(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 279 749 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.11.2023 Bulletin 2023/47

(21) Application number: **23174368.3**

(22) Date of filing: **19.05.2023**

(51) International Patent Classification (IPC):
F15B 1/02 *(2006.01)* ***A63G 7/00*** *(2006.01)*
A63G 31/00 *(2006.01)* ***F15B 1/24*** *(2006.01)*
F15B 11/00 *(2006.01)* ***F15B 15/14*** *(2006.01)*
F15B 15/20 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F15B 1/024; F15B 1/24; F15B 11/003; F15B 15/1428; F15B 15/1438; F15B 15/1466; F15B 15/149; F15B 15/202; F15B 2201/205; F15B 2201/31; F15B 2211/30505; F15B 2211/30515; F15B 2211/327; F15B 2211/625

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **20.05.2022 IT 202200010547**

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(54) HYDRAULIC LOCKING DEVICE

(57) The present invention concerns a hydraulic device 1 for locking an element 200 connected to such device, preferably for locking a restraining element for restraining a passenger on an amusement ride, the hydraulic device comprising;
- a cylinder-piston 1a having a cylindrical chamber 10 and a piston 12 adapted to slide inside the cylindrical chamber 10 and defining a first and a second portion 10', 10" of the cylindrical chamber 10,
- an accumulator 100,
- a hydraulic circuit 22 which fluidly connects the first portion 10' and the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a and which further fluidly connects the accumulator 100 with at least one of the first portion 10' and the second portion 10" of the cylindrical chamber 10,
- intercepting means 30, 32 for intercepting the passage of fluid in the hydraulic circuit, which can be controlled such as to reach at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in at least one direction,
the device 1 being characterized in that the accumulator 100 comprises a chamber 20 surrounding the cylindrical chamber 10 of the cylinder-piston 1a.

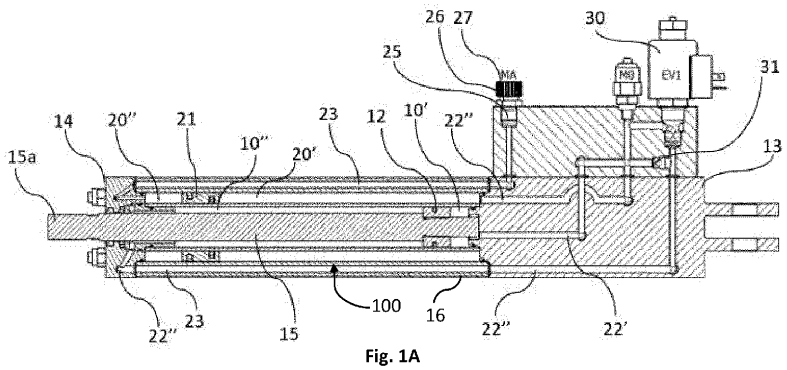

Fig. 1A

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Description

FIELD OF THE INVENTION

[0001] The present invention generally concerns hydraulic devices adapted for locking an outer element directly or indirectly connected to the device.

[0002] In particular, the invention is particularly used in restraining systems for restraining passengers on amusement rides and thus concerns a hydraulic device for locking a restraining element for restraining a passenger on an amusement ride.

[0003] Furthermore, the present invention concerns a passenger restraining system which comprises a restraining element movable between a closed position and an open position and a hydraulic device according to the invention, the latter being adapted for locking the restraining element for restraining the passenger.

[0004] Although reference is henceforth made to a restraining system for amusement rides, embodiments in which the hydraulic device according to the invention is connected to restraining systems of vehicles in general, in which it is necessary to lock the restraining system in a closed position, or further applications also in different fields and sectors, are not excluded, and thus the hydraulic device according to the invention can generally be applied for locking an element which is directly or indirectly connected to the hydraulic device.

KNOWN PRIOR ART

[0005] Hydraulic locking devices, and in particular locking devices adapted for being used in combination with restraining systems for restraining passengers on amusement rides and by means of which passengers are secured to the respective seat, so as not to be able to abandon such safe position while the amusement ride is moving, are known in the art. As a result of the intense forces and accelerations exerted on the passenger while the amusement ride is running, it is essential that the restraining and locking device is placed in a locked position for the entire duration of the amusement ride's run, so as the passenger can be efficiently restrained in a safe position, for example so as to be efficiently and safely restrained at his/her seat.

[0006] In this regard, known restraining systems limit the freedom of movement of the passenger by securing him/her on a seat, for example.

[0007] Common restraining elements are for examples brackets or restraining bars which can be fastened by means of a pin to the vehicle of the amusement ride on which a passenger is accommodated, so as to lock the passenger in different positions and to be adapted to the individual height and build of each passenger.

[0008] Locking systems of the known art comprise hydraulically driven mechanical locking devices, for example a cylinder-piston assembly in combination with a hydraulic accumulator.

[0009] The locking position is operated thanks to the fact that the hydraulic fluid (preferably oil) is sealingly locked into a work chamber of the cylinder-piston, for example in the work chamber of the rod of the cylinder-piston.

[0010] The volume of each chamber of the cylinder-piston varies with the position of the piston. This allows to lock the restraining element in different closing and restraining positions for closing and restraining the passenger also according to his/her height and build.

[0011] In addition to the locking function of the restraining element, known devices can also perform the further function of actively opening and/or closing the restraining element after it was unlocked, for example following the command for actuating valve means of the hydraulic circuit.

[0012] The hydraulic accumulator is loaded or emptied by means of the hydraulic fluid displaced by the piston of the cylinder-piston when the restraining element is respectively closed or opened, so that the hydraulic accumulator stores the hydraulic fluid under pressure, while, when desiring to allow the opening of the element restraining the passenger, for example at the end of the amusement ride's run, the fluid present in the accumulator contributes to the opening of the restraining element by flowing in the reverse direction.

[0013] In known devices, the hydraulic accumulator is configured as an accumulation element outside the cylinder-piston and in fluidic connection therewith.

[0014] For example, US2021/0069603 describes a hydraulic accumulator and a cylinder-piston unit arranged side by side and parallel to one another to form an integrated cylinder assembly.

[0015] The devices of the known art have the disadvantage of being bulky and they further provide a complex hydraulic circuit to allow the passage of the fluid between the hydraulic accumulator and the cylinder-piston.

[0016] Moreover, known devices are in a non-symmetrical and bulky configuration due to the arrangement of the two elements, i.e. the accumulator and cylinder-piston, which are placed side-by-side to one another.

[0017] The passage of the fluid inside the hydraulic connections between the cylinder-piston and the hydraulic accumulator placed side-by-side are affected by such side-by-side arrangement, since the device has orientation restrictions with respect to the assembly positions.

[0018] Object of the present invention is to make a compact hydraulic locking device preferably adapted for being connected with a restraining system for restraining a passenger of amusement rides.

[0019] Further object of the present invention is to improve the flexibility of assembly and use, also in confined spaces, so that the hydraulic device can be mounted connected to a restraining system devoid of constraints in terms of spatial orientation.

SUMMARY OF THE INVENTION

[0020] These and further objects are achieved by means of a hydraulic device according to claim 1 and/or by means of a passenger restraining system for amusement rides according to claim 18.

[0021] Further aspects and/or characteristics are set forth in the dependent claims.

[0022] The present invention concerns a hydraulic device for locking an element connected to the device, preferably for locking a restraining element for restraining a passenger on a seat of an amusement ride, the hydraulic device comprising:

- a cylinder-piston having a cylindrical chamber and a piston adapted to slide inside the cylindrical chamber and defining a first and a second portion of the cylindrical chamber,
- an accumulator,
- a hydraulic circuit which fluidly connects the first portion and the second portion of the cylindrical chamber of the cylinder-piston and which further fluidly connects the accumulator with at least one of the first portion and the second portion of the cylindrical chamber,
- intercepting means for intercepting the passage of fluid in the hydraulic circuit, which can be controlled such as to reach at least one locking position in which the sliding of the piston inside the cylindrical chamber is prevented in at least one direction.

[0023] The device is characterized in that the accumulator comprises a chamber surrounding the cylindrical chamber of the cylinder-piston.

[0024] It should be noted that the expression "cylindrical chamber of the cylinder-piston" means a cylinder-shaped chamber thus extending longitudinally along an axis and which, according to possible embodiments, can have a cross section of circular, elliptical or oval shape.

[0025] According to an aspect, the chamber of the accumulator surrounding the cylindrical chamber of the cylinder-piston is an annular chamber. More in detail, the chamber of the accumulator has an annular shape when seen in section, preferably in section perpendicular to the longitudinally-extending axis of the cylinder-piston and in particular to the movement direction of the piston.

[0026] It should be noted that the expression "chamber surrounding the cylindrical chamber of the cylinder-piston" means a chamber which forms an outer perimeter, i.e. outwardly encloses or surrounds, thus forming a closed perimeter around the cylindrical chamber of the cylinder-piston.

[0027] Preferably, such chamber of the accumulator is annular and thus extends ring-like around the cylindrical chamber.

[0028] According to an aspect, such chamber of the accumulator preferably has a circular cross section (i.e. the shape of the outer perimeter delimiting the accumulator is circular), but embodiments wherein such chamber has an oval or elliptical section (i.e. the shape of the outer perimeter delimiting the accumulator is oval or elliptical) are not excluded.

[0029] Advantageously, such a configuration allows to make a hydraulic device for locking, preferably, a restraining element for restraining a passenger on an amusement ride, which is very compact and less bulky than devices of the known art.

[0030] In fact, in the devices according to the known art, the cylindrical chamber and the hydraulic accumulator are made as two separate bodies in fluidic connection, for example, such two components are side-by-side to one another, while, in the device according to the present invention, the cylindrical chamber housing the piston is surrounded by the hydraulic accumulator and such configuration allows to achieve a more compact device.

[0031] According to an aspect, the chamber of the accumulator and the cylindrical chamber of the cylinder-piston are coaxial.

[0032] Advantageously, such configuration allows to improve the flexibility of assembly and use of the hydraulic device, also in confined spaces, so as the hydraulic device can be mounted connected to an outer element intended to be locked, for example a restraining system for restraining a passenger in an amusement ride, without constraints in terms of spatial orientation.

[0033] According to an aspect, the movable piston is connected to a rod movable inside the second portion of the cylindrical chamber and jutting out outside the cylindrical chamber for the connection to the element to be locked.

[0034] Advantageously, the linear movement of the piston and respective rod connected to the locking element, allows a corresponding movement of the locking element between an open position and a closed position.

[0035] According to an aspect, the rod comprises at least one inner hollow portion into which a tubular element placed inside the cylindrical chamber of the cylinder-piston, is inserted.

[0036] Advantageously, such tubular element is a portion of the hydraulic circuit and its positioning inside an inner hollow portion of the rod allows further saving in terms of space with respect to the devices of the known art.

[0037] According to an aspect, the chamber of the accumulator comprises a piston, which is preferably annular and adapted to slide inside the chamber of the accumulator.

[0038] According to such aspect, the piston (preferably annular or anyhow having a shape complementary to the cross section of the chamber of the accumulator) defines a first portion and a second portion of the hydraulic chamber of the accumulator, the first portion of the chamber of the accumulator being in fluidic connection with the hydraulic circuit.

[0039] According to a preferred embodiment, the accumulator is a hydropneumatic accumulator within which

the second portion of the hydraulic chamber of the accumulator is loaded with a gas and the first portion of the chamber of the accumulator is in fluidic connection with the hydraulic circuit.

[0040] According to an aspect, the hydraulic circuit comprises at least one duct portion extending along the outer wall (or jacket) of the chamber of the accumulator, preferably extending in longitudinal direction along the outer wall of the chamber of the accumulator.

[0041] Advantageously, such configuration is achieved by means of a simple machining of the accumulator, which accumulator is made as a hollow element, for example of cylindrical shape, so as to form an outer wall or jacket, preferably of a metal material and whose outer surface can comprise tubular ducts made in one piece on such outer surface of the accumulator and which extend in the longitudinal direction of such outer surface of the hydraulic accumulator.

[0042] Such configuration results in a simple hydraulic circuit which allows to transport the fluid while maintaining a compact volume since the channels are made along the outer wall (or jacket) of the accumulator, without having to make one or more channels inside the body of the accumulator, for example by means of further mechanical machining. In other words, such channels are made on the outer surface of the wall (or jacket) of the accumulator.

[0043] According to an aspect, the hydraulic circuit comprises at least one duct portion extending inside a tubular element placed inside the cylindrical chamber of the cylinder-piston.

[0044] According to an aspect, the hydraulic circuit comprises at least one duct portion extending within the thickness of the wall (or jacket) of the chamber of the accumulator.

[0045] Advantageously, such a configuration is achieved by means of a simple machining of the accumulator, which accumulator is made as a hollow element, preferably cylindrical, preferably of a metal material and which can comprise tubular ducts made within the thickness of the wall of the accumulator (or jacket of the accumulator) and which extend in the longitudinal direction of the hydraulic accumulator. In other words, the thickness of the outer wall or jacket of the accumulator has a thickness such as to be able to contain one or more ducts within the thickness.

[0046] Such configuration results in a simple hydraulic circuit which allows the transport of the fluid while maintaining a compact volume since the channels are made within the thickness of the outer wall (or jacket) of the accumulator.

[0047] According to an aspect, the intercepting means for intercepting the passage of fluid in the hydraulic circuit comprise at least one valve fluidically interposed between the first portion and the second portion of the cylindrical chamber of the cylinder-piston, and in the at least one locking position, in which the sliding of the piston inside the cylindrical chamber is prevented in at least one direction, the valve is in a closed position and the passage of fluid is prevented at least from the second portion to the first portion of the cylindrical chamber.

[0048] Advantageously, such intercepting means comprising at least one valve to selectively allow or hinder the passage of the fluid between the second and the first portion of the cylindrical chamber of the cylinder-piston assembly.

[0049] According to an aspect, the at least one valve is electrically controlled and preferably comprises at least one electrovalve, wherein, in the at least one locking position in which the sliding of the piston inside the cylindrical chamber is prevented in at least one direction, the electrically operated valve is in the non-energized state.

[0050] Advantageously, such configuration prevents the passage of the fluid from the working space of the rod to the working space of the piston in the locking position.

[0051] According to an aspect, in the at least one locking position in which the sliding of the piston inside the cylindrical chamber is prevented in at least one direction, the passage of fluid from the first portion of the cylindrical chamber of the cylinder-piston to the chamber of the accumulator is allowed.

[0052] Advantageously, such configuration allows the passage of the fluid from the working space of the piston to the working space of the rod during the closing operation of the locking element.

[0053] According to an aspect, the hydraulic circuit further comprises at least one non-return valve fluidically interposed between the first portion and the second portion of the cylindrical chamber and which allows the flow of fluid from the first portion to the second portion and prevents the flow of fluid in the opposite direction.

[0054] According to an aspect, the cylindrical chamber of the cylinder-piston and the chamber of the accumulator are closed at their ends by means of two closing portions.

[0055] The present invention further concerns a passenger restraining system for amusement rides comprising at least one restraining element for restraining a passenger and movable between a closed position and an open position, the restraining system further comprises a hydraulic device described and/or claimed herein.

BRIEF DESCRIPTION OF THE FIGURES

[0056] These and further aspects of the present invention will become clearer in the following detailed description provided herein by way of example only and without limitations, with reference to the accompanying figures, in which:

- figures 1A, 1B, 1C are sectional views of a possible embodiment of the hydraulic device according to the invention, provided with an electrovalve and operating the locking in the piston extraction direction, shown respectively in the retracted position of the piston, in the extracted position of the piston and a

schematic view of the hydraulic circuit;

- figures 2A, 2B, 2C are sectional views of a possible embodiment of the hydraulic device according to the invention, provided with an electrovalve and operating the locking in the piston pushing direction, shown respectively in the retracted position of the piston, in the extracted position of the piston and a schematic view of the hydraulic circuit;
- figures 3A, 3B, 3C are sectional views of a possible embodiment of the hydraulic device according to the invention, provided with two electrovalves and operating the locking in both piston movement directions, shown respectively in the retracted position of the piston, in the extracted position of the piston and a schematic view of the hydraulic circuit;
- figure 4A is a sectional view of a further possible embodiment of the hydraulic device according to the invention, in the recessed position of the piston and provided with a duct for the passage of the fluid in an element inside the chamber of the cylinder-piston;
- figure 4B is a sectional view of the hydraulic device of figure 4A according to the invention in the retracted position of the piston;
- figure 5A is a sectional view of a further possible embodiment of the hydraulic device according to the invention, in the retracted position of the piston and provided with ducts, for the passage of the fluid, made on the outer surface of the accumulator;
- figure 5B is a top view of the hydraulic device of figure 5A according to the invention:
- figure 5C is a front view of the hydraulic device of figure 5A according to the invention:
- figure 6A is a perspective view of a possible embodiment of the hydraulic accumulator of the hydraulic device according to the embodiment shown in figure 5A and in which the ducts are made on the outer surface of the wall or jacket of the accumulator;
- figure 6B shows a sectional view of the hydraulic accumulator of figure 5A;
- figures 7A - 7D schematically show the restraining system and a possible embodiment of the hydraulic circuit of the device according to the invention provided with an electrovalve and operating the locking in the piston extraction direction in four different operating steps;
- figures 8A - 8D schematically show the restraining system and a possible embodiment of the hydraulic circuit of the device according to the invention, provided with an electrovalve and operating the locking in the piston pushing direction in four different operating steps.

DETAILED DESCRIPTION OF POSSIBLE EMBODIMENTS OF THE INVENTION

[0057] With reference to the accompanying figures, some possible embodiments of the hydraulic device 1 according to the present invention will be described.

[0058] The hydraulic device 1 according to the present invention is adapted for locking a restraining system 110 comprising an element 200 connected to such hydraulic device 1 for locking the restraining element 200.

[0059] Preferably, the restraining system 110 for restraining a passenger on a seat of an amusement ride.

[0060] As discussed above, the use in a passenger restraining system is not to be understood as limiting and the hydraulic device according to the invention can be used for locking any element directly or indirectly connected thereto.

[0061] The hydraulic device 1 comprises a cylinder-piston 1a having a cylindrical chamber 10, and a piston 12 adapted to slide inside such cylindrical chamber 10 and defining a first and a second portion 10', 10" of the cylindrical chamber 10. The cylindrical chamber is outwardly delimited by an outer wall.

[0062] The piston 12 defines a first and a second portion 10', 10" of the cylindrical chamber 10, wherein such two portions 10', 10" thus have variable dimensions depending on the displacement of the piston 12.

[0063] In particular, the piston 12 is movable between two end positions inside the cylindrical chamber 10, however it is not necessary for the piston the reach the two end positions inside the cylindrical chamber during the operating steps.

[0064] The cylindrical chamber 10 of the cylinder-piston preferably has a circular cross section, but embodiments in which such chamber of the accumulator have different section, for example an oval or elliptical section, are not excluded.

[0065] In a possible embodiment, such as for example visible in all accompanying figures, the movable piston 12 is connected to a rod 15 movable inside the second portion 10" of the cylindrical chamber 10 and jutting out outside the cylindrical chamber 10 for the connection to the element 200 to be locked.

[0066] In a possible embodiment, with reference for example to figures 4A and 4B, the rod 15 comprises at least one inner hollow portion 15' into which a tubular element 23a, placed inside the cylindrical chamber 10 of the cylinder-piston 1a, is inserted.

[0067] In order to allow the sliding of the rod 15, the end and closing portion 14 of the cylinder-piston assembly comprises an opening 14a to allow the passage of the rod 15 of the piston 12.

[0068] It should be noted that the first portion 10' of the cylindrical chamber 10 constitutes the working space of the piston 12, i.e. the cylindrical chamber on the piston side, while the second portion 10" of the cylindrical chamber constitutes the working space of the rod 15 of the piston 12, i.e. the cylindrical chamber on the rod side.

[0069] The hydraulic device 1 according to the invention comprises an accumulator 100 which comprises a chamber 20 surrounding the cylindrical chamber 10 of the cylinder-piston 1a. The chamber 20 is formed, and thus outwardly delimited, by means of an outer wall 16 (or jacket) of the accumulator.

[0070] As mentioned, the cylindrical chamber 10 and the chamber 20 of the accumulator are outwardly delimited by respective outer walls and the outer wall 16 of the accumulator thus surrounds the outer wall of the cylindrical chamber 10 of the cylinder-piston.

[0071] It should be noted that the expression "surrounding chamber" means a chamber which forms an outer perimeter, i.e. outwardly encloses or surrounds to form a closed perimeter around the cylindrical chamber.

[0072] Preferably, such chamber 20 is annular and thus extends ring-like around the cylindrical chamber 10.

[0073] Such chamber 20 of the accumulator 100 preferably has circular cross section, but embodiments in which such chamber of the accumulator have different section, for example an oval or elliptical section, are not excluded.

[0074] In a possible preferred embodiment, the chamber 20 of the accumulator 100 and the cylindrical chamber 10 of the cylinder-piston 1a are coaxial.

[0075] The hydraulic device 1 comprises a hydraulic circuit 22 which fluidly connects the first portion 10' and the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a and which further fluidly connects the accumulator 100 with at least one of the first portion 10' and the second portion 10" of the cylindrical chamber 10.

[0076] With exemplifying reference to figures 1A - 1C, 2A - 2C, 3A -3C, 4A - 4B, 5A - 5C, according to an aspect, the chamber 20 of the accumulator 100 comprises a piston 21 adapted to slide inside the chamber 20 of the accumulator 100.

[0077] Preferably, the piston 21 is annular and adapted to slide inside the chamber 20 of the accumulator having a corresponding annular shape.

[0078] As discussed above, the expression "annular chamber" means a chamber which forms an outer perimeter, i.e. outwardly encloses or surrounds to form a perimeter closed around the cylindrical chamber of the cylinder-piston and thus extending ring-like around the cylindrical chamber.

[0079] In particular, the piston 21 defines a first portion 20' and a second portion 20" of the chamber 20 of the accumulator 100, wherein the first portion 20' of the chamber 20 of the accumulator 100 is in fluidic connection with the hydraulic circuit 22.

[0080] In fact, the accumulator 100 is preferably a hydropneumatic accumulator within which the second portion 20" of the chamber 20 is loaded with a gas and the first portion 20' of the chamber 20 of the accumulator 100 is in fluidic connection with the hydraulic circuit 22.

[0081] As will be better described hereunder, the second portion 20" of the chamber 20 of the accumulator 100 is loaded with gas and thus acts as a gas spring.

[0082] The second portion 20" of the chamber 20 of the accumulator 100 is sealed with a sealing gasket 24, also against high gas pressures.

[0083] For this purpose, the gasket 24 comprises a filling fitting 25 used to fill the second portion 20" of the chamber 20 of the accumulator 100 with gas.

[0084] As shown in figures 1A - 1C, 2A- 2C, 3A-3C, 4A - 4B, 5A - 5C, the filling fitting 25 can be provided with a two-stage sealing system.

[0085] A check valve 26 forms a primary sealing element, while a screw cap 27 forms a secondary sealing element.

[0086] It is thus possible to precisely regulate the gas pressure in the second portion 20" of the chamber 20 and to maintain the gas pressure set.

[0087] The device 1 further comprises a first end and closing portion 13 which sealingly closes the cylinder-piston assembly at the free end of the first portion 10' of the cylindrical chamber 10, and the second end and closing portion 14 sealingly closes the cylinder-piston assembly at the free end of the second portion 10" of said cylindrical chamber 10.

[0088] The hydraulic device 1 comprises intercepting means 30 for intercepting the passage of fluid in the hydraulic circuit 22, which are controlled such as to reach at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in at least one direction.

[0089] In an embodiment, the intercepting means 30 comprise at least one valve 30 fluidically interposed between the first portion 10' and the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a.

[0090] As will be better illustrated hereunder, in a possible embodiment shown by way of example in figures 1A - 1C and 7A - 7D, in the locking position, the sliding of the piston 12 inside the cylindrical chamber 10 is prevented at least in the direction of extraction of the piston 12, i.e. the passage of the fluid is prevented by the intercepting means 30 at least in the direction from the second portion 10" to the first portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a, i.e. from the working space of the rod 15 to the working space of the piston 12.

[0091] This prevents the piston from being pulled out.

[0092] In this regard, in the at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in at least one direction, the valve 30 is in a closed configuration to prevent the passage of fluid at least from the second portion 10" to the first portion 10' of the cylindrical chamber 10.

[0093] In a further possible embodiment shown by way of example in figures 2A - 2C and 8 - 8D, in the locking position, the sliding of the piston 12 inside the cylindrical chamber 10 is prevented at least in the direction of insertion (pushing) of the piston 12 inside the cylindrical chamber, i.e. the passage of the fluid is prevented by the intercepting means 30 at least in the direction from the first portion 10' to the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a, i.e. from the working space of the piston 12 to the working space of the rod 15.

[0094] This way, the piston insertion (pushing) movement is prevented.

[0095] In this regard, in the at least one locking position,

in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in at least one direction, the valve 30 is in a closed configuration to prevent the passage of fluid at least from the first portion 10' to the second portion 10" of the cylindrical chamber 10.

[0096] Moreover, according to an aspect, the at least one valve 30 is electrically controlled and preferably comprises at least one electrovalve 30, wherein, in the at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in at least one direction, the electrically operated valve 30 is in the non-energized state.

[0097] However, with reference for example to the embodiment shown in figures 1A-1C and 7A - 7D, in the at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in the extraction direction, the passage of fluid from the first portion 10' to the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a and from the first portion 10' of the cylindrical chamber 10 to the chamber 20 of the accumulator 100 is allowed.

[0098] In this regard, in an embodiment, the hydraulic circuit 22 of the hydraulic device 1 further comprises at least one non-return valve 31 fluidically interposed between the first portion 10' and the second portion 10" of the cylindrical chamber 10 and which allows the flow of fluid from the first portion 10' to the second portion 10" and prevents the flow of fluid in the opposite direction.

[0099] It should be noted that such non-return valve 31 allows the flow of fluid from the first portion 10' to the second portion 10" independently of the fact that the intercepting means 30 are in the energized state or not.

[0100] With reference for example to the schematic representation shown in figures 1A - 1C and 7A - 7D, it should be noted that in a possible embodiment, the electrovalve 30 is arranged in fluidic connection between the first portion 10' and the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a.

[0101] In other words, the electrovalve 30 is arranged in fluidic connection between the working space of the piston 12 formed in the first portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a and the working space of the rod 15 of the piston 12 formed in the second portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a.

[0102] Similarly, with reference for example to the embodiment shown in figures 2A - 2C and 8A - 8D, in the at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in the insertion (pushing) direction, the passage of fluid from the second portion 10' to the first portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a and from the second portion 10' of the cylindrical chamber 10 to the chamber 20 of the accumulator 100 is allowed.

[0103] In such case, as shown for example in figures 2A - 2C and 8A - 8D, at least one non-return valve 31 fluidically interposed between the first portion 10' and the second portion 10" of the cylindrical chamber 10 and which allows the flow of fluid from the second portion 10" to the first portion 10' and prevents the flow of fluid in the opposite direction, is present.

[0104] It should be noted that such non-return valve 31 allows the flow of fluid from the second portion 10" to the first portion 10' independently of the fact that the intercepting means 30 are in the energized state or not.

[0105] With reference for example to the schematic representation shown in figures 5A - 5D and 6A - 6D, it should be noted that in a possible embodiment, the electrovalve 30 is arranged in fluidic connection between the first portion 10' and the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a.

[0106] In other words, the electrovalve 30 is arranged in fluidic connection between the working space of the piston 12 formed in the first portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a and the working space of the rod 15 of the piston 12 formed in the second portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a.

[0107] In a further embodiment shown for example in figures 3A - 3C, the intercepting means 30 comprise at least one further valve 32 fluidically interposed between the first portion 10' and the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a.

[0108] According to such embodiment, in the locking position, the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in the direction of extraction of the piston 12 by means of the first valve 30, i.e. the passage of the fluid is prevented from the first valve 30 at least in the direction from the second portion 10" to the first portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a, and the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in the direction of insertion of the piston 12 by means of the second valve 32, i.e. the passage of the fluid is prevented from the second valve 32 at least in the direction from the first portion 10' to the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a.

[0109] In this regard, at least one locking position, in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in both directions, is further present, wherein the valves 30, 32 are in a closed configuration to prevent the passage of fluid respectively from the second portion 10" to the first portion 10' of the cylindrical chamber 10 and from the first portion 10' to the second portion 10" of the cylindrical chamber 10.

[0110] Preferably, both valves 30, 32 are electrically controlled and preferably comprise two respective electrovalves 30, 32, wherein, in the at least one locking position in which the sliding of the piston 12 inside the cylindrical chamber 10 is prevented in both directions, the electrically operated valves 30, 32 are in the non-energized state.

[0111] With reference to the embodiment shown in figures 1A-1C and 7A - 7D, in the locking position, whenever the electrovalve 30 is in the non-energized state, the flow of fluid is hindered in the direction from the working space

of the rod 15 of the piston 12, formed in the second portion 10" of the cylindrical chamber 10, to the working space of the piston 12, formed in the first portion 10' of the cylindrical chamber 10, however, the non-return valve 31 allows a flow of the fluid from the first portion 10' of the cylindrical chamber 10, i.e. from the working space of the piston 12, to the second portion 10" of the cylindrical chamber 10, i.e. to the working space of the rod 15 of the piston, but prevents it in the opposite direction.

[0112] With reference to the embodiment shown in figures 2A - 2C and 8A and 8D, in the locking position, whenever the electrovalve 30 is in the non-energized state, the flow of fluid is hindered in the direction from the working space of the piston 12, formed in the first portion 10' of the cylindrical chamber 10, to the working space of the rod 15 of the piston 12, formed in the second portion 10" of the cylindrical chamber 10, however, the non-return valve 31 allows a flow of the fluid from the second portion 10" of the cylindrical chamber 10, i.e. from the working space of the rod 15 of the piston 12, to the first portion 10' of the cylindrical chamber 10, i.e. to the working space of the piston 12, but prevents it in the opposite direction.

[0113] With reference to the embodiment shown in figures 3A - 3C, in the locking position, the hydraulic device comprises a first and a second electrovalve 30, 32 both placed in the non-energized state, so that the flow of fluid is hindered both in the direction from the working space of the rod 15 of the piston 12 to the working space of the piston 12 by means of the first electrovalve 30, and in the direction from the working space of the piston 12 to the working space of the rod 15 of the piston 12, by means of the second electrovalve 32.

[0114] Whenever the electrovalve 30 is energized, the flow of fluid is allowed in the direction from the working space of the rod 15 of the piston 12, formed in the second portion 10" of the cylindrical chamber 10, to the working space of the piston 12 formed in the first portion 10' of the cylindrical chamber 10.

[0115] In an embodiment, the cylindrical chamber 10 and the chamber 20 of the accumulator 100 are closed at their ends by means of two closing portions 13, 14. In other words, the respective outer walls of the cylindrical chamber 10 and chamber 20 of the accumulator 100 are closed at their ends by two closing elements or portions 13, 14.

[0116] As for example visible in the schematic representation of figures 1C, 2C, 3C, 7A-7D and 8A-8D, the first and the second portion 10', 10" of the cylindrical chamber 10 are fluidly connected with the hydraulic accumulator 100, in particular with the first portion 20' of the hydraulic chamber 20 of the accumulator 100, by means of the hydraulic circuit 22.

[0117] The hydraulic circuit 22 comprises duct portions 22', 22", 23, 23a for the fluidic connection between the cylinder-piston 1a and the accumulator 100.

[0118] In particular, such duct portions 22', 22", 23, 23a are adapted to fluidly connect the working space of the piston 12, formed in the first portion 10' of the cylindrical chamber 10 of the cylinder-piston 1a, and the working space of the rod 15 of the piston 12, formed in the second portion 10" of the cylindrical chamber 10 of the cylinder-piston 1a, and are further adapted to connect such first and second portion 10', 10" of the cylindrical chamber 10 of the cylinder-piston 1a with the first portion 20' of the chamber 20 of the accumulator 100.

[0119] Such connection allows the passage of fluid, preferably oil, between the components of the hydraulic device 1.

[0120] In an embodiment, such as for example visible in figures 1A - 1C, 2A- 2C, 3A-3C, 4A - 4B, 5A - 5C, such duct portions 22', 22", 23, 23a comprise at least one first duct portion 22' for the fluidic connection between the first chamber portion 20' of the hydraulic chamber 20 of the accumulator 100 and the first portion 10' of the cylindrical chamber 10, and at least one second duct portion 22" for the fluidic connection between the first chamber portion 20' of the hydraulic chamber 20 of the accumulator 100 and the second portion 10" of the cylindrical chamber 10.

[0121] In a first possible embodiment, for example shown in figures 1A - 1C, 2A- 2C, 3A-3C, the first duct portion 22' is formed at least partially at a respective closing portion 13 of the device 1, and the second duct portion 22" is formed at least partially at the other closing portion 14 of the device 1.

[0122] In particular, the closing portions 13, 14 are preferably formed by mechanical machining and with reference to figures 1A - 1C, 2A - 2C, 3A-3C, 4A - 4B, 5A - 5C, the first and second duct portions 22', 22" are formed as ducts inside the respective closing portions 13, 14 of the device 1.

[0123] In a further possible embodiment, such as for example visible in figures 2A, 2B, the first duct portion 22' and the second duct portion 22" are both formed at least partially at a single end and closing portion 13, 14 of the device 1.

[0124] In a further possible embodiment, for example visible in figures 5A - 5C, 6A - 6B, the hydraulic circuit 22 comprises at least one duct portion 23 extending along the outer wall 16 of the chamber 20 of the accumulator 100, and preferably extending in longitudinal direction along the outer wall of the chamber 20 of the accumulator 100.

[0125] As better visible for example with reference to figures 6A, 6B, according to such possible configuration, the hydraulic accumulator 100, and in particular the outer part 16, can be configured as a cylindrical or tubular element preferably made of a metal material and whose inner surface is adapted to delimit the annular hydraulic chamber 20 and whose outer surface can comprise tubular ducts 23 formed on such outer surface of the wall 16 and which extend in the longitudinal direction of the cylindrical or tubular surface of the hydraulic accumulator 100.

[0126] With reference to figure 5A, the intermediate

tubular ducts 23 are fluidly connected at least between the first portion 10' and the second portion 10" of the cylindrical chamber 10 and fluidly connect said first and second duct portion 22', 22".

[0127] In a further possible embodiment visible for example in figures 4A, 4B, the hydraulic circuit 22 comprises at least one duct portion 23a extending inside at least part of a cavity 15' of the piston 15, preferably inside at least part of the piston 12 and rod 15 of the piston 12, which are placed inside the cylindrical chamber 10 of the cylinder-piston 1a.

[0128] As for example visible in figures 4A, 4B, a possible alternative embodiment of the cylinder-piston assembly 1 according to the invention is shown, wherein the piston 12 and respective rod 15 are hollow bodies, i. e. they provide a cavity 15' adapted for housing a channel 23a for the passage of the fluid.

[0129] In a further embodiment for example visible in figures 1A - 1C, 2A- 2C, 3A-3C, the hydraulic circuit 22 comprises at least one duct portion 23 extending within the thickness of the outer wall 16 (or jacket) of the chamber 20 of the accumulator 100.

[0130] The present application further concerns a passenger restraining system 110 for amusement rides, comprising at least one restraining element 200 for restraining a passenger and movable between at least one closed position and one open position.

[0131] The restraining system 110 further comprises a hydraulic device 1 according to the invention.

[0132] The piston 12 movable inside the cylindrical chamber 10 comprises a rod 15 mechanically constrained to the restraining element 200 for moving it between a closed position and an open position and for locking it in a closed position.

[0133] In particular, the restraining system 110 is adapted for a restraining element 200 for restraining passengers of a vehicle of an amusement ride, but embodiments in which the restraining system is used on different types of vehicles are not excluded.

[0134] With reference to figures 7A - 7D and 8A - 8D, the restraining system 110 is arranged on the vehicle of an amusement ride so as the free end 15a of the rod 15 of the piston 12 is constrained to the movable restraining element 200, so as the rectilinear movement of the piston 12 determines the opening and closing movement of the movable restraining element 200, for example by means of appropriate connections and leverages known in the art and thus not described herein.

[0135] With reference to figures 7A - 7D, the steps of a possible embodiment of the method for actuating the restraining system 110 comprising a hydraulic device 1 with a flow intercepting element 30 and the respective movable restraining element 200 will be illustrated hereunder and, in particular, a locking configuration and an open configuration of the restraining system 110 and the respective movable restraining element 200.

[0136] In the locking configuration shown in figure 7A, the rod 15 is in a retracted position inside the cylindrical chamber 10, so as the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, has a greater dimension than the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0137] It should be noted that the rod 15 can be completely retracted inside the cylinder-piston and thus can reach the position of abutment with the end of the first portion 10' of the cylindrical chamber 10, however, embodiments in which the locking position provides that the rod 15 is not completely retracted are not excluded.

[0138] In such locking configuration, the movable restraining element 200 is in the closed position.

[0139] In such locking configuration, the electrovalve 30 is not electrically energized and thus hinders the passage of fluid from the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0140] This way, the piston cannot move in the extraction direction, thus preventing the restraining element 200 from rising.

[0141] However, in such configuration, the passage of fluid is allowed from the first portion 10' of the cylindrical chamber, i.e. the working space of the piston 12, to the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, so that the restraining element can be lowered, possibly gradually, and locked in the desired closed position.

[0142] In such locking configuration, the first chamber portion 20' of the chamber 20 of the accumulator 100 is loaded with fluid.

[0143] Subsequently, as shown in figure 7B, the method for actuating the restraining device 110 provides a step in which the electrovalve 30 is electrically energized by switching its state and thus allowing the passage of fluid from the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0144] Consequently, the fluid present inside the first chamber portion 20' of the chamber 20 of the accumulator 100 can pass from the chamber portion 20' of the hydraulic accumulator 100 to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, thus co-operating the rising and causing the restraining element 200 to rise.

[0145] The step of extracting the piston 12 ends when all the fluid initially present in the chamber portion 20' of the hydraulic chamber 20 of the accumulator 100 substantially came out of such chamber portion 20' and is fed into the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0146] Thus, in such configuration, the first chamber portion 20' of the chamber 20 of the accumulator 100 is emptied with respect to the initial locking configuration shown in figure 7A and the piston 12 moves inside the cylindrical chamber 10, so that the first portion 10' of the

cylindrical chamber 10, i.e. the working space of the piston 12, has a greater dimension than the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, as shown in figure 7C. In such open configuration, the movable restraining element 200 is in the open position.

[0147] Subsequently, as shown in figure 7D, the electrovalve 30 is de-energized and the restraining device 110 is once again in a state in which the passage of fluid is hindered in the direction from the second portion 10" of the cylindrical chamber 10 towards the first portion 10' of the cylindrical chamber 10.

[0148] In such step, the non-return valve 31 instead allows the passage of the fluid in the opposite direction, i.e. from the first portion 10' of the cylindrical chamber 10 towards the second portion 10" of the cylindrical chamber 10.

[0149] This way, the piston 12 is locked in the piston extraction direction, however the user can continue to regulate the closing position of the restraining system 110, since the piston 12 can move in the direction opposite the extraction direction.

[0150] This allows to finely regulate the most effective locking position for each user according to the height and build of the user, whenever a user operates a closing movement on the restraining element 200.

[0151] With reference to figures 8A - 8D, the steps of a possible embodiment of the method for actuating the restraining system 110 comprising a hydraulic device 1 with a flow intercepting element 30 and the respective movable restraining element 200 and, in particular, a locking configuration and an open configuration of the restraining system 110 and the respective movable restraining element 200, will be illustrated hereunder.

[0152] In the locking configuration shown in figure 8A, the rod 15 is in a position extracted from the cylindrical chamber 10 so as the first portion 10' of the cylindrical chamber 10, i.e. the working space of the rod 15, has a greater dimension than the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0153] It should be noted that the rod 15 can be completely extracted from the cylinder-piston and thus reach the position of abutment with the end of the second portion 10" of the cylindrical chamber 10, however, embodiments in which the locking position provides that the rod 15 is not completely extracted are not excluded.

[0154] In such locking configuration, the movable restraining element 200 is in the closed position.

[0155] In such locking configuration, the electrovalve 30 is not electrically energized and thus hinders the passage of fluid from the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, to the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15.

[0156] This way, the piston cannot move in the insertion (pushing) direction, thus preventing the restraining element 200 from rising.

[0157] However, in such configuration, the passage of fluid is allowed from the second portion 10" of the cylindrical chamber, i.e. the working space of the rod 15, to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, so that the restraining element can be lowered, possibly gradually, and locked in the desired closed position.

[0158] In such locking configuration, the first chamber portion 20' of the chamber 20 of the accumulator 100 is loaded with fluid.

[0159] Subsequently, as shown in figure 8B, the method for actuating the restraining device 110 provides a step in which the electrovalve 30 is electrically energized by switching its state and thus allowing the passage of fluid from the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, to the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15.

[0160] Consequently, the fluid present inside the first chamber portion 20' of the chamber 20 of the accumulator 100 can pass from the chamber portion 20' of the hydraulic accumulator 100 to the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, thus co-operating the rising and causing the restraining element 200 to rise.

[0161] The step of inserting the piston 12 ends when all the fluid initially present in the chamber portion 20' of the hydraulic chamber 20 of the accumulator 100 substantially came out of such chamber portion 20' and is fed into the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15.

[0162] Thus, in such configuration, the first chamber portion 20' of the chamber 20 of the accumulator 100 is emptied with respect to the initial locking configuration shown in figure 8A and the piston 12 moves inside the cylindrical chamber 10, so that the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, has smaller dimension than the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, as shown in figure 8C. In such open configuration, the movable restraining element 200 is in the open position.

[0163] Subsequently, as shown in figure 8D, the electrovalve 30 is de-energized and the restraining device 110 is once again in a state in which the passage of fluid is hindered in the direction from the first portion 10' of the cylindrical chamber 10 towards the second portion 10" of the cylindrical chamber 10.

[0164] In such step, the non-return valve 31 instead allows the passage of the fluid in the opposite direction, i.e. from the second portion 10" of the cylindrical chamber 10 towards the first portion 10' of the cylindrical chamber 10.

[0165] This way, the piston 12 is locked in the insertion (pushing) direction of the piston towards the inside of the cylindrical chamber, however the user can continue to regulate the closing position of the restraining system 110, since the piston 12 can move in the direction opposite the insertion direction.

[0166] This allows to finely regulate the most effective locking position for each user according to the height and build of the user, whenever a user operates a closing movement on the restraining element 200.

[0167] The steps of a possible embodiment of the method for actuating the restraining system 110 comprising a hydraulic device 1 with two flow intercepting element 30, 32 and the respective movable restraining element 200 and, in particular, a locking configuration and an open configuration of the restraining system 110 and the respective movable restraining element 200, will be illustrated hereunder.

[0168] In the locking configuration, the rod 15 is in a retracted position inside the cylindrical chamber 10, so as the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, has a greater dimension than the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0169] It should be noted that the rod 15 can be completely retracted inside the cylinder-piston and thus can reach the position of abutment with the end of the first portion 10' of the cylindrical chamber 10, however, embodiments in which the locking position provides that the rod 15 is not completely retracted are not excluded.

[0170] In such locking configuration, the movable restraining element 200 is in the closed position.

[0171] In such locking configuration, at least the electrovalve 30 is in an electrically non-energized state and thus hinders the passage of fluid from the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0172] This way, the piston cannot move in the extraction direction, thus preventing the restraining element 200 from rising.

[0173] However, in such configuration, the passage of fluid is allowed from the first portion 10' of the cylindrical chamber, i.e. the working space of the piston 12, to the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, so that the restraining element 200 can be lowered, possibly gradually, and locked in the desired closed position.

[0174] Once the locking position has been reached, the second electrovalve 32 can also be put in an electrically non-energized state and thus can hinder the passage of fluid from the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, to the first portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15.

[0175] In such configuration, in which both the electrovalves 30, 32 are in a non-energized state, the restraining element 200 can neither be raised nor lowered, so as to prevent both the opening of the restraining element 200 and an excessive lowering thereof which could be caused by a push of the user during the run.

[0176] In such locking configuration, the first chamber portion 20' of the chamber 20 of the accumulator 100 is loaded with fluid.

[0177] Subsequently, the method for actuating the restraining system 110 provides a step in which at least the first electrovalve 30 is electrically energized by switching its state and thus allowing the passage of fluid from the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0178] Consequently, the fluid present inside the first chamber portion 20' of the chamber 20 of the accumulator 100 can pass from the chamber portion 20' of the hydraulic accumulator 100 to the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, thus co-operating the rising and causing the restraining element 200 to rise.

[0179] The step of extracting the piston 12 ends when all the fluid initially present in the chamber portion 20' of the hydraulic chamber 20 of the accumulator 100 substantially came out of such chamber portion 20' and is fed into the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0180] Thus, in such configuration, the first chamber portion 20' of the chamber 20 of the accumulator 100 is emptied with respect to the initial locking configuration and the piston 12 moves inside the cylindrical chamber 10, so that the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, has a greater dimension than the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15. In such open configuration, the movable restraining element 200 is in the open position.

[0181] Once the completely open configuration of the movable restraining element 200 has been reached, the second electrovalve 32 put in an electrically non-energized state hinders the passage of fluid from the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, to the first portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, thus preventing the accidental closing of the restraining element.

[0182] Such configuration is adapted for keeping the movable restraining element 200 open during the passenger boarding step, thus preventing the restraining element 200 from being accidentally lowered.

[0183] Subsequently, the first electrovalve 30 is put in the electrically non-energized state and the second electrovalve 32 is put in the electrically energized state and the restraining device 110 is in a state in which the passage of fluid is hindered in the direction from the second portion 10" of the cylindrical chamber 10, i.e. the working space of the rod 15, towards the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12.

[0184] In such step, the second electrovalve 32 and non-return valve 31 allow the passage of the fluid in the opposite direction, i.e. from the first portion 10' of the cylindrical chamber 10, i.e. the working space of the piston 12, towards the second portion 10" of the cylindrical

chamber 10, i.e. the working space of the rod 15.

[0185] This way, the piston 12 is locked in the piston extraction direction, however the user can continue to regulate the closing position of the restraining system 110, since the piston 12 can move in the direction opposite the extraction direction.

[0186] This allows to finely regulate the most effective locking position for each user according to the height and build of the user, whenever a user operates a closing movement on the restraining element 200.

Claims

1. Hydraulic device (1) for locking an element (200) connected to said device, preferably for locking a restraining element for restraining a passenger on an amusement ride, said hydraulic device comprising;

   - a cylinder-piston (1a) having a cylindrical chamber (10) and a piston (12) adapted to slide inside said cylindrical chamber (10) and defining a first and a second portion (10', 10") of said cylindrical chamber (10),
   - an accumulator (100),
   - a hydraulic circuit (22) which fluidly connects said first portion (10') and said second portion (10") of the cylindrical chamber (10) of the cylinder-piston (1a) and which further fluidly connects said accumulator (100) with at least one of said first portion (10') and said second portion (10") of the cylindrical chamber (10),
   - intercepting means (30, 32) for intercepting the passage of fluid in said hydraulic circuit, which can be controlled such as to reach at least one locking position in which the sliding of the piston (12) inside the cylindrical chamber (10) is prevented in at least one direction,

   said device (1) being **characterized in that** said accumulator (100) comprises a chamber (20) surrounding said cylindrical chamber (10) of the cylinder-piston (1a).

2. Device (1) according to claim 1, wherein said chamber (20) of the accumulator (100) is annular.

3. Device (1) according to claim 1 or 2, wherein said chamber (20) of the accumulator (100) and said cylindrical chamber (10) of the cylinder-piston (1a) are coaxial.

4. Hydraulic device according to any one of the preceding claims, wherein said movable piston (12) is connected to a rod (15) movable inside said second portion (10") of the cylindrical chamber (10) and jutting out outside of said cylindrical chamber (10) for the connection to said element (200) to be locked.

5. Hydraulic device according to any one of the preceding claims, wherein said rod (15) comprises at least one inner hollow portion (15') into which a tubular element (23a), placed inside the cylindrical chamber (10) of the cylinder-piston (1a), is inserted.

6. Device (1) according to any one of the preceding claims, wherein said chamber (20) of the accumulator (100) comprises a piston (21), preferably annular and adapted to slide inside said chamber (20) of the accumulator (100).

7. Hydraulic device (1) according to any one of the preceding claims, wherein said piston (21) defines a first portion (20') and a second portion (20") of said chamber (20), said first portion (20') of the chamber (20) of the accumulator (100) being in fluidic connection with said hydraulic circuit (22), preferably said accumulator (100) is a hydropneumatic accumulator within which said second portion (20") of the chamber (20) is loaded with a gas and said first portion (20') of the chamber (20) of the accumulator (100) being in fluidic connection with said hydraulic circuit (22).

8. Hydraulic device (1) according to any one of the preceding claims, wherein said hydraulic circuit (22) comprises at least one duct portion (23) extending along the outer wall (16) of said chamber (20) of the accumulator (100), preferably extending in longitudinal direction along the outer wall of said chamber (20) of the accumulator (100).

9. Hydraulic device according to any one of the preceding claims, wherein said hydraulic circuit (22) comprises at least one duct portion (23) extending inside a tubular element (15a) placed inside the cylindrical chamber (10) of the cylinder-piston (1a).

10. Hydraulic device according to any one of the preceding claims, wherein said hydraulic circuit (22) comprises at least one duct portion (23) extending inside the thickness of the outer wall (16) of the chamber (20) of the accumulator (100).

11. Hydraulic device according to any one of the preceding claims, wherein said intercepting means (30, 32) for intercepting the passage of fluid in said hydraulic circuit comprise at least one valve (30, 32) fluidically interposed between said first portion (10') and said second portion (10") of the cylindrical chamber (10) of the cylinder-piston (1a), in said at least one locking position in which the sliding of the piston (12) inside the cylindrical chamber (10) is prevented in at least one direction, said at least one valve (30) is in a closed position and the passage of fluid is prevented at least from said second portion (10") to said first

portion (10') of said cylindrical chamber (10).

12. Hydraulic device according to any one of the preceding claims, wherein said intercepting means (30, 32) for intercepting the passage of fluid in said hydraulic circuit comprise at least one valve (30, 32) fluidically interposed between said first portion (10') and said second portion (10") of the cylindrical chamber (10) of the cylinder-piston (1a), in said at least one locking position in which the sliding of the piston (12) inside the cylindrical chamber (10) is prevented in at least one direction, said at least one valve (30) is in a closed position and the passage of fluid is prevented at least from said first portion (10') to said second portion (10") of said cylindrical chamber (10).

13. Hydraulic device according to any one of the preceding claims, wherein said intercepting means (30, 32) for intercepting the passage of fluid in said hydraulic circuit comprise a first valve (30) and a second valve (32) which are fluidically interposed between said first portion (10') and said second portion (10") of the cylindrical chamber (10) of the cylinder-piston (1a), in said at least one locking position the sliding of the piston (12) inside the cylindrical chamber (10) is prevented in both directions, said first valve (30) and said second valve (32) being in a closed position and preventing the passage of fluid from said second portion (10") to said first portion (10') of said cylindrical chamber (10) and vice versa.

14. Hydraulic device according to any one of the preceding claims, wherein said at least one valve (30, 32) is electrically controlled and preferably comprises at least one electrovalve, wherein, in said at least one locking position in which the sliding of the piston (12) inside the cylindrical chamber (10) is prevented in at least one direction, said electrically operated valve (30, 32) is in the non-energized state.

15. Hydraulic device according to any one of the preceding claims, wherein, in said at least one locking position in which the sliding of the piston (12) inside the cylindrical chamber (10) is prevented in at least one direction, the passage of fluid from said first portion (10') of the cylindrical chamber (10) of the cylinder-piston (1a) to said chamber (20) of the accumulator (100) is allowed, or the passage of fluid from said second portion (10") of the cylindrical chamber (10) of the cylinder-piston (1a) to said chamber (20) of the accumulator (100) is allowed.

16. Hydraulic device according to one of the preceding claims, wherein said hydraulic circuit (22) further comprises at least one non-return valve (31) fluidically interposed between said first portion (10') and said second portion (10") of the cylindrical chamber (10) and which allows the flow of fluid from said first portion (10') to said second portion (10") and prevents the flow of fluid in the opposite direction, or allows the flow of fluid from said second portion (10") to said first portion (10') and prevents the flow of fluid in the opposite direction.

17. Hydraulic device according to any one of the preceding claims, wherein said cylindrical chamber (10) of the cylinder-piston (1a) and said chamber (20) of the accumulator (100) are closed at their ends by means of two closing portions (13, 14).

18. Passenger restraining system for amusement rides, comprising at least one restraining element (200) for restraining a passenger and movable between at least one closed position and one open position, the restraining system further comprising at least one hydraulic device (1) according to any one of the preceding claims.

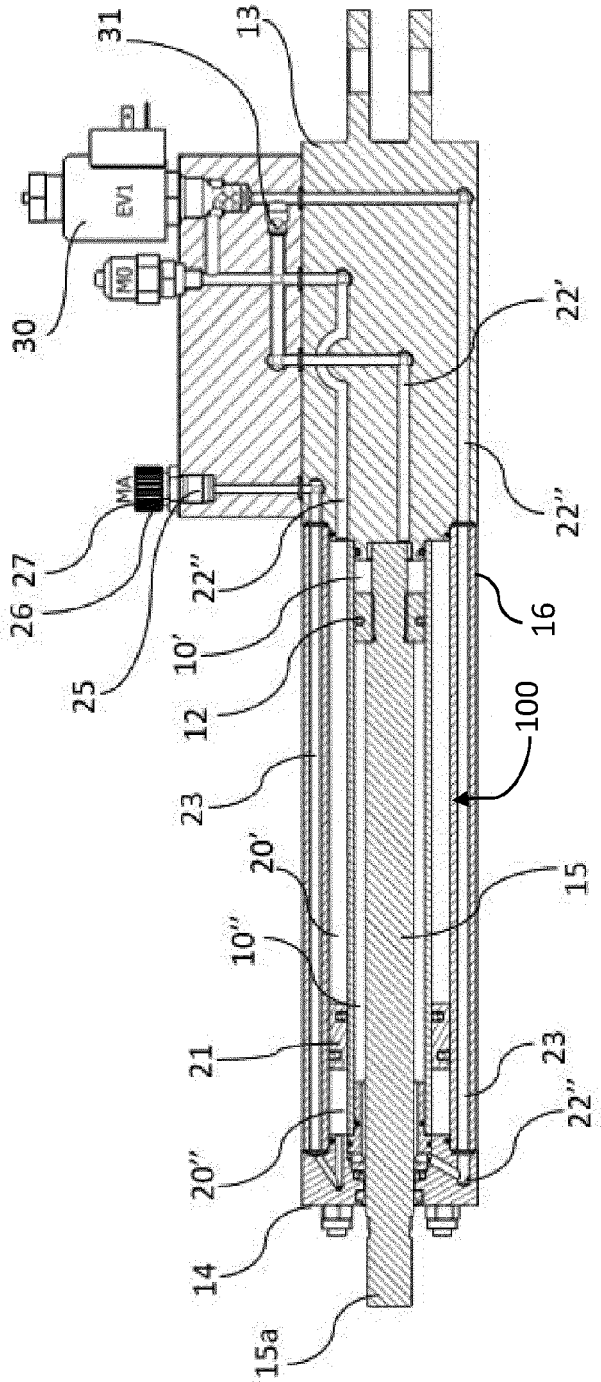
31
13
EV1
30
22'
22''
27
26
25
10'
12
100
16
23
20'
10''
15
21
20''
14
15a

Fig. 1A

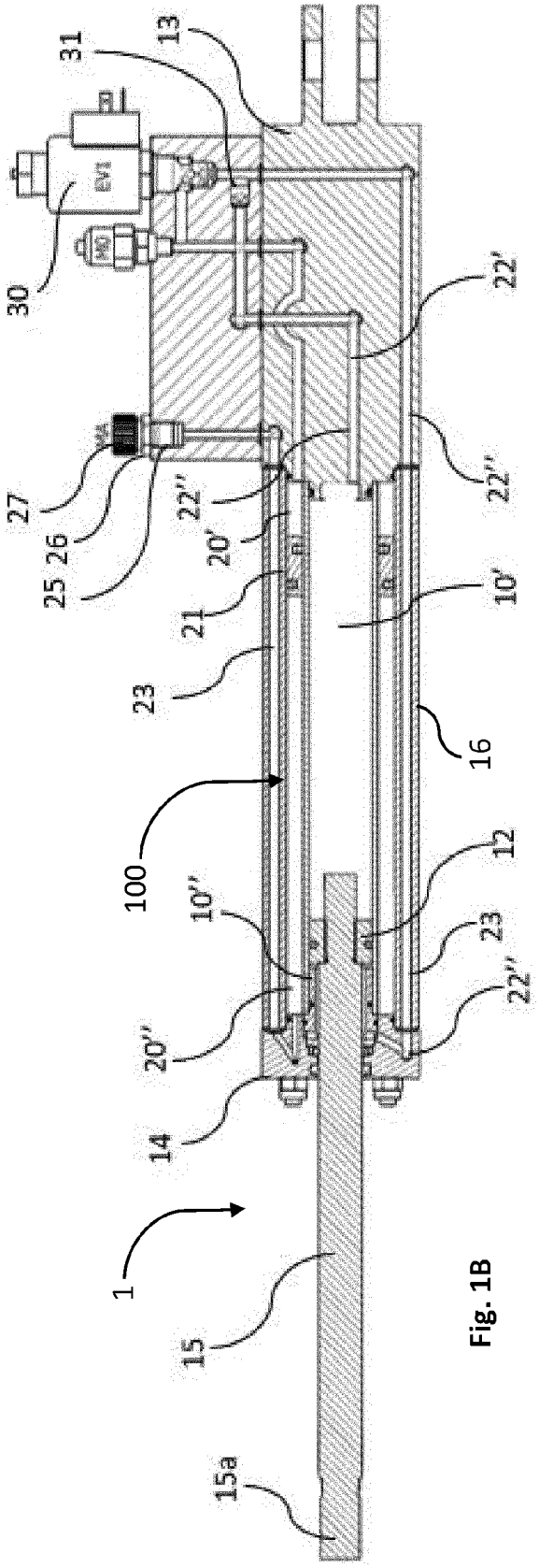
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Fig. 1B

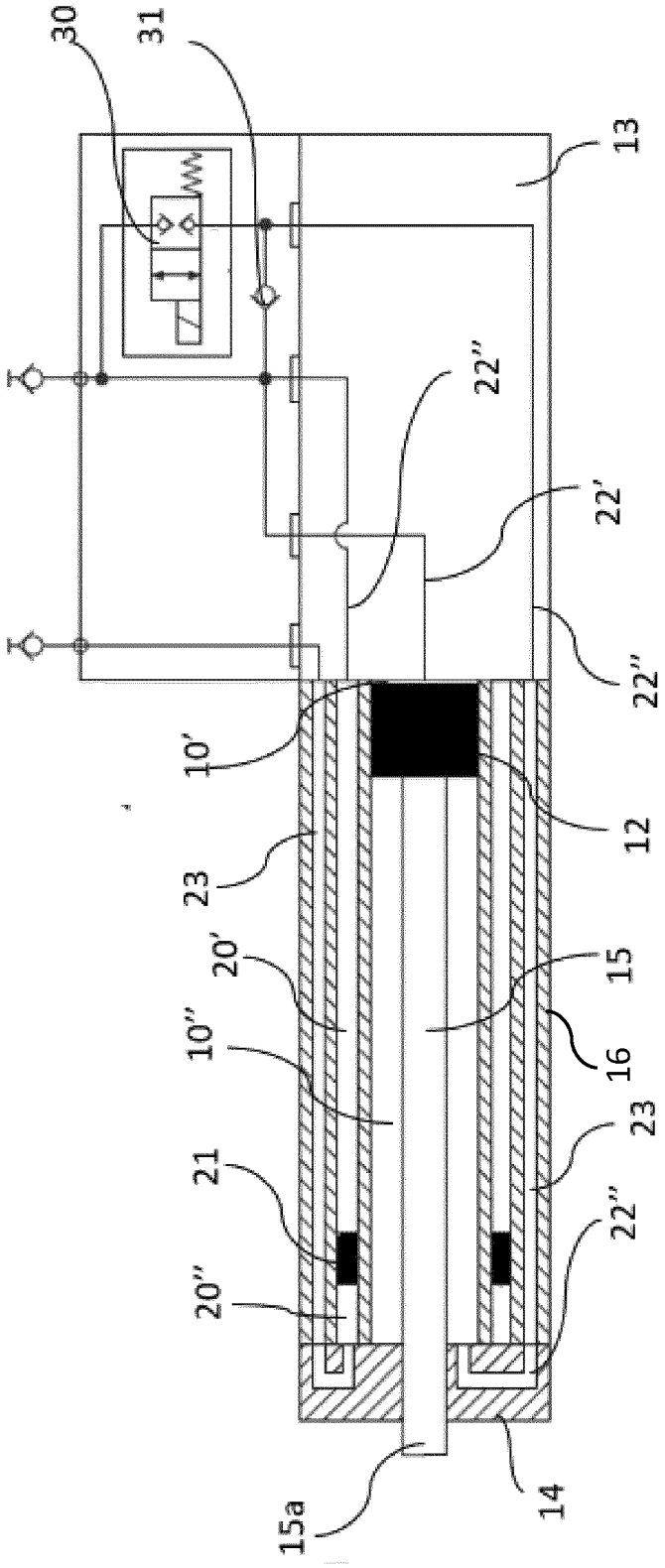

Fig. 1C

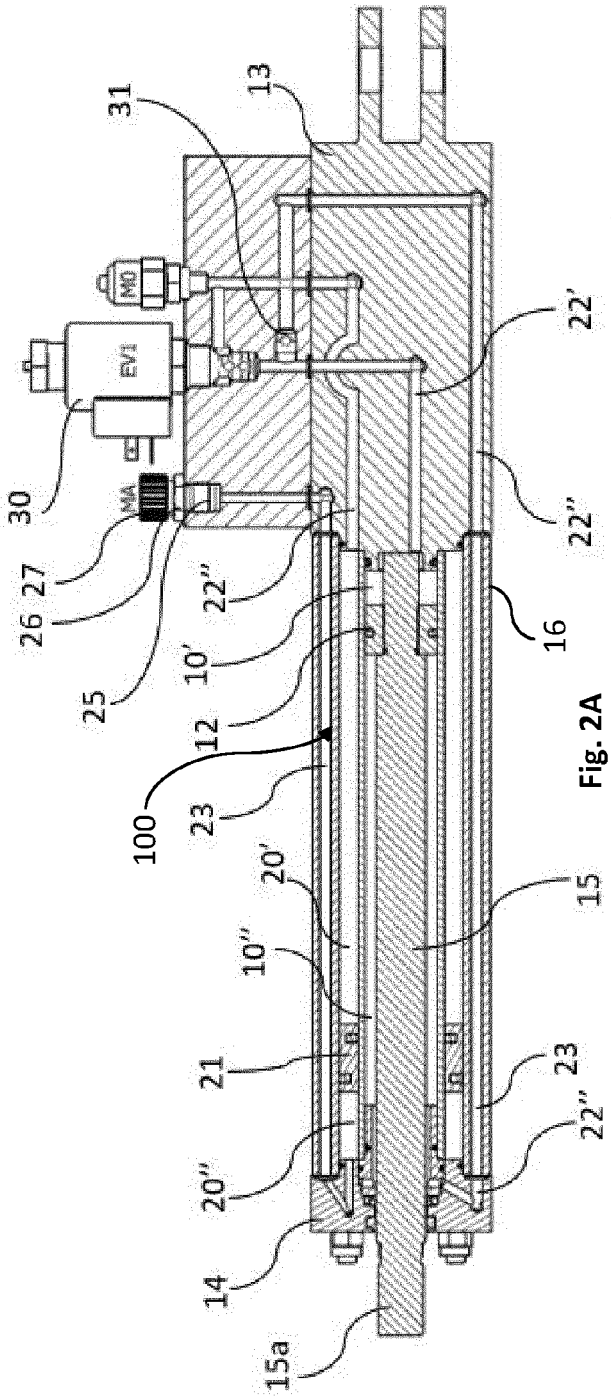
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Fig. 2A

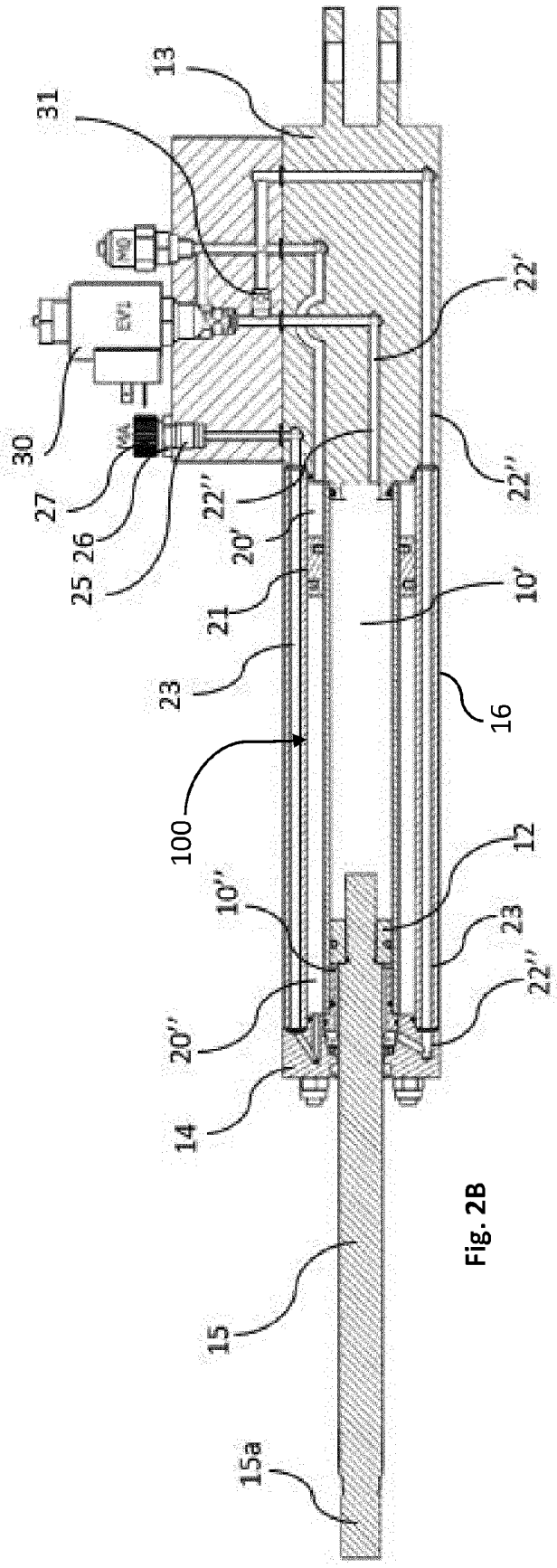
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Fig. 2B

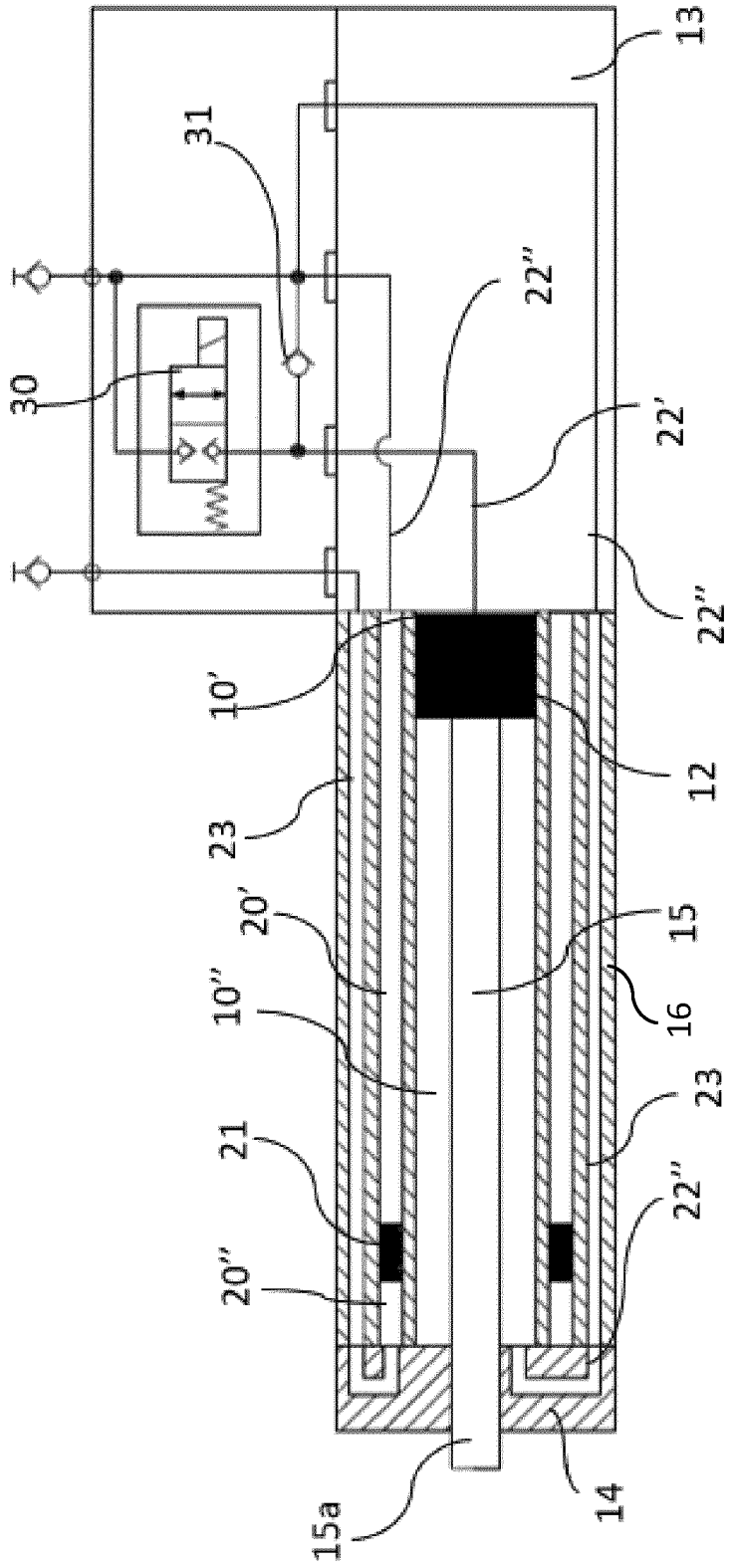

Fig. 2C

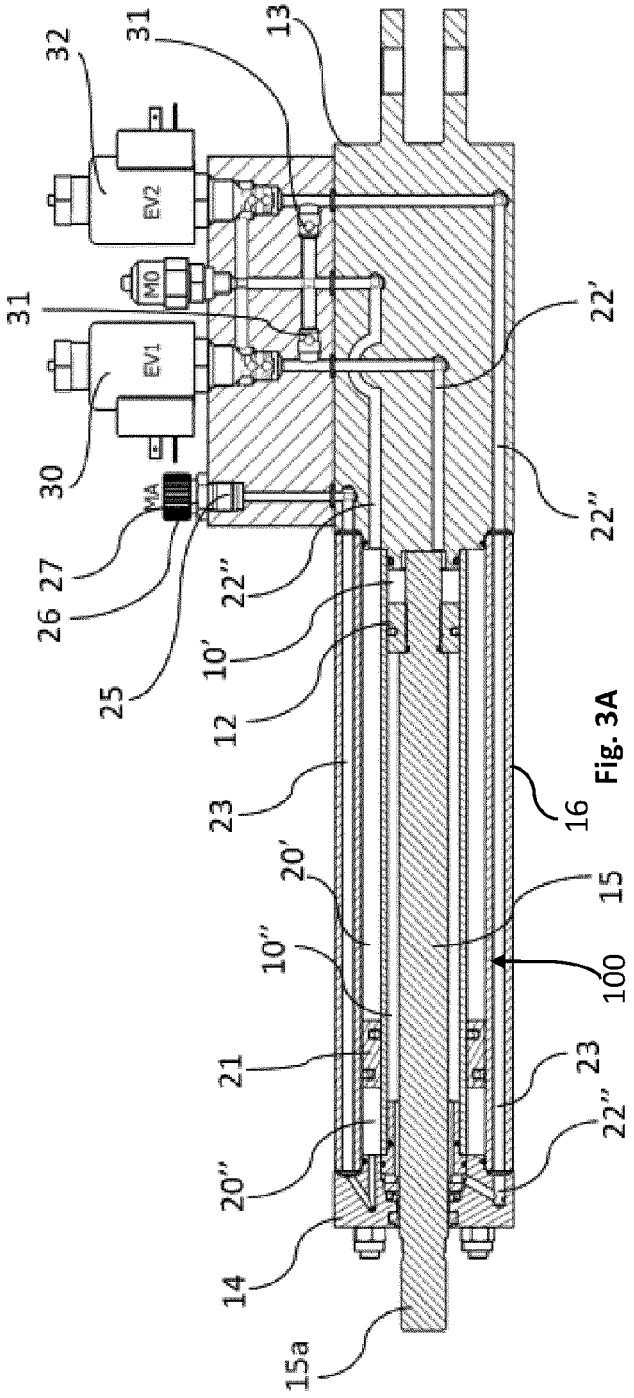
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Fig. 3A

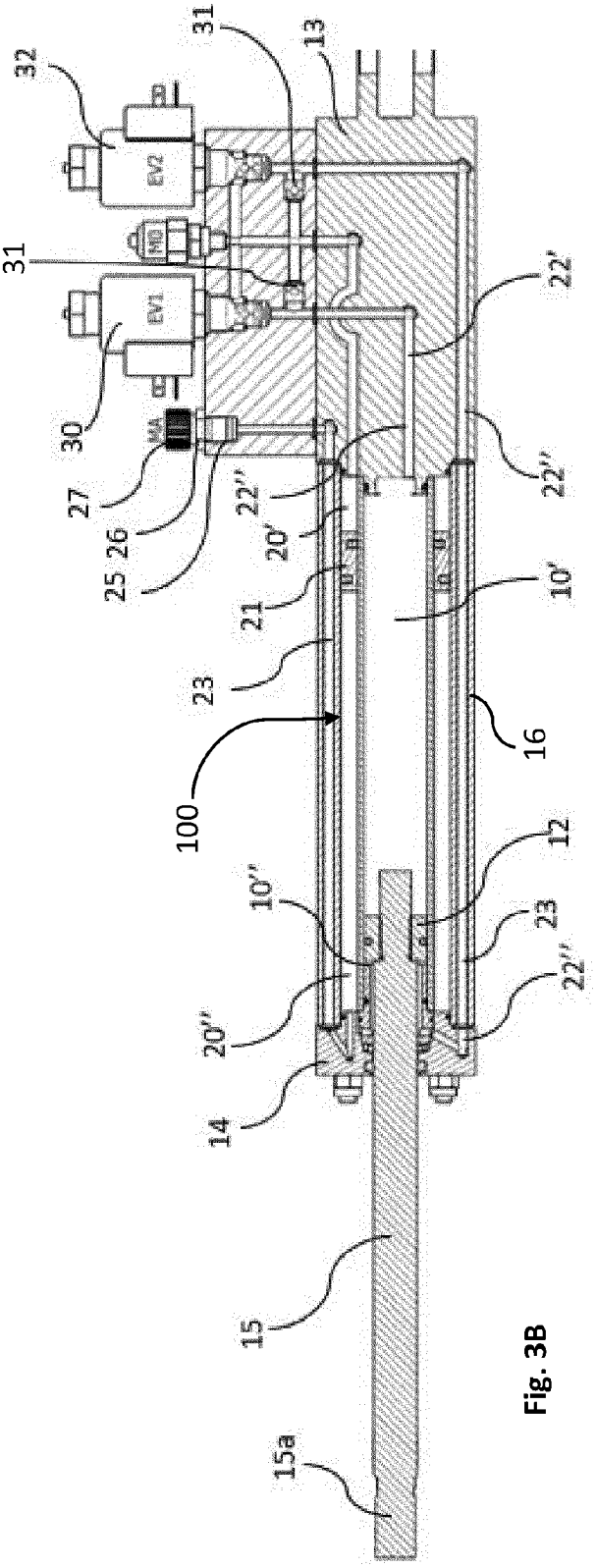
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Fig. 3B

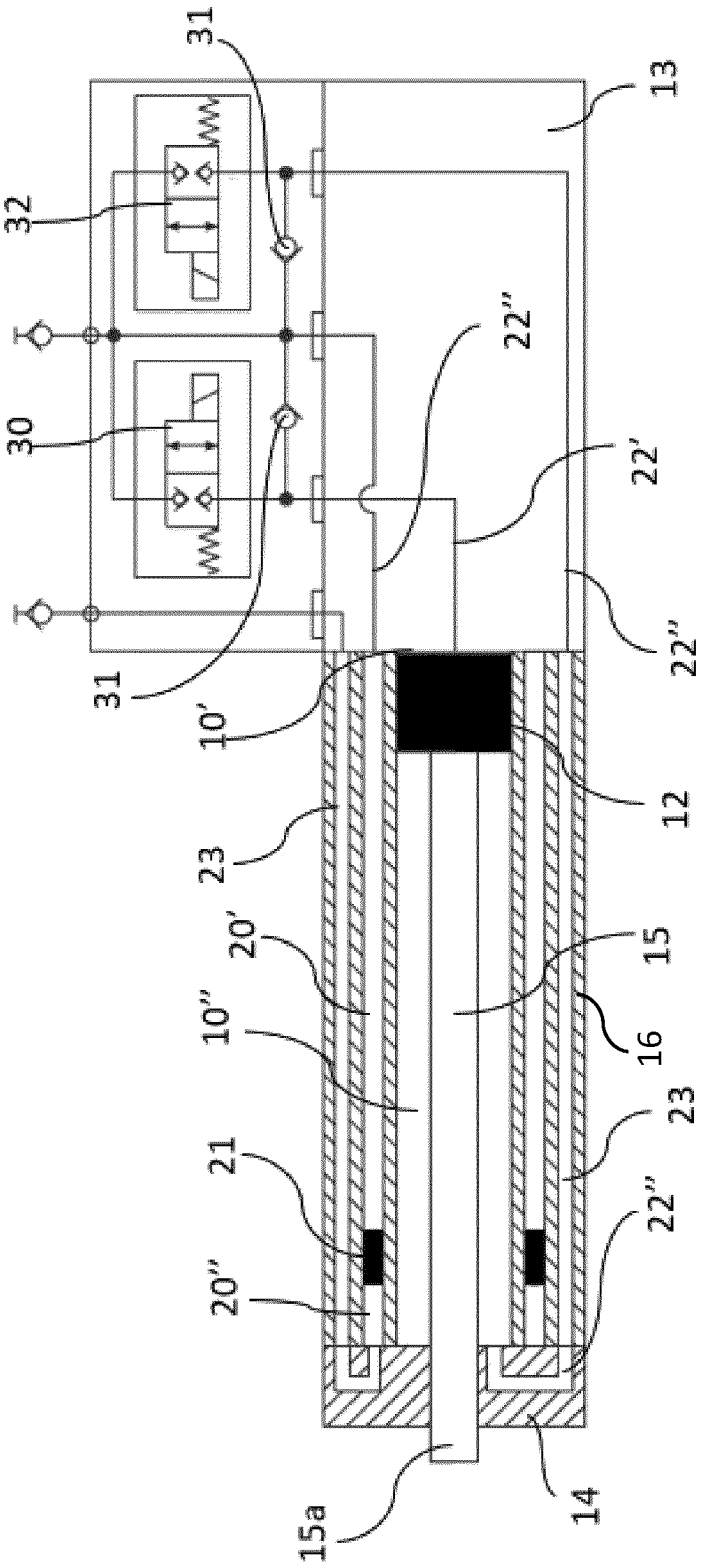

Fig. 3C

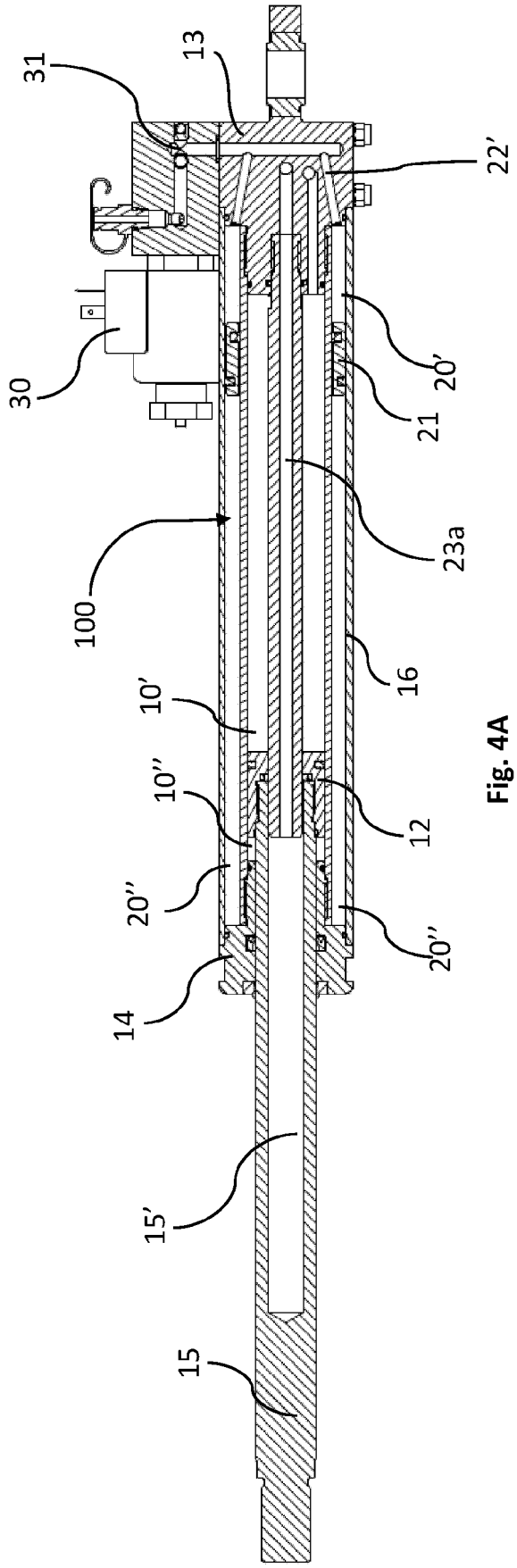
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Fig. 4A

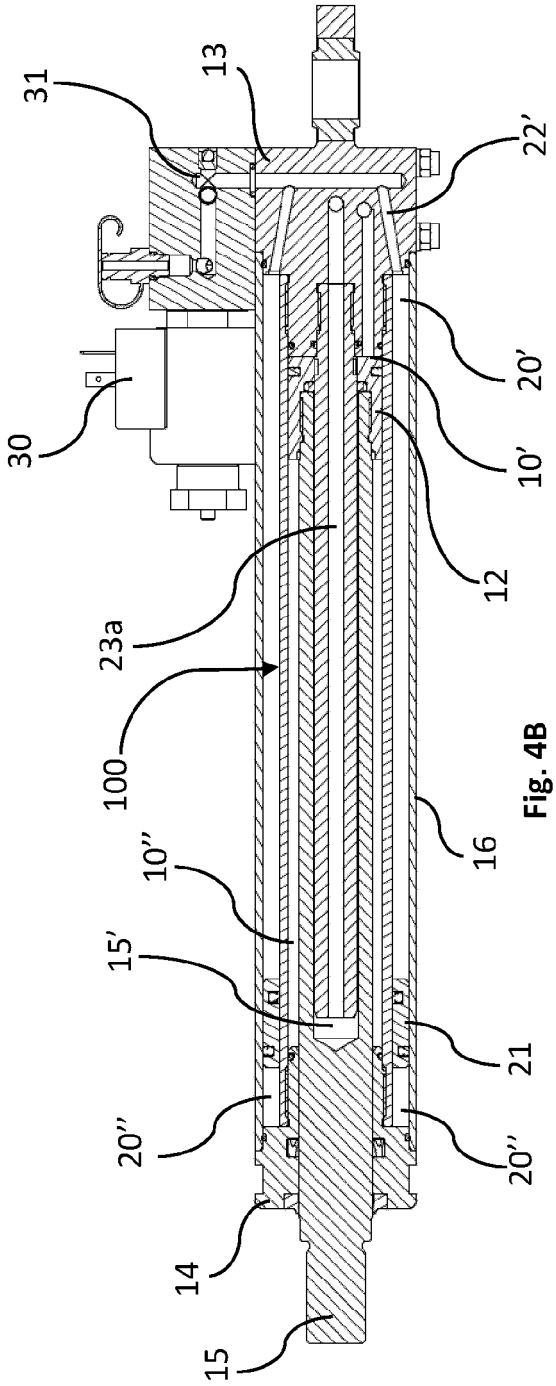
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Fig. 4B

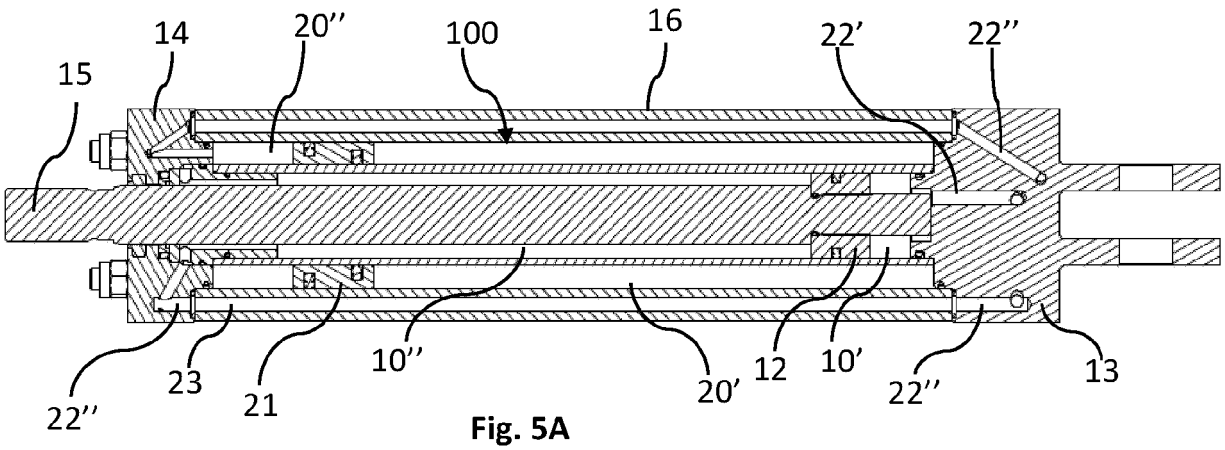

Fig. 5A

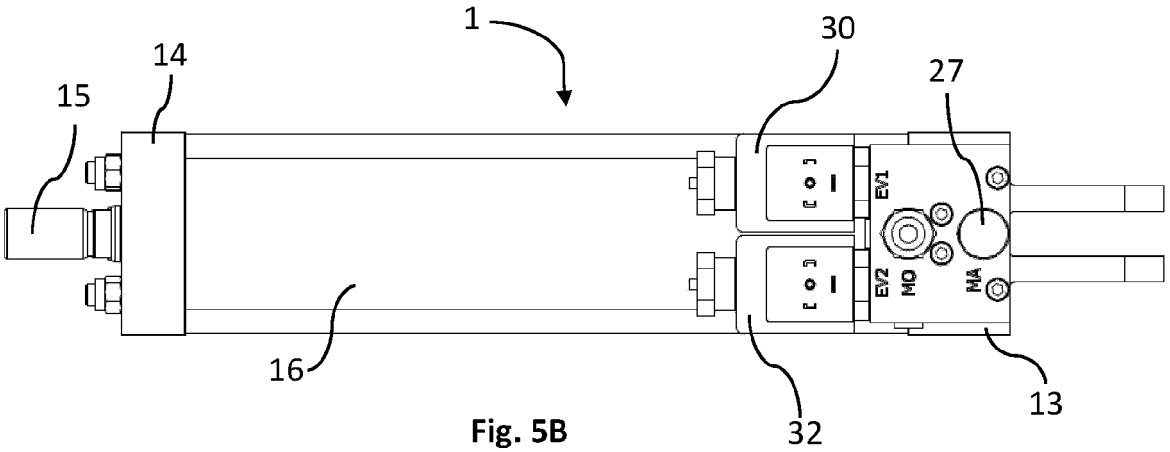

Fig. 5B

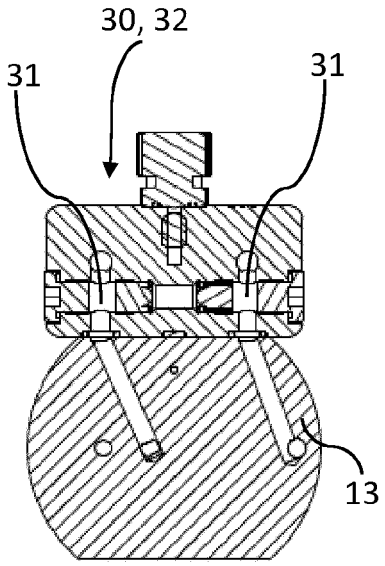

Fig. 5C

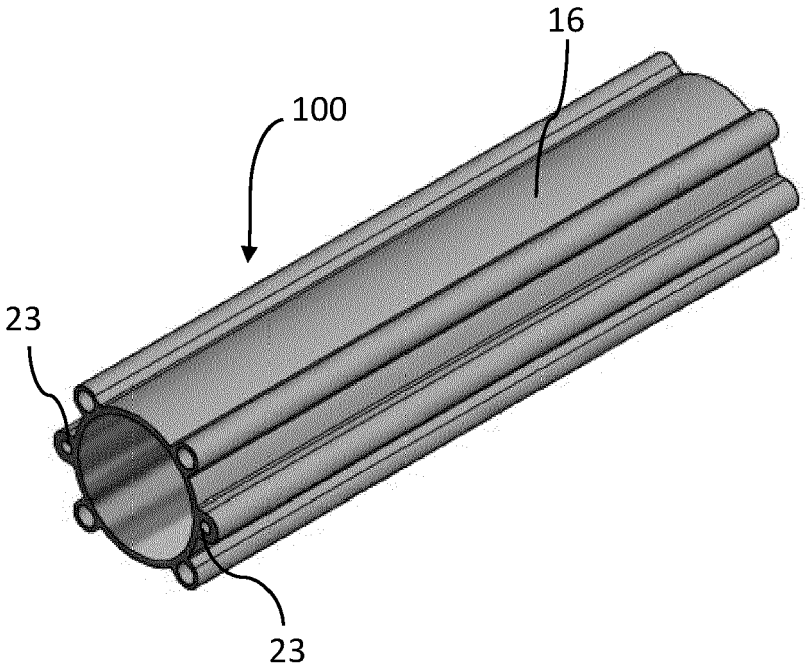

Fig. 6A

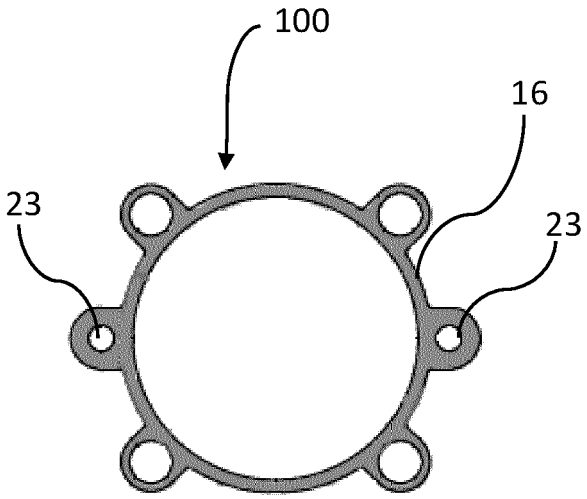

Fig. 6B

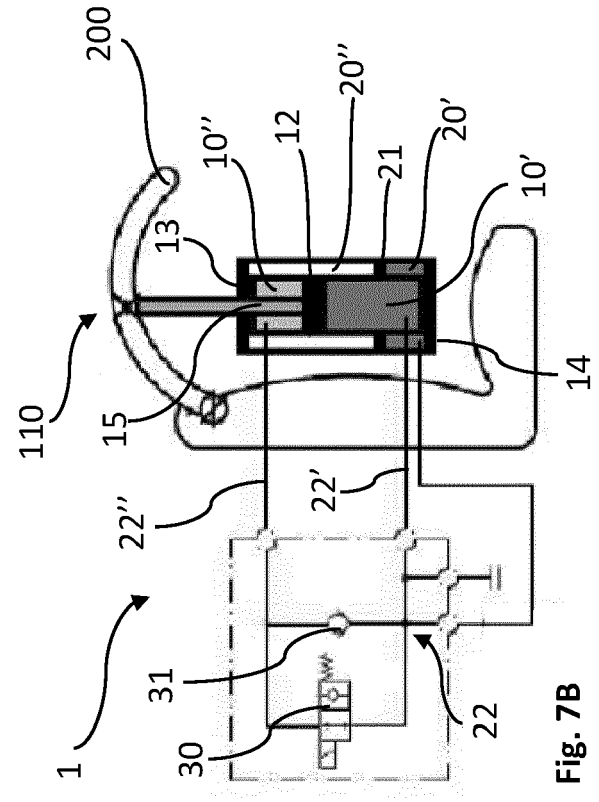

Fig. 7B

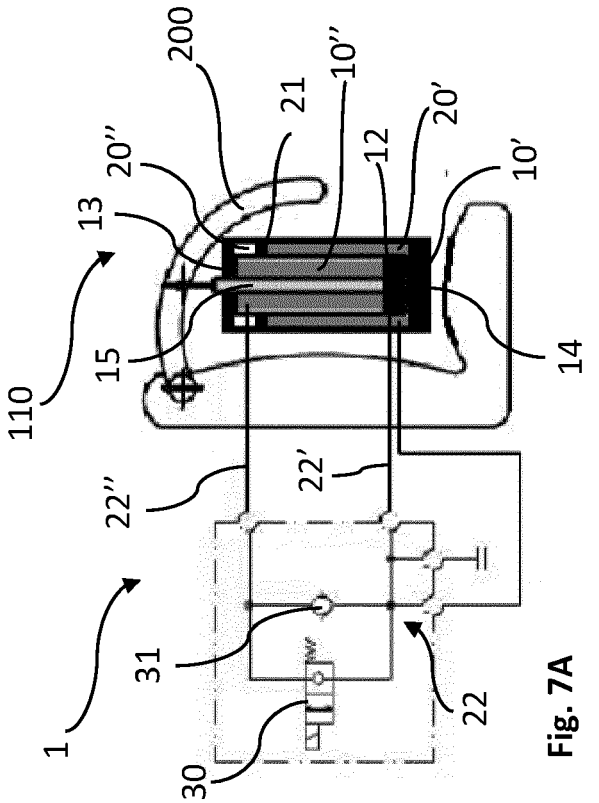

Fig. 7A

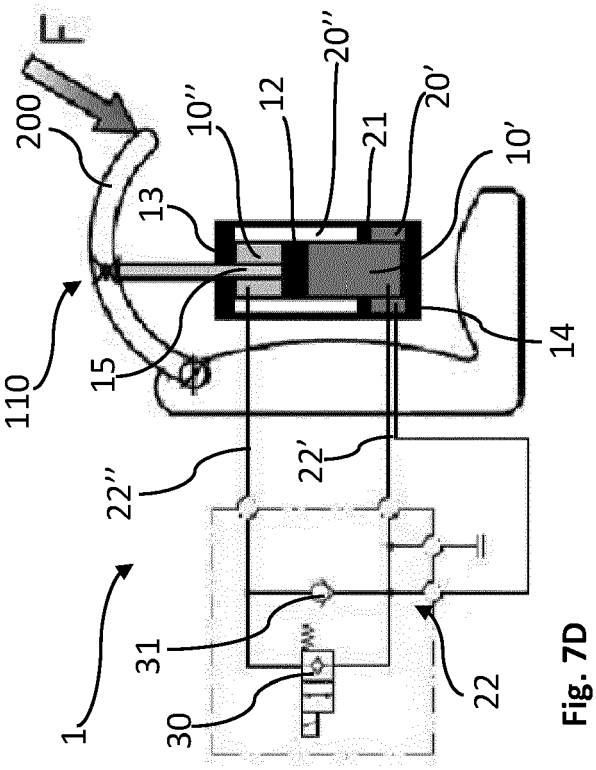

Fig. 7D

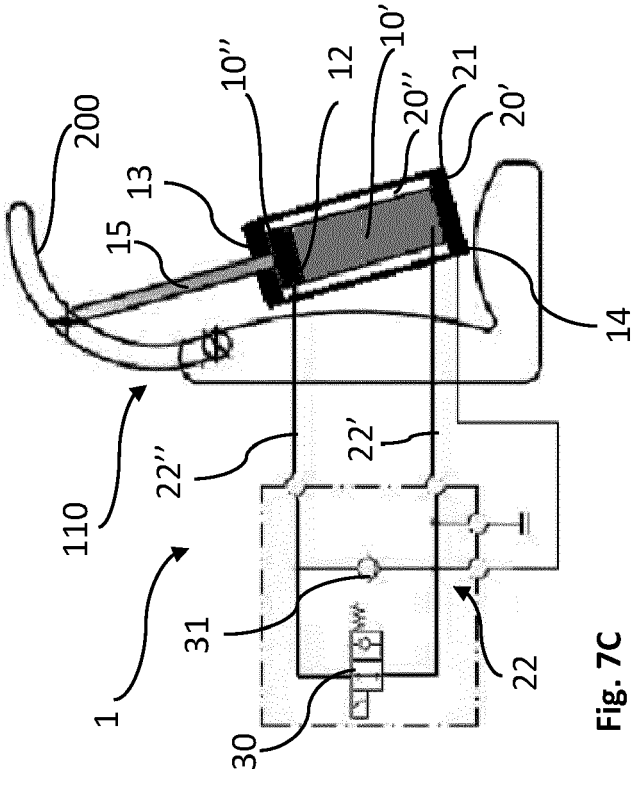

Fig. 7C

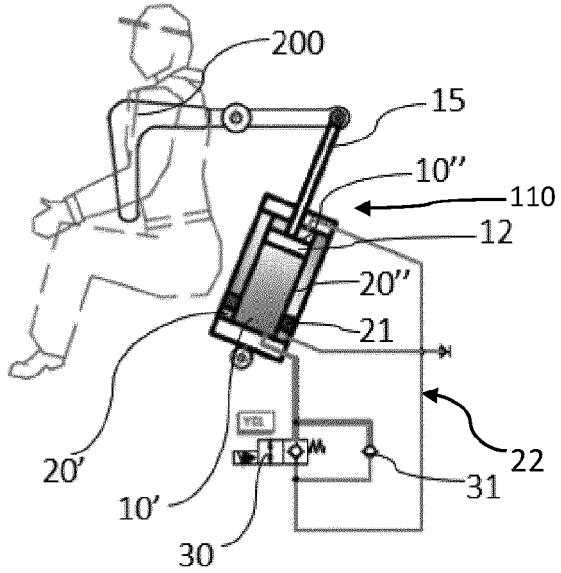

Fig. 8A

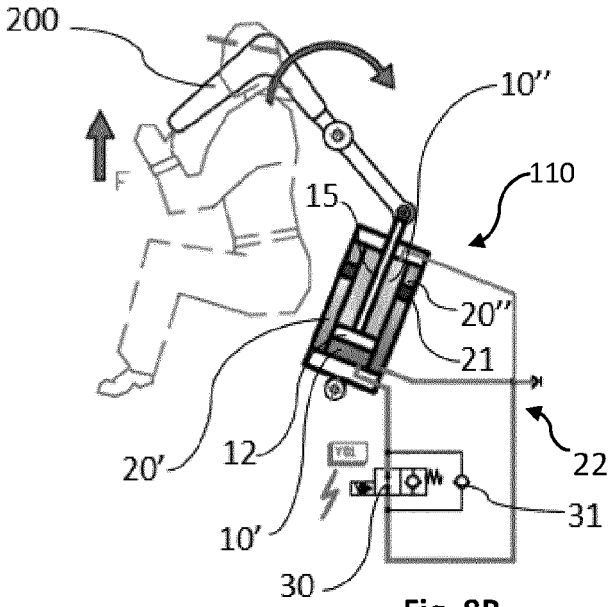

Fig. 8B

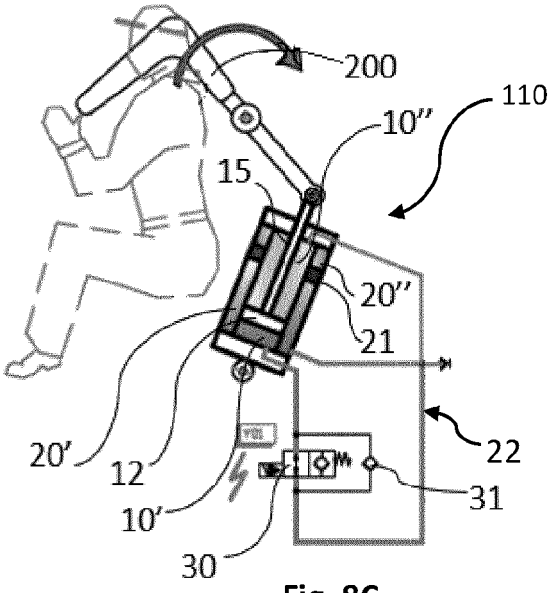

Fig. 8C

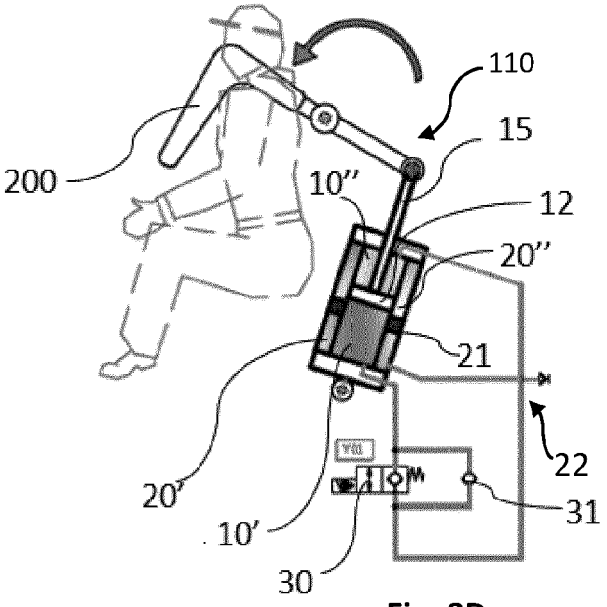

Fig. 8D

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 4368

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2019/063472 A1 (BLANDING DAVID E [US] ET AL) 28 February 2019 (2019-02-28)	1-4,6,7, 10-12, 14-17	INV. F15B1/02 A63G7/00 A63G31/00 F15B1/24 F15B11/00 F15B15/14 F15B15/20
A	* paragraphs [0038], [0067], [0078], [0083]; figures 1,2,3,4,5; examples 22,24,26,32,34,36,330,44,322,324 *	5,8,9, 13,18	
X	US 2007/157612 A1 (HE XINHUA [US]) 12 July 2007 (2007-07-12)	1-4,6-8, 10-13, 15-17	
A	* paragraphs [0038], [0040], [0041], [0048], [0052]; figures 3,5; examples 42,44,36,"valves",82,84,86 *	5,9,14, 18	
X	CN 104 564 865 A (UNIV JIAOTONG SOUTHWEST) 29 April 2015 (2015-04-29)	1-4,6-8, 10-13, 16,17	
Y	* figures 4,1,2; examples 7,a,b,14,19,18 *	1-4,6-8, 10-18	
A		5,9	
X	US 6 092 816 A (SEKINE CHIGAYA [JP] ET AL) 25 July 2000 (2000-07-25)	1-7,9, 10,14, 15,17,18	TECHNICAL FIELDS SEARCHED (IPC) F15B A63D A63G B60R
A	* col. 6, li.20-32;col. 10,li.66-col.11,li.11; figures 1,2,3; examples 1,106,4,104,5,105,3a,3b,103a,103b *	16	
Y,D	US 2021/069603 A1 (AHLE ALEXANDER [DE]) 11 March 2021 (2021-03-11) * paragraphs [0035], [0036], [0008], [0014]; claims 17,23; figures 1,2,3,5; examples 10,8,46,22,39,32,13,15,16,17,49,52 *	1-4,6-8, 10-18	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 September 2023	Deligiannidis, N

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EUROPEAN SEARCH REPORT

Application Number
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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	JP 6 170755 B2 (SUMITOMO PRECISION PROD CO) 26 July 2017 (2017-07-26) * paragraph [0016]; figures 3,4,5,2; examples 81,83,84,85 *	1-4,6-8, 10-12, 14,16,17 1-4,6-8, 10-18	
Y	DE 10 2019 216453 A1 (BOSCH GMBH ROBERT [DE]) 29 April 2021 (2021-04-29) * paragraphs [0005], [0010], [0012]; figures 1,2; examples 6,12,14,8 *	1-4,6-8, 10-18	
A	EP 1 703 142 A1 (DEERE & CO [US]) 20 September 2006 (2006-09-20) * see par. 0003 "spatial efficiency"; paragraphs [0002], [0003]; figures 3,4,1,2; examples 120,121,118,112a *	1,5-7,9	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 September 2023	Deligiannidis, N

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26-09-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019063472 A1	28-02-2019	BR 102018014563 A2	26-03-2019
		CA 3003277 A1	28-02-2019
		CN 109424597 A	05-03-2019
		EP 3450773 A1	06-03-2019
		ES 2947333 T3	07-08-2023
		JP 7190845 B2	16-12-2022
		JP 2019074203 A	16-05-2019
		US 2019063472 A1	28-02-2019
US 2007157612 A1	12-07-2007	EP 1806506 A2	11-07-2007
		US 2007157612 A1	12-07-2007
CN 104564865 A	29-04-2015	NONE	
US 6092816 A	25-07-2000	JP H10338017 A	22-12-1998
		US 6092816 A	25-07-2000
US 2021069603 A1	11-03-2021	CN 111050869 A	21-04-2020
		EP 3621711 A1	18-03-2020
		US 2021069603 A1	11-03-2021
		WO 2019229183 A1	05-12-2019
JP 6170755 B2	26-07-2017	EP 2816237 A1	24-12-2014
		JP 6170755 B2	26-07-2017
		JP 2015001297 A	05-01-2015
		US 2014366522 A1	18-12-2014
DE 102019216453 A1	29-04-2021	DE 102019216453 A1	29-04-2021
		EP 4048903 A1	31-08-2022
		US 2022397127 A1	15-12-2022
		WO 2021078727 A1	29-04-2021
EP 1703142 A1	20-09-2006	EP 1703142 A1	20-09-2006
		JP 4689478 B2	25-05-2011
		JP 2006258287 A	28-09-2006
		US 7104052 B1	12-09-2006

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Patent documents cited in the description

- US 20210069603 A **[0014]**