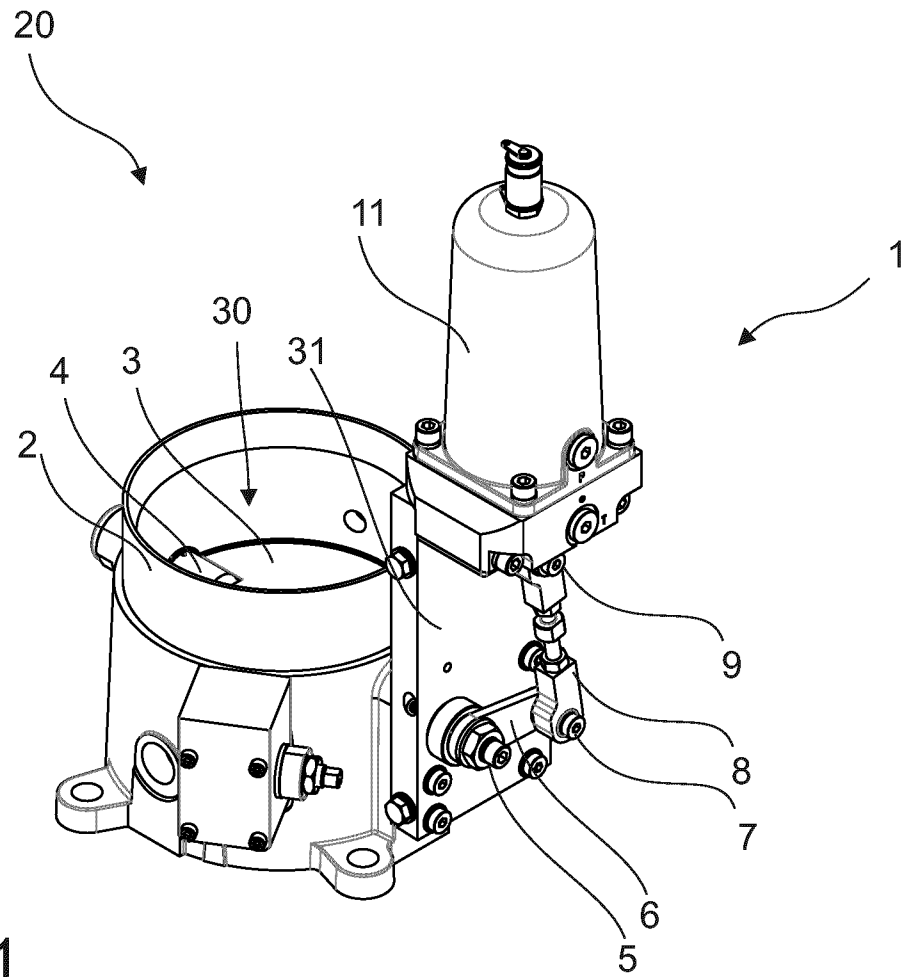


Fig. 1

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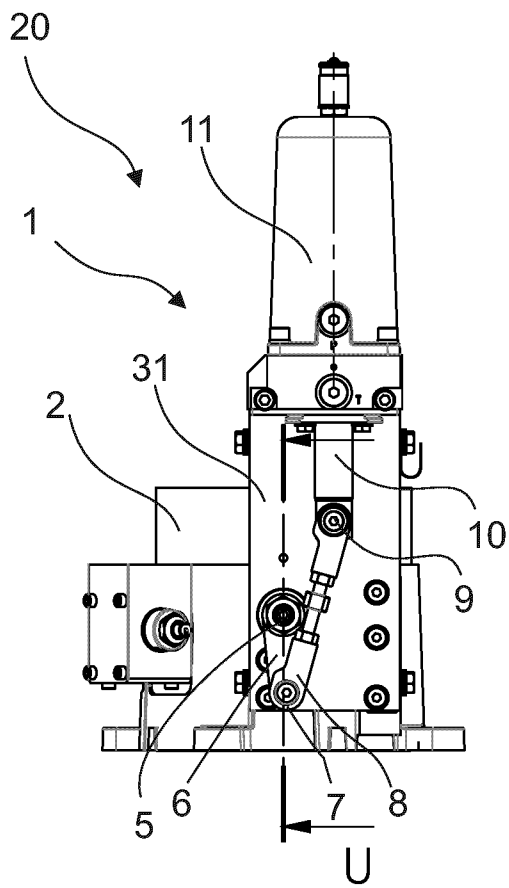


Fig. 2

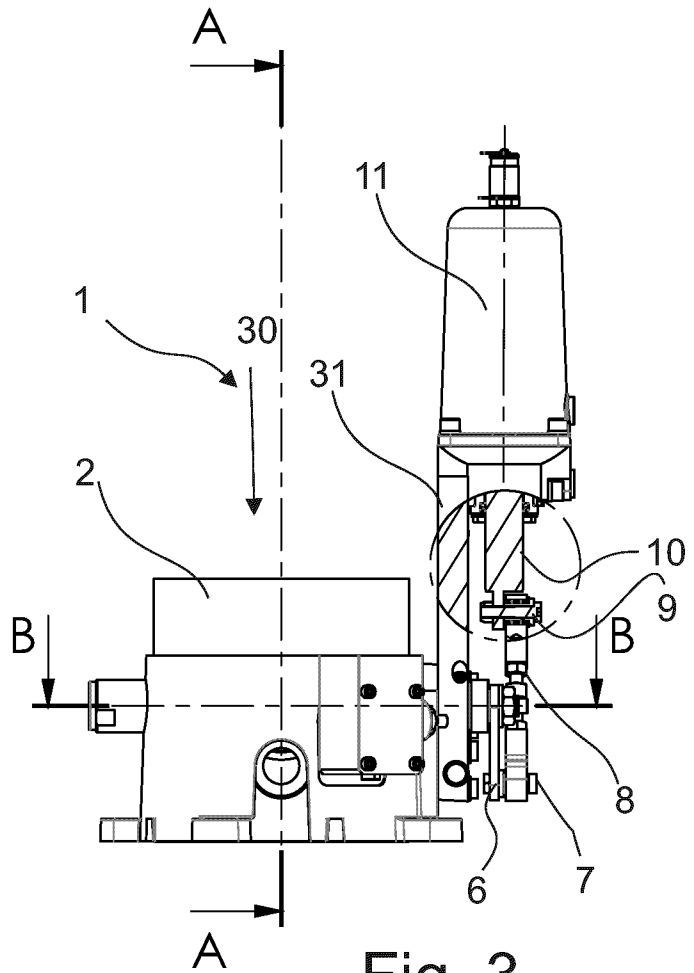


Fig. 3

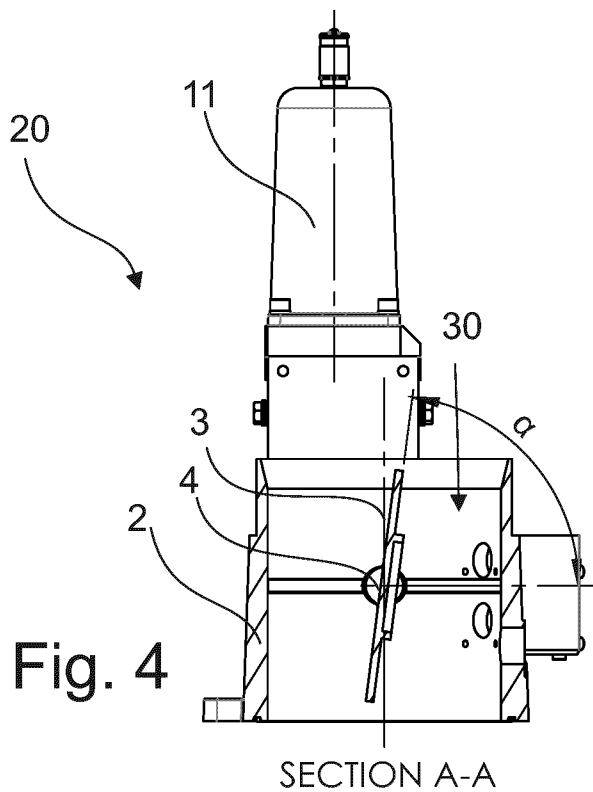


Fig. 4

SECTION A-A

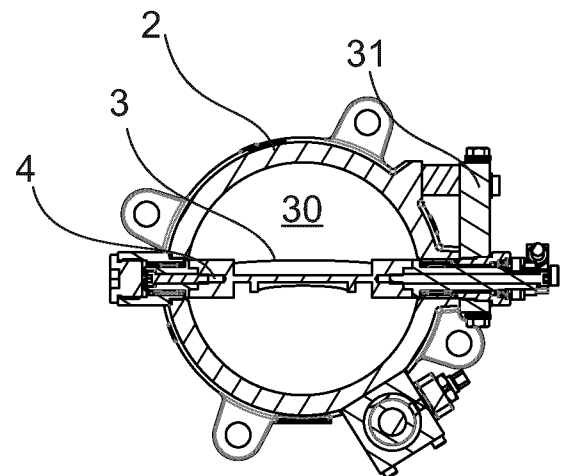


Fig. 5

SECTION B-B

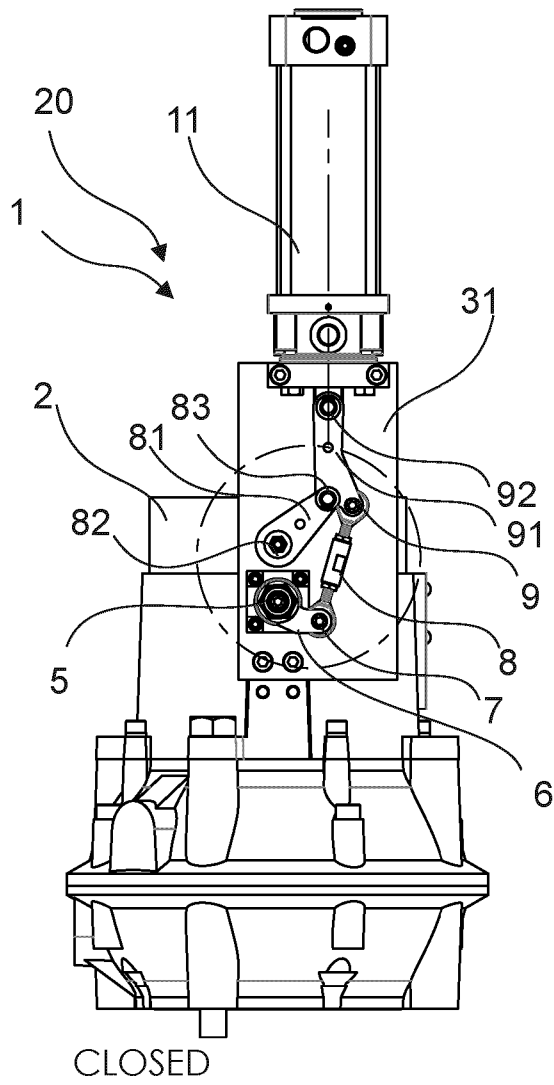


Fig. 6

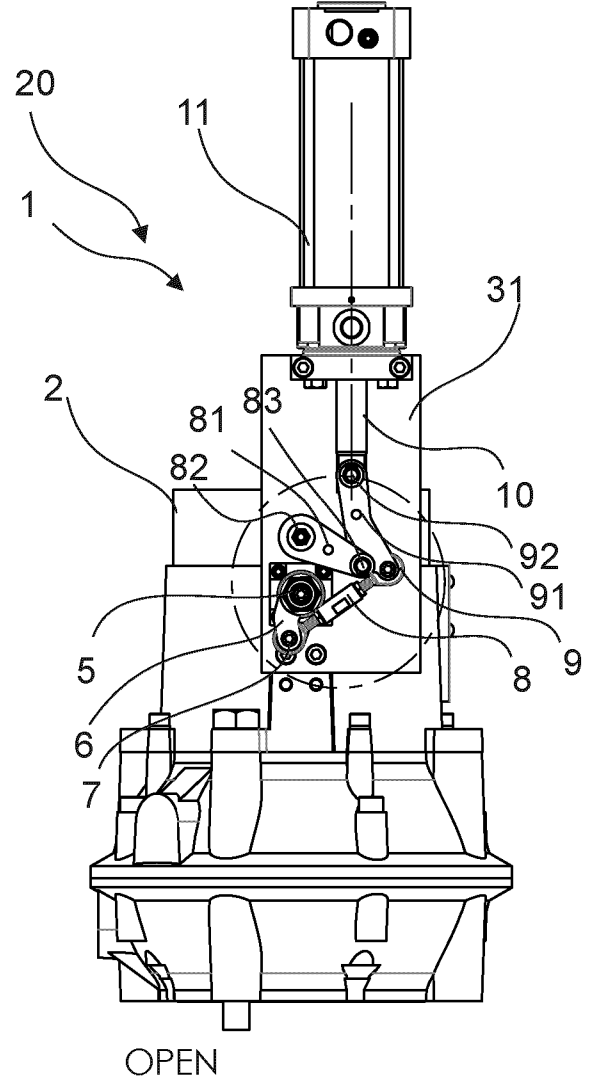
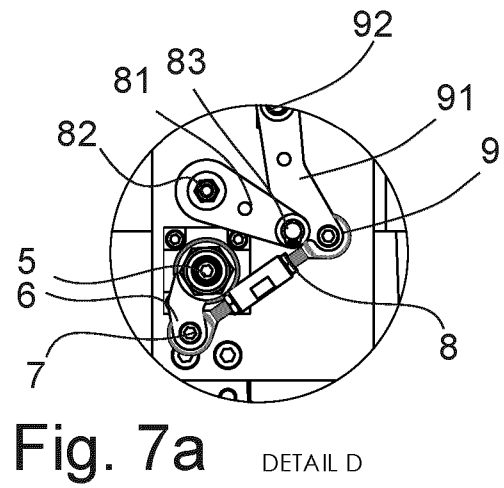
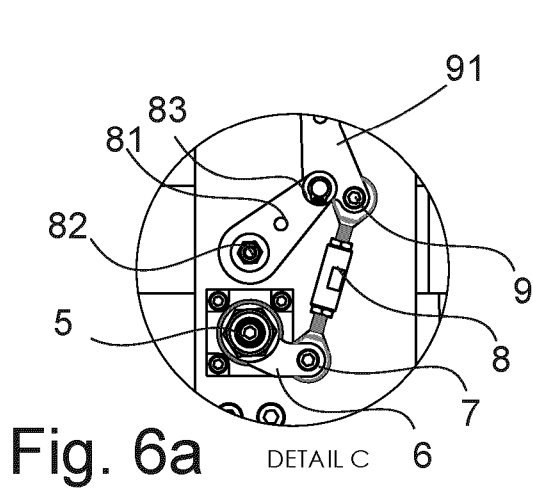


Fig. 7



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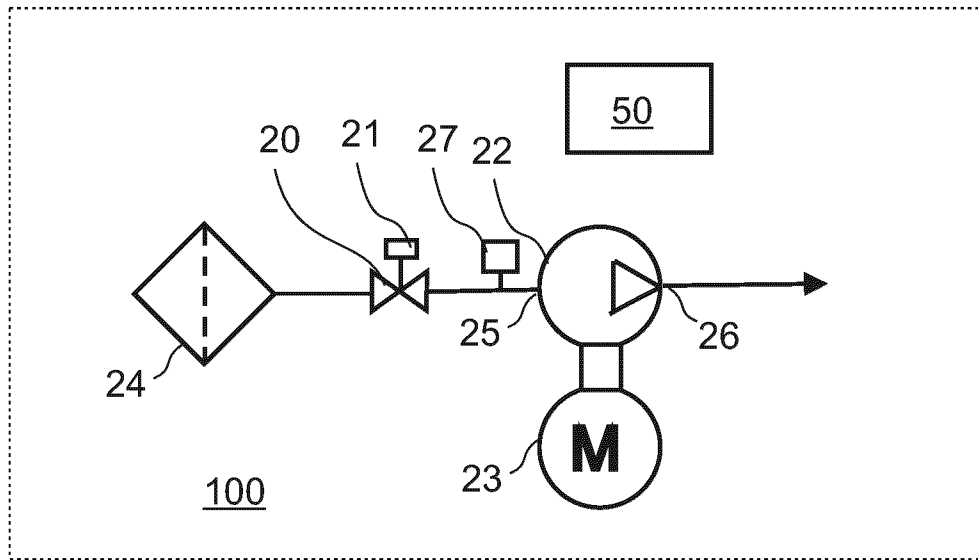


Fig. 8

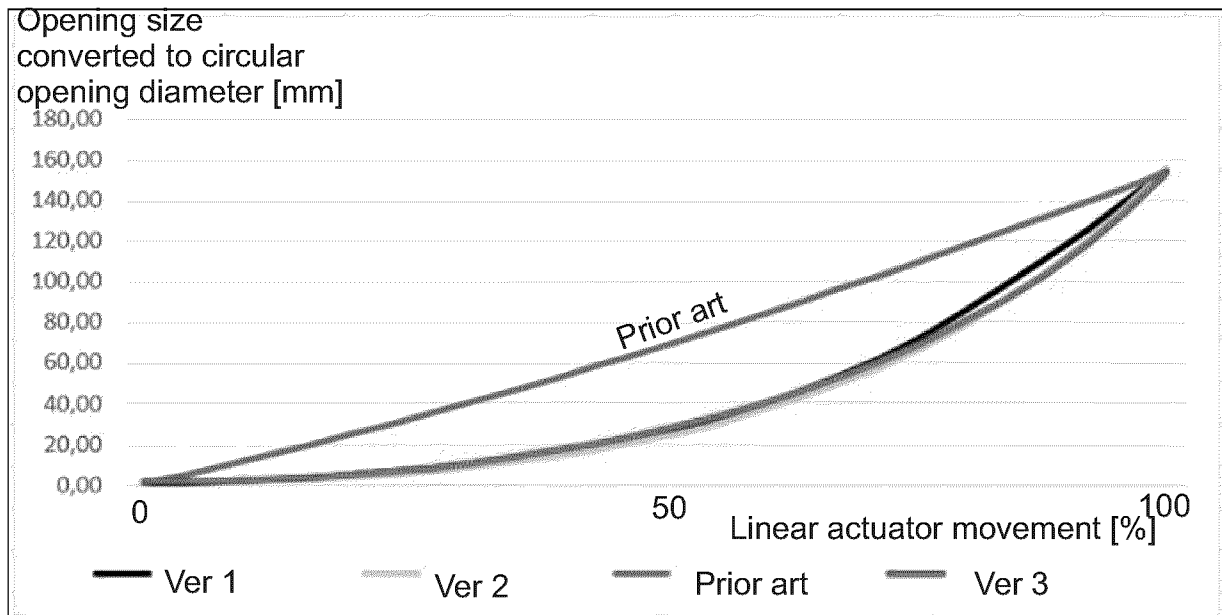


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/066856

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	F04B39/10	F04B49/22
	F16K31/16	F16K31/52
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)		
F04B F16K		
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		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 317 179 A (DAVID F. WISEMAN & SONS LTD. [GB]) 2 May 1967 (1967-05-02) figures 1-4 column 1, line 10 - line 35 column 1, line 44 - column 2, line 56 claim 1 -----	1 - 14
A	US 4 134 619 A (FMC CORPORATION [US]) 16 January 1979 (1979-01-16) figures 1, 9 column 4, line 49 - column 7, line 36 column 10, line 13 - line 33 -----	1 - 14
A	US 2 991 002 A (CHICAGO PNEUMATIC TOOL CO. [US]) 4 July 1961 (1961-07-04) figures 1-3 column 1, line 10 - line 48 column 2, line 38 - column 4, line 25 ----- - / - -	1 - 14
☒ Further documents are listed in the continuation of Box C.		
☒ See patent family annex.		
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"E" earlier application or patent but published on or after the international filing date		
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		
"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		
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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
30 July 2024		02/09/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Gnüchtel, Frank

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2024/066856

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 2002/108659 A1 (HOERBIGER KOMPRESSORTECH SERVICES [AT]) 15 August 2002 (2002-08-15) figures 1, 2 paragraph [0001] - paragraph [0006] paragraphs [0015], [0016] -----	1 - 14

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International application No

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