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# (54) Railway switch

Stellvorrichtung für eine Eisenbahnweiche

Commande d'aiguilles

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## Description

**[0001]** The present invention relates to a switch machine for railway and tramway switches or the like, which switch machine comprises
at least one switch point shifting actuator for displacing said points, using actuation drive means, between two limit positions, one of which positions is called normal position and the other of said two positions is called reverse position, and in which positions each of the two points is thrown or open relative to the closest rail, in alternation with the other point, the shifting stroke of the points between said two positions having a predetermined length, matching a given actuation stroke of said actuator,
and lock/unlock means for locking/unlocking said points in one of said limit positions, referred to as switch point lock means, which switch point lock means are driven into their unlocking state by said actuator, through an initial actuation overstroke, whose end coincides with the point unlocked state, and with the time at which said point shifting actuation stroke starts, whereas the end of the point shifting actuation stroke, in which one of the points is moved from an open position to a thrown position relative to the closest rail and the other point is moved from a thrown position to an open position relative to the closest rail, coincides with the time at which a final actuation overstroke, through which said actuator drives said point locking means into their locking state.

**[0002]** Prior art switch machines have the drawback that, when several actuators are provided along the switch, such actuators may be displaced in unsynchronized or inappropriate manner, which may possibly lead to the impossibility of properly completing displacement thereof.

**[0003]** This problem especially occurs switches for high speed railway lines, in which switches have relatively long points to provide such a wide radius of curvature as to withstand the high speed of the train. Unlike conventional switches, in which one switch machine is provided at the heels of the switch points and an additional switch machine is possibly provided at the frog of the switch, high speed switches as described hereinbefore have multiple switch machines arranged all along the points, to keep the latter in the proper curvature condition as the train runs therethrough. It will be apparent here that perfect synchronization of the drive steps of all actuators and particularly of the drive start-up step of all actuators is critical and challenging.

**[0004]** Also, switch machines typically have automatic lock means for locking the points in the thrown position, which means are automatically releasable when the machine is actuated to move the points from a starting thrown position to the opposing thrown position.

**[0005]** Typically, point locking means are driven into the locking and unlocking state by the actuator itself, e. g. by the translational motion of coupling means that couple the points to means for transferring/converting the motion of a motor. The locking/unlocking control is given by initial and final overstrokes of the actuators, during which the points keep still and only the point locking/unlocking means are actuated to enable/disable them.

**[0006]** These means for locking/unlocking points in their limit positions are known in the special railway jargon as switch point lock means.

**[0007]** The latter consist of point locking means which lock the points against any displacement applied thereon, and are operated as soon as a point reaches its closed or open position, i.e. its thrown or open position relative to the corresponding rail. When the point displacing motion to displace the point away from its thrown position against the rail and move the other point/s, previously not thrown, into said position, is applied by the actuator and the actuation drive means, through an overstroke generally run by the point pulling rods, the lock means are switched to an idle position. The lock/unlock means generally consist of hook-like means or latches which are moved into an active or inactive locking state according to the position of the point with which they are connected relative to the rail. The displacement of the hook-like means or latches is controlled by cams that are displaced with the pulling rods and act upon said hook-like or latch means by displacing them, according to the position of the point and the stroke being run, from a position of engagement with a hook-receiving or retaining seat to a position of disengagement from said seat.

**[0008]** The switch point lock devices and the latches may have any construction whatever, for instance as disclosed in any one of EP 1 024 987 B2, EP 1 219 521 B1 and EP 1 594 732 B1 or of other types.

**[0009]** Switches typically have intermediate actuators, which are actuated by actuators that exert greater forces on some of them and smaller forces on others; in this case, synchronization of actuators actuated with different levels of force is difficult, because the initial displacement step, that corresponds to the unlocking stroke of the switch point lock members, requires approximately the same force over all the intermediate actuators, and uneven displacement occurs along the switch.

**[0010]** The present invention has the object of obviating the above drawbacks of prior art switch machines by providing a device as described hereinbefore.

**[0011]** The invention fulfills the above objects with a device as described hereinbefore, which also comprises means for adjusting the force exerted by said actuator, for setting said force at different levels for at least two of said initial actuation overstroke, said point shifting actuation stroke and said final actuation overstroke.

**[0012]** The provision of variable-force actuators affords the important advantage that the different parts of the switch may be set with the force specially required for the different operating steps of each switch machine, thereby allowing perfect synchronization of point motion all along the switch.

**[0013]** In one example, said means for adjusting the actuation stroke operate to cause said actuator to exert

a first predetermined actuation force during the initial actuation overstroke to unlock said point switch lock means, a second predetermined actuation force during said point shifting actuation stroke and a third predetermined actuation stroke during the final actuation overstroke to lock said point lock means.

**[0014]** This will ensure the proper force or thrust from the actuator for each operating step of the switch machine, and will prevent any advance or delay in the completion of the initial unlocking step of the switch point lock means.

**[0015]** In a particular embodiment, said first predetermined actuation force, said second predetermined actuation force and said third predetermined actuation force are different.

**[0016]** Thus, the force exerted by the actuator may be calibrated in a different manner for each operating step of the switch, each force being specific to the step in which it is exerted and being different from the force exerted in the other steps.

**[0017]** In an alternative embodiment, two of said first predetermined actuation force, said second predetermined actuation force and said third predetermined actuation force are equal to each other and different from the other actuation force.

**[0018]** This will allow the first predetermined actuation force, and the second predetermined actuation force to be equal to each other and different from the third actuation force: Thus, the force exerted when driving the switch point lock means into their unlocking state may be equal to the force exerted for shifting points, whereas the actuation of the switch point lock means during the final overstroke occurs with a different force.

**[0019]** Alternatively, the first predetermined actuation force, and the third predetermined actuation force may be equal to each other and different from the second actuation force: Thus, the forces exerted to drive the switch point lock means into their unlocking and locking states during the initial and final actuation overstrokes are equal to each other and different from the actuation force exerted during the actuation point shifting stroke.

**[0020]** In a preferred embodiment, the second predetermined actuation force, and the third predetermined actuation force are equal to each other and different from the first actuation force.

**[0021]** Particularly, in a preferred example, said first predetermined actuation force is greater than said second predetermined actuation force and said third predetermined actuation force.

**[0022]** A different thrust, particularly a greater thrust is required to drive the switch point lock means into their unlocking state than the trust required to move the points from the initial to the final thrown positions and for later actuation of the switch point lock means into their unlocking state. Initial synchronous unlocking of the switch point lock means causes each intermediate actuator to start moving the points when all the other intermediate actuators have already completed the switch point lock unlocking step. This arrangement prevents an intermediate actuator that locks the switch point lock means from being hindered by point displacement stresses from the other intermediate actuators, and prevents the switch from being locked at the start of the actuation. Furthermore, since all the intermediate actuators are free to move the point, the displacement force exerted by each intermediate actuator on the point is utilized as a positive feedback on the driving action of the other intermediate actuators, and point displacement can be completed with smaller efforts. During switch point displacement, and at the end of the switch displacement step, while locking the switch point lock means, it is advantageous to keep different force levels on the various intermediate actuators, to ensure that the intermediate actuators are sensitive to any obstacle interposing between each point and its rail, that might put railway traffic in danger. Therefore, when the effort required of the points to complete displacement at each intermediate actuator reaches a given level, possibly different for each actuator, the intermediate actuators are required to be unable to complete their displacement whereas if the effort remains below such level, the actuators shall properly complete their displacement and lock the switch point lock means.

**[0023]** As regards construction, various alternative mechanical or hydraulic embodiments may be provided, which are described below in the description of the particular example.

**[0024]** In one example, said actuator is a hydraulic actuator connected to at least one delivery branch and at least one return branch of a closed hydraulic fluid circulation circuit.

**[0025]** Either a double-acting linear actuator or two independent oppositely operating linear actuators may be provided, which are connected to the delivery branches of a hydraulic circuit.

**[0026]** Fluid is fed to actuators by a motor-driven pump, which draws the fluid from a reservoir and circulates the fluid in a closed circuit having a delivery branch and a return branch.

**[0027]** In order to obtain displacement from the normal position to the reverse position and from the reverse position to the normal position, electrically controlled valves are provided that can be switched to connect the delivery of the circulation pump, i.e. the delivery branch of the circuit to the inlet of one of the two actuators or to one the two inlets of a double-acting actuator, in a first state, and to the inlet of the other of two actuators or the other of the inlets of the double-acting actuator in a second state. At the same time, the actuator that is not fed with fluid or the inlet of the double-acting cylinder that is not connected with the delivery branch is connected to the suction of the circulation pump from the return branch of the circulation circuit.

**[0028]** A fluid reservoir is used for drawing said fluid and fill the closed circuit or for collecting the fluid discharged from one or more drains of said circuit.

**[0029]** In a preferred embodiment, said force adjust-

ment means consist of the actuator itself, which comprises at least one pushing or pulling rod adapted to be connected to one or both of said points and to be displaced from a minimum-extension position to a maximum-extension position to run said initial actuation overstroke, said point shifting actuation stroke and said final actuation overstroke and is designed so that, given a pressure of the fluid, it exerts said first predetermined actuation force along the length of rod displacement that corresponds to said initial actuation overstroke, said second predetermined actuation force along the length of rod displacement that corresponds to the point shifting actuation stroke, and said third predetermined actuation force along the length of rod displacement that corresponds to said final actuation overstroke.

**[0030]** Advantageously, said actuator comprises an outer cylinder and an inner cylinder, the outside diameter of said inner cylinder being substantially equal to the inside diameter of said outer cylinder, the height of said inner cylinder being smaller than the height of said outer cylinder and said inner cylinder being disposed coaxially inside said outer cylinder to be displaceable therein between two end positions defined by the inner extension of said outer cylinder, a piston being also provided in said inner cylinder and being connected to said rod and displaceable between two and positions defined by the inner extension of said inner cylinder, said rod being adapted to extend through an opening formed in at least one head surface of said inner cylinder and at least one head surface of said outer cylinder.

**[0031]** Said first predetermined force is exerted by the displacement of said inner cylinder within said outer cylinder from a first end position to a second end position, and said second predetermined force and said third predetermined actuation force, which are equal, are exerted by the displacement of said piston within said inner cylinder from a first end position to a second end position.

**[0032]** The invention also relates to a housing case for the operating units which is of the same size as a tie and adapted to be installed like a tie.

**[0033]** Thus, the switch machine is connected to the rails and the switch points, and is advantageously positioned like a tie.

**[0034]** In a further example, the outer surface of the switch machine has a covering on at least part of it, which covering consists of materials having railway ballast interface surface characteristics similar to concrete.

**[0035]** The present invention relates to a method of operating a switch machine for railway and tramway switches or the like, which switch machine comprises at least one switch point shifting actuator, which actuator displaces said points, using actuation drive means, between two limit positions, one of which positions is called normal position and the other of said two positions is called reverse position, and in which positions each of the two points is thrown or open relative to the closest rail, in alternation with the other point, the shifting stroke of the points between said two positions having a predetermined length, matching a given actuation stroke of said actuator,
and lock/unlock means for locking/unlocking said points in one of said limit positions, referred to as switch point lock means, which switch point lock means are driven into their unlocking state by said actuator, through an initial actuation overstroke, whose end coincides with the point unlocked state, and with the time at which said point shifting actuation stroke starts, whereas the end of the point shifting actuation stroke, in which one of the points is moved from an open position to a thrown position relative to the closest rail and the other point is moved from a thrown position to an open position relative to the closest rail, coincides with the time at which a final actuation overstroke, through which said actuator drives said point locking means into their locking state,
which method comprises the steps of:

a) actuating said actuator, so that it can exert a first predetermined force during the initial actuation overstroke for unlocking said switch point lock means;
b) further actuating said actuator, so that it can exert a second predetermined actuation force during said point shifting actuation stroke;
c) further actuating said actuator, so that it can exert a third predetermined force during the final actuation overstroke for locking said switch point lock means.

**[0036]** In one embodiment, said first predetermined force is greater than said second predetermined force and said third predetermined force.

**[0037]** In a preferred embodiment, said second predetermined force and said third predetermined force are equal.

**[0038]** The invention further relates to a switch machine for railway and tramway switches or the like, having a housing case for its operating units of the same size as a tie and adapted to be installed like a tie.

**[0039]** Switch machines of this type are known and widely used and generally comprise a metal case, e.g. formed by iron casting or structural steelwork, with sheet bending, welding, etc.

**[0040]** Prior art switch machines of this type usually have a protective coating, consisting of plain paint.

**[0041]** Such switch machines have the drawback of having railway ballast interface surface characteristics that cause ballast to tend to move due to the vibrations induced by running trains.

**[0042]** This is due to the surface characteristics of the metal material, which are actually unchanged by painting and cause the switch machine to have a very different behavior from wooden or concrete ties.

**[0043]** When these switch machines remain in operating conditions for a long time, the ballast may be significantly displaced and create gaps below and around the switch machine, thereby affecting rail stability and support, and requiring earthing up of the ballast.

**[0044]** The present invention has the purpose of obvi-

ating the above drawbacks of prior art switch machines with a switch machine as described above, whose outer surface further has a covering on at least part of the case, which covering consists of a material having railway ballast interface surface characteristics similar to concrete.

**[0045]** Particularly, said surface characteristics are roughness, friction coefficient and hardness.

**[0046]** In one embodiment, said material has a hardness ranging from 60 to 100 Shore, preferably from 70 to 85 Shore, particularly of 75 Shore.

**[0047]** In a further embodiment, said material is an epoxy resin.

**[0048]** In a further example, said epoxy resin is filled with ceramic beads.

**[0049]** In yet another example, said material has a thickness ranging from 2 to 10 mm, preferably from 4 to 8 mm, preferably of 6 mm.

**[0050]** The covering with the above mentioned properties imparts concrete-like ballast interface characteristics and overcomes the above mentioned ballast displacement problems.

**[0051]** Also, the covering ensures an excellent protection of the switch machine, so that the expected life of the switch machine may be increased to 30 years.

**[0052]** The covering may be applied to the outer surface of the case in any manner whatever.

**[0053]** Particularly, in a first example, said material is applied to said outer covering surface by manual and/or automatic spreading.

**[0054]** In a further embodiment, said material is applied to said outer surface of the case by embedment, i.e. by placing said case in a negative mold that has an inner mold surface mating with said outer surface of the case, said negative mold being previously filled with said material in a fluid phase.

**[0055]** Such second application method is particularly advantageous in many applications, in which the construction of molds is economically supported by great numbers of uses thereof.

**[0056]** The present invention also relates to a hollow tie for railway tracks or the like, consisting of an case of substantially the same size as a tie, which hollow tie has a covering on at least part of the outer surface of said enclosure, which covering consists of a material having railway ballast interface surface characteristics similar to concrete.

**[0057]** The above advantageous ballast interface characteristics of the switch machine apply not only to switch machines but to all wayside units or railway ties or the like.

**[0058]** All the above switch machine characteristics also apply to said hollow tie.

**[0059]** These and other features and advantages of the invention will be more apparent from the following description of a few embodiments shown in the accompanying drawings, in which:

Fig. 1 is a general view of an exemplary switch machine of the present invention;

Fig. 2 is an exploded view of the switch machine in which the various components are shown;

Fig. 3 is partially sectional side view of the switch machine;

Fig. 4 is a top view of the switch machine;

Fig. 5 is a general view of an exemplary actuator;

Fig. 6 is an axially sectional view of the actuator;

Fig. 7 is a cross sectional view of the actuator;

Fig. 8 is a detail view of the actuator;

Figs. 9a, 9b, 9c, 9d and 9e show the various operating steps of the actuator;

Figures 10a to 10d show the various operating steps of the switch machine.

**[0060]** Figures 1 to 4 show the switch machine 1, which comprises a switch point shifting actuator, particularly a hydraulic cylinder 2.

**[0061]** The actuator 2 displaces the points, using actuation drive means, between two limit positions, one of which positions is called normal position and the other of said two positions is called reverse position, and in which positions each of the two points is thrown or open relative to the closest rail, in alternation with the other point.

**[0062]** The shifting stroke of the points between said two positions having a predetermined length, matches a given actuation stroke of the actuator 2.

**[0063]** Lock/unlock means are further provided for locking/unlocking said points in one of said limit positions, referred to as switch point lock means, which switch point lock means are driven into their unlocking state by said actuator 2, through an initial actuation overstroke, whose end coincides with the point unlocked state, and with the time at which said point shifting actuation stroke starts, whereas the end of the point shifting actuation stroke, in which one of the points is moved from an open position to a thrown position relative to the closest rail and the other point is moved from a thrown position to an open position relative to the closest rail, coincides with the time at which a final actuation overstroke, through which said actuator 2 drives said point locking means into their locking state.

**[0064]** The switch machine 1 and at least the actuator 2 and said actuation drive means and at least said switch point lock means have a modular construction.

**[0065]** Said switch point lock means consist of two point pulling and locking modules 30 and 31, which are located at the opposite ends of said hydraulic cylinder 2.

**[0066]** Each point pulling and locking module has its own case or frame, which case or frame has means for fastening it in predetermined positions, cooperating with coincident fastener means, in predetermined positions on the tie-like box module 100 in which the switch machine 1 is housed.

**[0067]** The tie-like box module 100 consists of a C or Ω-shaped section, open at its top as a channel and closed by one or more covers.

**[0068]** Particularly, the tie-like box module 100 has lat-

eral longitudinal fins 101 having holes in predetermined positions for receiving cover elements and/or lateral flanges for fastening operating modules such as the point pulling and locking modules 30 and 31.

**[0069]** The point pulling and locking modules 30 and 31 also have holes at predetermined positions coinciding with the holes of the tie-like box module 100 and are mounted in a predetermined position with reference to the tie-like box module using fastener means.

**[0070]** The ends of the channel section are closed by end heads 130 that may also be removably fastened or possibly welded.

**[0071]** A portion of the cover of the tie-like box module 100 is formed by the upper cover of the modules, whereas the portions of the tie-like box module 100 that are open at their top as they are not filled by operating units are closed by a plurality of cover elements having the same size as said open or exposed parts. Such cover elements are referenced 260, 261 and 262.

**[0072]** One end of the switch machine 1 is designed for connection with fluid supply lines and/or power lines for any electronic diagnostic system or the like.

**[0073]** Each of the point pulling and locking modules 30 and 31 has a pulling rod 144 which is dynamically connected to pulling sliders 145 that project out of an upper fastening plate 146. The fastening plate 146 has lateral holes for fixation to the lateral longitudinal fins 101 of the tie-like box module 100 and also forms the closing cover of said tie-like box module 100 when the pulling and locking module is mounted to the tie-like box module itself. The pulling sliders 145 have a positive geometry mating with the negative seat in the brackets for connection to the points.

**[0074]** The pulling rod 144 has a removable terminal for connection to the actuator 2 or to further actuation drive means.

**[0075]** Means are further provided for adjusting the actuation stroke exerted by the actuator 2, which operate to cause the actuator 2 to exert a first predetermined actuation force during the initial actuation overstroke to unlock said point switch lock means, a second predetermined actuation force during said point shifting actuation stroke and a third predetermined actuation stroke during the final actuation overstroke to lock the point lock means.

**[0076]** The actuator 2 may consist of any kind of motor, such as an electric motor and a kinematic drive chain, which kinematic drive chain may be of any type and consist, for instance, of a screw-and-nut or recirculating-ball assembly.

**[0077]** In this case, the actuation force exerted by the actuator 2 may be controlled by setting the force to be generated by the motor. In an alternative configuration, said kinematic drive chain may change the drive ratio according to the stroke that has been run: a first drive ratio is used for the initial actuation overstroke, a second drive ratio is used for the point shifting actuation stroke, and a third drive ratio is used for the final actuation overstroke.

**[0078]** In the illustrated example, the actuator 2 is a hydraulic actuator, particularly a hydraulic cylinder 2, which is connected to at least one delivery branch and at least one return branch of a closed hydraulic fluid circulation circuit.

**[0079]** In one example, the means for adjusting the actuation force exerted by the actuator 2 consist of means for setting the fluid delivery to the actuator 2, particularly comprising at least one adjustable flow pump.

**[0080]** The pump may be a positive-displacement pump controlled at a variable speed and having a predetermined fixed displacement.

**[0081]** As used herein, the term positive-displacement pump is intended to designate a pump having a suction/compression chamber of predetermined volume, which changes fluid delivery according to the speed of actuation of a suction/compression member. A particular positive-displacement pump is the piston or gear pump. In this case, the volume of pressure fluid that can be delivered per unit of time is determined by the displacement and number of suction/compression strokes of the piston. Nevertheless, other types of pumps may be considered as positive-displacement pumps according to the definition as used herein, such as rotor pumps and/or pumps having suction/compression members based on the Wankel engine principle, in which the suction/compression chamber has a fixed and predetermined volume.

**[0082]** Alternatively, two or three or more pumps with different displacements may be provided, one or more of which are designed to be alternately and specially driven for actuating a particular operating step of the switch machine 1. The use of multiple positive-displacement pumps is generally disclosed in EP 2192020.

**[0083]** In the example as particularly shown in Figures 5 to 10d, said force adjustment means consist of the actuator 2 itself.

**[0084]** The actuator 2 consists of a hydraulic cylinder 2 which comprises at least one pushing or pulling rod 20 adapted to be connected to one or both of said points and to be displaced from a minimum-extension position to a maximum-extension position.

**[0085]** Particularly, the hydraulic cylinder 2 is a double acting cylinder, having two supply inlets, each of said supply inlets being adapted to be alternately connected to the delivery of the fluid circuit.

**[0086]** The rod 20 extends beyond both end walls of the hydraulic cylinder 2 and can be displaced from a position in which one part is in the minimum-extension state and the opposite part is in the maximum-extension state to a position in which the first part is in the maximum-extension state and the opposite part is in the minimum-extension state.

**[0087]** The ends of the rod 20 are removably connected to the pulling rods 144 of the point pulling and locking modules 30 and 31.

**[0088]** The displacement of the rod 20 drives the initial actuation overstroke, the point shifting actuation stroke

and the final actuation overstroke, as shown in Figures 10a to 10d.

**[0089]** The hydraulic cylinder 2 is so designed that, given a pressure of the fluid, it exerts said first predetermined actuation force along the length of displacement of the rod 20 that corresponds to the initial actuation overstroke, said second predetermined actuation force along the length of displacement of the rod 20 that corresponds to the point shifting actuation stroke, and said third predetermined actuation force along the length of displacement of the rod 20 that corresponds to the final actuation overstroke.

**[0090]** As clearly shown in Figures 6 and 7, the hydraulic cylinder 2 comprises an outer cylinder 21 and an inner cylinder 22, the outside diameter of the inner cylinder 22 being substantially equal to the inside diameter of the outer cylinder 21, the height of the inner cylinder 22 being smaller than the height of the outer cylinder 21 and the inner cylinder 22 being disposed coaxially inside the outer cylinder 21.

**[0091]** Thus, the inner cylinder 22 is displaceable in a fluid-tight manner in the outer cylinder 21 between two end positions defined by the inner extension of the outer cylinder 21.

**[0092]** A piston 23 is further provided in the inner cylinder, which is connected to the rod 20 and is displaceable between two end positions defined by the inner extension of the inner cylinder 22.

**[0093]** The rod 20 is adapted to extend through openings formed in the head surfaces of the inner cylinder 22 and the head surfaces of the outer cylinder 21.

**[0094]** In one example, the piston 23 has a fluid-tight connection with the inner cylinder 22 which in turn has a fluid-tight connection with the outer cylinder 21.

**[0095]** The piston 23 is coupled to the rod 20 in a central position thereof, to define two opposite parts of the rod 20, which extend through the heads 322 and 323 of the inner cylinder 22 and are guided in a fluid-tight manner in the heads 320 and 321 of the outer cylinder 21.

**[0096]** The passage from the inner cylinder to the delivery or return of the actuator 2 may occur in various manners.

**[0097]** Referring to Figures 6 to 9e, such passage particularly occurs through radial fluid supply/discharge openings or passages 37, 38, at the two heads 320 and 321 of the outer cylinder respectively.

**[0098]** In the illustrated embodiment, the cylinder has two fluid supply/discharge openings 37 formed in the first head 320, and two fluid supply/discharge openings 38 formed in the second head 321, to be used if multiple actuators are connected in parallel, so that, for instance, during fluid supply, the fluid coming from an upstream actuator in the supply line enters a first opening and exits a second opening to supply a downstream actuator in the supply line. Thus, the pressure fluid is delivered to all the actuators. The same principle applies to the fluid outlet of the cylinder.

**[0099]** In the same case of parallel supply of multiple actuators, a single fluid supply/discharge opening 37 and single fluid supply/discharge opening 38 may be also alternatively provided, with the provision of T-fittings to create parallel supply branches for each actuator 2.

**[0100]** The fluid supply/discharge openings 37 communicate with a radial opening 132 in the head 320, which is designed to communicate with the interior of the outer cylinder 22 through an annular slot 33 between the through rod 20 and the head 320.

**[0101]** An annular slot 34 is also provided between the head 322 and the rod 34, to put the chamber of the outer cylinder 21 in communication with the chamber of the inner cylinder 22.

**[0102]** The cylinder has the same structural parts in the opposite part, at the head 321.

**[0103]** In an initial limit position, the head 322 abuts against the corresponding head 320 and the piston 23 is at the head 322.

**[0104]** Upon delivery, the supply fluid flows through the radial opening 132 and through the annular slot 33 thereby causing a pressure increase.

**[0105]** Due to such initial pressure increase, the fluid exerts a force on the head surface 322 of the inner cylinder 22 facing toward the chamber of the outer cylinder 21, which force is greater than the force exerted on the piston 23 through the annular slot 34, as the head surface 322 of the inner cylinder 22 facing toward the chamber of the outer cylinder 21 is much larger than the surface of the piston 23 available to the fluid through the annular slot 34.

**[0106]** Thus, the fluid starts to fill the chamber of the outer cylinder 21, thereby pushing the inner cylinder 22 and hence the piston 23 toward the opposite head 321.

**[0107]** The inner cylinder 22 and the piston 23 are held in joined relation as they move by the limit stop abutment for the piston 23 on the head 322.

**[0108]** Once the inner cylinder abuts against the head 321, the pressure fluid starts to move the piston 23 in the inner cylinder 22 toward the head 323, thereby progressively filling the chamber of the inner cylinder 22 by flowing through the annular slot 34.

**[0109]** The fluid contained in the cylinder when such movement starts is simultaneously ejected from the return camber through the radial opening 132 that is also provided in the head 321.

**[0110]** The return occurs with much the same process as described above, except that the delivery and the discharge 37, 38 are reversed and the piston 23 and the rod 20 are pushed in an opposite direction. The movement and the parts that cause it is as described above concerning displacement in a first direction.

**[0111]** The various displacement steps are as shown in detail in Figures 9a to 9e.

**[0112]** The synchronous overstroke of the inner cylinder 22 and the piston 23 corresponds to the steps of Figures 9a, 9b and 9c, which show the passage from a first position in which the piston 23 is at the head 322 and the inner cylinder 22 is at the head 320 to a second po-

sition in which the piston 23 is still at the head 322 but the inner cylinder 22 abuts against its limit stop on the head 321 of the outer cylinder 21, thereby completing its movement.

**[0113]** In this condition, the rod 20 has had, in this construction example, a total displacement of 50 mm.

**[0114]** The further flow of fluid through the passage 132 of the head 320 acts upon the piston 23.

**[0115]** The displacement of the piston 23 to the position as shown in Figure 9d corresponds to a switch point displacement of 115 mm, i.e. a total displacement of the rod stem 20 of 165 mm.

**[0116]** Further displacement of the piston 23 occurs in the overstroke step for locking the switch point lock members of the actuator 2 and takes a further 50 mm distance to abutment on the head 323 of the inner cylinder 22, with 215 mm displacement of the stem 20 in total. The hydraulic cylinder 2 is mounted in the switch machine 1 in joined relation with the tie-like box module 100 by means of two coupling elements 24 attached at the ends of the hydraulic cylinder 2 and adapted to be fixed to the bottom of the switch machine 1.

**[0117]** The hydraulic cylinder 2 also comprises a plurality of bars, preferably four, which couple together the two coupling elements 24 and prevent any relative translational and rotational movement of the two coupling elements 24, thereby ensuring firm fixation of the hydraulic cylinder to the switch machine 1 also during the operating steps thereof.

**[0118]** In an alternative example, not shown, two or three or more hydraulic cylinders are provided, one or more of which are designed to be alternately and specially driven for actuating a particular operating step of the switch machine 1.

**[0119]** The operation of the switch machine of the invention is illustrated in detail in the example of Figures 10a, 10b, 10c and 10d, in which various performances of the hydraulic cylinder 2 are calibrated according to the actuation steps of the switch machine 1, as different steps require different forces or pressures, that must be properly exerted to avoid synchronization problems in point shifting along the switch, where many actuators are provided.

**[0120]** Figures 10a to 10d are detail views of the switch point lock means, which comprise a pair of hammers 28 and 29 supported to swing in the horizontal plane to and from the side wall 316 of the case of the tie-like box module 100 and a slider 27 driven by the pulling rod 144.

**[0121]** The hammers 28 and 29 have two opposed latching lugs 128 and 228, 129 and 229, projecting out of the two opposed sides, i.e. facing toward the side wall 316 of the point pulling and locking modules 30 and 31 and the slider 27.

**[0122]** One of the two opposed lugs 128, 129 cooperates with an associated latching recess 516, 616, formed in the corresponding vertical wall 316 of the point pulling and locking modules 30 and 31, for primary and secondary switch point locking actions.

**[0123]** The other of the two opposed lugs 228, 229 of the two hammers 28 and 29 cooperates with an associated abutment surface 227, 327 on the slider 27 to cause the slider 27 to pull or push the hammers 29 and 29 for coupling.

**[0124]** The slider 27 has a roller 39 on the side facing toward the hammers 29, 29, which adheres against a cam surface formed on an extension of said hammers 28, 29 and controls displacement thereof. Particularly, the hammers 28, 29 have a T shape, in which the two halves of the transverse stem form the opposed lugs 128, 129 and 228, 229, whereas the base stem 328, 329 is shaped like a cam on the side facing toward the slider 27 and cooperates with the roller 39 carried thereby.

**[0125]** The T-shaped hammers 28, 29 are pivoted about a vertical axis at the end of the base stem 328, 329, which extends to a certain extent beyond the fulcrum in such a manner that the roller 39 cooperating with the cam track on said end portion of the base stem 329 beyond the fulcrum, may cause the hammers to swing toward the slider 27 and to a condition of disengagement thereof from the latching recesses 516, 616 in the side wall 316 of the tie-like box module 100.

**[0126]** Particularly, the shape of the cam track on the base stems 328 and 329 of the hammers 28 and 29, formed by the side surfaces of said base stems facing toward the slider 27, the overall length of the two opposed lugs 128, 228 and 129, 229 and the inclination of the end sides are selected in such a manner that, when the hammers 28, 29 are in either engagement position, with the wall 316 or the slider 27, the other end surface of the opposed lug extends in a position of non-interference with the slider 27 or the wall 316.

**[0127]** The base stems have a widening shape toward the fulcrum end, with two divergent opposed edge portions, whereas the edge facing toward the slider 27 and the control roller 39 is inwardly inclined substantially level with the diameter that cuts the pivot or fulcrum hole along a bisector of the angle formed by the divergent stem edge portion.

**[0128]** The slider 27 may move to a certain extent in the direction of arrow D until the lug 229 of the hammer 29 cooperates with the abutment surface 327 of the slider 27. In this condition the slider 27 starts to exert a pulling force on the point operating rod on which the hammers 28 and 29 are pivotally fixed.

**[0129]** During the initial free stroke of the slider 27, whose start is shown in figure 10a and whose end is shown in Figure 10b, i.e. during the initial actuation overstroke, the roller 39 rolls along the cam-like edge of the base stem 328 of the hammer 28 and the cam-like edge of the base stem 329 of the hammer 29, and reaches an intermediate position therebetween, i.e. a position in which it adheres to the end portions of both base stems of the hammers 28, 29, thereby causing them to simultaneously swing to disengagement of the two hammers 28 and 29 from the recesses 516, 616 in the wall 316. Obviously, the switch point locking and pulling module

associated with the opposite point performs a reverse movement, according to the same principles.

**[0130]** In this step, the hydraulic cylinder 2 exerts said first predetermined actuation force.

**[0131]** Therefore, the slider 27 associated with the point runs its point shifting actuation stroke towards the thrown/open position of the point relative to the rail, from the position of Figure 10b to the position of Figure 10c.

**[0132]** The thrown position of a first point relative to the rail, and the open position of the opposite point relative to the opposite rail, as shown in Figure 10b, is reached before the end of the displacement stroke of the pulling rod 144.

**[0133]** In this step, the hydraulic cylinder 2 exerts said second predetermined actuation force.

**[0134]** The further final actuation overstroke will carry the hammer 29 from the abutment position against the abutment surface 227 of the slider 27, associated with the switch point 2, to the position of engagement of the lug 129 of the hammer 29 in the engagement recess 616.

**[0135]** In this step, the hydraulic cylinder 2 exerts said third predetermined actuation force.

**[0136]** Two of said first predetermined actuation force, said second predetermined actuation force and said third predetermined actuation force are equal to each other and different from the other actuation force.

**[0137]** Particularly, in the illustrated example, the first predetermined actuation force is greater than the second predetermined actuation force and the third predetermined actuation force.

**[0138]** This is ensured because the first predetermined force is exerted by the displacement of the inner cylinder 22 within the outer cylinder from a first end position to a second end position, i.e. from the position of Figure 10a to the position of Figure 10b, and the second predetermined force and the third predetermined actuation force, which are equal, are exerted by the displacement of the piston 23 within said inner cylinder from a first end position to a second end position, as shown in Figures 10b, 10c and 10d.

**[0139]** The switch machine as shown in Figures 1 to 4 comprises a housing case for the operating units, which is preferably made of metal, particularly a tie-like box module 100, has the same size as a tie, and is adapted to be installed like a tie, and has a covering on at least part of the case, which covering consists of a material having railway ballast interface surface characteristics similar to concrete.

**[0140]** The material is an epoxy resin filled with ceramic beads and has a hardness ranging from 60 to 100 Shore, preferably from 70 to 85 Shore, particularly of 75 Shore.

**[0141]** Advantageously, the material has a thickness ranging from 2 to 10 mm, preferably from 4 to 8 mm, preferably of 6 mm.

**[0142]** Such material is applied to said outer surface of the case by manual and/or automatic spreading.

**[0143]** Since epoxy resins mainly have a mechanical rather than chemical adhesion, or holding power, predetermined sanding is required to prepare the surface of the tie-like box module 100 before application of the resin.

**[0144]** This material has superior abrasion resistance properties and is not subject to shrinkage with time.

**[0145]** As an alternative, the material may be applied to the outer surface of the case by embedment, i.e. by placing said case in a negative mold that has an inner mold surface mating with said outer surface of the case, said negative mold being previously filled with said material in a fluid phase.

**[0146]** The above description of the switch machine 1 also applies to general ties: not only to switch machines, but also to hollow ties, preferably made of metal, for any wayside unit or part of the railway line or the like.

## Claims

**1.** A switch machine (1) for railway and tramway switches or the like, which switch machine (1) comprises:

at least one switch point shifting actuator (2), which actuator (2), in use, displaces said points, using actuation drive means, between two limit positions, one of which positions is called normal position and the other of said two positions is called reverse position, and in which positions each of the two points is thrown or open relative to the closest rail, in alternation with the other point, the shifting stroke of the points between said two positions having a predetermined length, matching a given actuation stroke of said actuator (2),

and lock/unlock means (30, 31) for locking/unlocking said points in one of said limit positions, referred to as switch point lock means, which switch point lock means are driven into their unlocking state by said actuator (2), through an initial actuation overstroke, whose end coincides with the point unlocked state, and with the time at which said point shifting actuation stroke starts, whereas the end of the point shifting actuation stroke, in which one of the points can be moved from an open position to a thrown position relative to the closest rail and the other point can be moved from a thrown position to an open position relative to the closest rail, coincides, in use, with the time at which a final actuation overstroke, through which said actuator (2) can drive said point locking means into their locking state,

**characterized in that**

it comprises means for adjusting the actuation force exerted by said actuator (2), for setting said actuation force at different levels for at least two of said initial actuation overstroke, said point shifting actuation stroke and said final actuation overstroke.

2. A switch machine as claimed in claim 1, wherein said actuator (2) is a hydraulic actuator to be connected to at least one delivery branch and at least one return branch of a closed fluid circulation circuit.

3. A switch machine as claimed in claim 2, wherein said actuator (2) comprises an outer cylinder (21) and an inner cylinder (22), the outside diameter of said inner cylinder (22) being substantially equal to the inside diameter of said outer cylinder (21), the height of said inner cylinder (22) being smaller than the height of said outer cylinder (21) and said inner cylinder (22) being disposed coaxially inside said outer cylinder (21) to be displaceable therein between two end positions defined by the inner extension of said outer cylinder (21), a piston (23) being also provided in said inner cylinder (22) and being connected to said rod (20) and displaceable between two and positions defined by the inner extension of said inner cylinder (22), said rod (20) being adapted to extend through an opening formed in at least one head surface of said inner cylinder (22) and at least one head surface of said outer cylinder (21) ; wherein, in use, during the displacement of said inner cylinder (22) within said outer cylinder (21) from a first end position to a second end position the actuator can exert a actuation force with a certain first intensity level, and wherein, in use, during the displacement of said piston (23) within said inner cylinder (22) from a first end position to a second end position the actuator can exert an actuation force with a certain second intensity level which is lower from the said first intensity level.

4. A switch machine according to claim 2, wherein the means for adjusting the intensity level of the actuation force to be exerted by the actuator (2) are means for setting the fluid delivery to the actuator (2).

5. A switch machine according to claim 4, **characterized in that** the said means for setting the fluid delivery to the actuator are constituted by a pump, said pump being a positive-displacement pump to be controlled at a variable speed and having a predetermined fixed displacement.

6. A switch according to claim 2 wherein the means for adjusting the intensity level of the actuation force to be exerted by the actuator (2) are two, three or more pumps with different displacements one or more of which pumps to be driven alternately and specially for actuating a particular of the said operating steps of the switch machine (1).

7. A switch machine according to claim 1 wherein the actuator (2) consist of an electric motor and a kinematic drive chain, the actuation force to be exerted by the actuator (2) being controlled, in use, by setting the force to be generated by the motor or by changing the drive ratio of the said kinematic drive chain according to the stroke that has been run.

8. A switch machine (1) as claimed in one or more of the preceding claims, comprising a housing case (100) for the operating units which is of the same size as a tie and adapted to be installed like a tie.

9. A switch machine as claimed in one or more of the preceding claims, wherein an outer surface of the switch machine (1) has a covering on at least part of it, which covering consists of materials having railway ballast interface surface characteristics similar to concrete.

10. A method of operating a switch machine (1) for railway and tramway switches or the like, which switch machine (1) comprises
at least one switch point shifting actuator (2), which actuator (2) displaces said points, using actuation drive means, between two limit positions, one of which positions is called normal position and the other of said two positions is called reverse position, and in which positions each of the two points is thrown or open relative to the closest rail, in alternation with the other point, the shifting stroke of the points between said two positions having a predetermined length, matching a given actuation stroke of said actuator (2),
and lock/unlock means for locking/unlocking said points in one of said limit positions, referred to as switch point lock means, which switch point lock means are driven into their unlocking state by said actuator (2), through an initial actuation overstroke, whose end coincides with the point unlocked state, and with the time at which said point shifting actuation stroke starts, whereas the end of the point shifting actuation stroke, in which one of the points is moved from an open position to a thrown position relative to the closest rail and the other point is moved from a thrown position to an open position relative to the closest rail, coincides with the time at which a final actuation overstroke, through which said actuator (2) drives said point locking means into their locking state,
**characterized in that**
it includes the steps of:

a) actuating said actuator (2), so that it can exert a first predetermined force during the initial actuation overstroke for unlocking said switch point lock means;
b) further actuating said actuator (2), so that it can exert a second predetermined actuation force during said point shifting actuation stroke;
c) further actuating said actuator (2), so that it can exert a third predetermined force during the

final actuation overstroke for locking said switch point lock means.

**11.** A method as claimed in claim 10, wherein said first predetermined force is greater than said second predetermined force and said third predetermined force.

**12.** A method as claimed in claim 11, wherein said second predetermined force and said third predetermined force are equal.

**Patentansprüche**

**1.** Stellvorrichtung (1) für Eisenbahn- und Straßenbahnweichen oder dergleichen, welche Stellvorrichtung (1) umfasst:

mindestens einen Weichenzungen-Umstellaktuator (2), welcher Aktuator (2) im Betrieb die Weichenzungen unter Verwendung von Betätigungsantriebsmitteln zwischen zwei Endpositionen verschiebt, wobei eine dieser Positionen als Normalposition und die andere dieser beiden Positionen als Umkehrposition bezeichnet werden, und wobei in welche Positionen jeweils eine der beiden Weichenzungen in Abwechslung mit der anderen Weichenzunge zu der nächstliegenden Schiene angestellt oder von dieser entfernt wird, und der Umstellhub der Weichenzungen zwischen diesen beiden Positionen eine vorbestimmte Länge aufweist, die einem vorgegebenen Betätigungshub des Aktuators (2) entspricht,
und Ver-/Entriegelungsmittel (30, 31) zum Verriegeln/Entriegeln der genannten Weichenzungen in einer der genannten Endpositionen, sog. Weichenverschlussmittel, welche Weichenverschlussmittel durch den Aktuator (2) in ihren Entriegelungszustand getrieben werden durch einen anfänglichen Betätigungsüberhub, dessen Ende dem Weichen-Entriegelungszustand und dem Zeitpunkt entspricht, zu dem der Weichenumstell-Betätigungshub beginnt, während das Ende des Weichenumstell-Betätigungshubs, in dem eine der Zungen von einer geöffneten Position in eine angestellte Position relativ zu der nächstliegenden Schiene und die andere Zunge aus einer angestellten Position in eine geöffnete Position relativ zu der nächstliegenden Schiene bewegbar ist, im Betrieb mit dem Zeitpunkt zusammenfällt, zu dem ein Endbetätigungs-Überhub erfolgt, durch den der Aktuator (2) die Weichenverschlussmittel in ihren Verriegelungszustand antreiben kann,
**dadurch gekennzeichnet, dass**
Mittel zum Einstellen der von dem Aktuator (2) ausgeübten Betätigungskraft vorgesehen sind, zum Einstellen der Betätigungskraft auf unterschiedliche Niveaus für wenigstens zwei von dem anfänglichen Betätigungsüberhub, der Weichenumstell-Betätigungshub und der Endbetätigungs-Überhub.

**2.** Stellvorrichtung nach Anspruch 1, wobei der Aktuator (2) ein hydraulischer Aktuator ist, der mit mindestens einem Förderzweig und mindestens einem Rücklaufzweig eines geschlossenen Fluidkreislaufs verbunden ist.

**3.** Stellvorrichtung nach Anspruch 2, wobei der Aktuator (2) einen Außenzylinder (21) und einen Innenzylinder (22) umfasst, der Außendurchmesser des Innenzylinders (22) im Wesentlichen gleich dem Innendurchmesser des Außenzylinders (21) ist, die Höhe des Innenzylinders (22) kleiner als die Höhe des Außenzylinders ist (21) und wobei der Innenzylinder (22) koaxial innerhalb des Außenzylinders (21) zwischen zwei durch die Innenerstreckung des Außenzylinders (21) definierten Endlagen verschiebbar angeordnet ist, ferner in dem Innenzylinder (22) ein Kolben (23) vorgesehen ist, der mit der Stange (20) verbunden und zwischen zwei durch die Innenerstreckung des Innenzylinders (22) definierten Positionen verschiebbar ist, und die Stange (20) dazu eingerichtet ist, sich durch eine in mindestens einer Stirnfläche des Innenzylinders (22) und mindestens einer Stirnfläche des Außenzylinders (21) ausgebildete Öffnung zu erstrecken; wobei im Betrieb bei der Verschiebung des Innenzylinders (22) innerhalb des Außenzylinders (21) von einer ersten Endposition in eine zweite Endposition der Aktuator eine Betätigungskraft mit einem bestimmten ersten Intensitätsniveau ausüben kann, und wobei im Betrieb bei der Verschiebung des Kolbens (23) innerhalb des Innenzylinders (22) von einer ersten Endposition in eine zweite Endposition, der Aktuator eine Betätigungskraft mit einem bestimmten, als des erste Intensitätsniveau niedrigeren zweiten Intensitätsniveau ausüben kann.

**4.** Stellvorrichtung nach Anspruch 2, wobei die Mittel zur Einstellung des Intensitätsniveaus der vom Aktuator aufzubringenden Betätigungskraft (2) Mittel zur Einstellung der Fluidabgabe an den Aktuator (2) sind.

**5.** Stellvorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** die Mittel zur Einstellung der Fluidabgabe an den Aktuator von einer Pumpe gebildet sind, wobei die Pumpe eine Verdrängerpumpe, welche mit variabler Geschwindigkeit zu steuern ist und eine feste vorgegebene Verdrängung aufweist.

**6.** Stellvorrichtung nach Anspruch 2, wobei die Mittel

zum Einstellen des Intensitätsniveaus der vom Aktuator (2) aufzubringenden Betätigungskraft zwei, drei oder mehr Pumpen mit unterschiedlichen Verdrängungen sind, von denen eine oder mehrere abwechselnd und insbesondere zur Betätigung eines bestimmten der genannten Arbeitsschritte der Stellvorrichtung (1) antreibbar sind.

**7.** Stellvorrichtung nach Anspruch 1, wobei der Aktuator (2) aus einem Elektromotor und einer kinematischen Antriebskette besteht und die vom Aktuator (2) aufzubringende Betätigungskraft im Betrieb gesteuert wird, durch Einstellen der von dem Motor zu erzeugenden Kraft oder durch Verändern des Antriebsverhältnisses der kinematischen Antriebskette gemäß dem erfolgten Hub.

**8.** Stellvorrichtung (1) nach einem oder mehreren der vorhergehenden Ansprüche, mit einem Aufnahmegehäuse (100) für die Funktionseinheiten, das gleich groß wie eine Schwelle und dazu eingerichtet ist, wie eine Schwelle eingebaut zu werden.

**9.** Stellvorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei eine Außenfläche der Stellvorrichtung (1) einen Überzug auf zumindest einem Teil davon aufweist, welcher Überzug aus einem Material mit Eisenbahnschotter-Schnittstelleneigenschaften besteht, die dem Beton ähnlich sind.

**10.** Verfahren zum Betreiben einer Stellvorrichtung (1) für Eisenbahn- und Straßenbahnweichen oder dergleichen, welche Stellvorrichtung (1) umfasst:

mindestens einen Weichenzungen-Umstellaktuator (2), welcher Aktuator (2) die Weichenzungen unter Verwendung von Betätigungsantriebsmitteln zwischen zwei Endpositionen verschiebt, wobei eine dieser Positionen als Normalposition und die andere dieser beiden Positionen als Umkehrposition bezeichnet werden, und wobei in welche Positionen jeweils eine der beiden Weichenzungen in Abwechselung mit der anderen Weichenzunge zu der nächstliegenden Schiene angestellt oder von dieser entfernt wird, und der Umstellhub der Weichenzungen zwischen diesen beiden Positionen eine vorbestimmte Länge aufweist, die einem vorgegebenen Betätigungshub des Aktuators (2) entspricht,
und Ver-/Entriegelungsmittel zum Verriegeln/Entriegeln der genannten Weichenzungen in einer der genannten Endpositionen, sog. Weichenverschlussmittel, welche Weichenverschlussmittel durch den Aktuator (2) in ihren Entriegelungszustand getrieben werden, durch einen anfänglichen Betätigungsüberhub, dessen Ende dem Weichen-Entriegelungszustand und dem Zeitpunkt entspricht, zu dem der Weichenumstell-Betätigungshub beginnt, während das Ende des Weichenumstell-Betätigungshubs, in dem eine der Zungen von einer geöffneten Position in eine angestellte Position relativ zu der nächstliegenden Schiene und die andere Zunge aus einer angestellten Position in eine geöffnete Position relativ zu der nächstliegenden Schiene bewegbar ist, mit dem Zeitpunkt zusammenfällt, zu dem ein Endbetätigungs-Überhub erfolgt, durch den der Aktuator (2) die Weichenverschlussmittel in ihren Verriegelungszustand antreibt,
**dadurch gekennzeichnet, dass**
es die Schritte umfasst:

a) Betätigen des Aktuators (2), so dass er eine erste vorbestimmte Kraft während des anfänglichen Betätigungsüberhubs zum Entriegeln der Weichenverschlussmittel ausüben kann;
b) ferner Betätigen des Aktuators (2), so dass er eine zweite vorbestimmte Betätigungskraft während des Weichenumstell-Betätigungshubs ausüben kann
c) ferner Betätigen des Aktuators (2), so dass er eine dritte vorbestimmte Kraft während des Endbetätigungs-Überhubs zum Verriegeln der Weichenverschlussmittel ausüben kann.

**11.** Verfahren nach Anspruch 10, wobei die erste vorbestimmte Kraft größer als die zweite vorbestimmte Kraft und als die dritte vorbestimmte Kraft ist.

**12.** Verfahren nach Anspruch 11, wobei die zweite vorbestimmte Kraft und die dritte vorbestimmte Kraft gleich sind.

**Revendications**

**1.** Dispositif de manoeuvre d'aiguillage (1) destiné à des aiguilles de voies ferrées, de tramway ou analogues, ledit dispositif de manoeuvre (1) comprenant :

au moins un actionneur de commande d'aiguilles (2), ledit actionneur (2), lors de son utilisation, déplaçant lesdites aiguilles, par des moyens d'entraînement d'actionnement, entre deux positions limite, l'une desdites positions étant nommée position normale et l'autre desdites deux positions étant nommée position inverse, et dans lesquelles positions chacune des deux aiguilles est engagée ou dégagée par rapport au rail le plus proche, de façon alternée avec

l'autre aiguille, la course de manoeuvre des aiguilles entre lesdites deux positions ayant une longueur préétablie, correspondant à une course d'actionnement dudit actionneur (2), et par des moyens de verrouillage/déverrouillage (30, 31), pour verrouiller(déverrouiller lesdites aiguilles dans l'une desdites positions limite, appelés moyens de verrouillage d'aiguillage, lesdits moyens de verrouillage d'aiguillage étant entraînés dans leur état de déverrouillage par ledit actionneur (2), au moyen d'une surcourse d'actionnement initiale, dont l'extrémité coïncide avec l'état de déverrouillage d'aiguillage, et avec le moment de début de ladite course d'actionnement d'aiguillage, alors que l'extrémité de la course d'actionnement d'aiguillage, dans laquelle l'une des aiguilles peut être déplacée d'une position de dégagement à une position d'engagement par rapport au rail le plus proche et l'autre aiguille peut être déplacée d'une position d'engagement à une position de dégagement par rapport au rail le plus proche, coïncide, lors de l'utilisation, avec le moment d'une surcourse d'actionnement finale, par laquelle ledit actionneur (2) peut entraîner lesdits moyens de verrouillage d'aiguillage dans leur état de verrouillage, **caractérisé en ce qu'**il comprend des moyens de réglage de la force d'actionnement exercée par ledit actionneur (2) pour mettre à point ladite force d'actionnement à des niveaux différents pour au moins une de ladite surcourse d'actionnement initiale, de ladite course d'actionnement d'aiguillage et de ladite surcourse d'actionnement finale.

**2.** Dispositif de manoeuvre d'aiguillage selon la revendication 1, dans lequel ledit actionneur (2) est un actionneur hydraulique destiné à être relié à au moins une branche d'arrivée et à au moins une branche de retour d'un circuit de circulation de fluide fermé.

**3.** Dispositif de manoeuvre d'aiguillage selon la revendication 2, dans lequel ledit actionneur (2) comprend un cylindre extérieur (21) et un cylindre intérieur (22), le diamètre extérieur dudit cylindre intérieur (22) étant sensiblement égal au diamètre intérieur dudit cylindre extérieur (21), la hauteur dudit cylindre intérieur (22) étant inférieure que la hauteur dudit cylindre extérieur (21) et ledit cylindre intérieur (22) étant situé en position coaxiale à l'intérieur dudit cylindre extérieur (21) pour pouvoir être déplacé à l'intérieur de celui-ci entre deux positions d'extrémité, définies par l'étendue intérieure dudit cylindre extérieur (21), un piston (23) étant également situé dans ledit cylindre intérieur (22) et étant relié à ladite tige (20)[SI1] et pouvant être déplacé entre deux positions d'extrémité définies par l'étendue intérieure dudit cylindre intérieur (22), ladite tige (20) étant apte à s'étendre à travers une ouverture formée dans au moins une surface de tête dudit cylindre extérieur (21) et au moins une surface de tête dudit cylindre extérieur (21); dans lequel, lors de l'utilisation, pendant le déplacement dudit cylindre intérieur dans ledit cylindre extérieur (21) d'une première position d'extrémité à une seconde position d'extrémité, l'actionneur peut exercer une force d'actionnement avec un certain premier niveau d'intensité, et dans lequel, lors de l'utilisation, pendant le déplacement dudit piston (23) à l'intérieur dudit cylindre intérieur (22) d'une première position d'extrémité à une seconde position d'extrémité l'actionneur peut exercer une force d'actionnement avec un certain second niveau d'intensité plus faible que ledit premier niveau d'intensité.

**4.** Dispositif de manoeuvre d'aiguillage selon la revendication 2, dans lequel les moyens d'ajustement du niveau d'intensité de la force d'actionnement destinée à être exercée par l'actionneur (2) sont des moyens de réglage du débit de fluide vers l'actionneur (2).

**5.** Dispositif de manoeuvre d'aiguillage selon la revendication 4, **caractérisé en ce que** lesdits moyens de réglage du débit de fluide vers l'actionneur sont constitués d'une pompe, ladite pompe étant une pompe volumétrique conçue pour être commandée à vitesse variable et ayant un déplacement fixe préétabli.

**6.** Dispositif de manoeuvre selon la revendication 2 dans lequel les moyens d'ajustement du niveau d'intensité de la force d'actionnement à exercer par l'actionneur (2) sont deux, trois ou plusieurs pompes avec des déplacements différents, dont une ou plusieurs pompes sont destinées à être commandées de façon alternée, notamment pour l'actionnement d'une étape particulière desdites étapes de fonctionnement du dispositif de manoeuvre (1).

**7.** Dispositif de manoeuvre selon la revendication 1, dans lequel l'actionneur (2) est constitué d'un moteur électrique et d'une chaîne d'entraînement cinématique, la force d'actionnement à exercer par l'actionneur (2) étant régulée, lors de l'utilisation, en définissant la force à générer par le moteur ou en changeant le rapport d'entraînement de ladite chaîne cinématique d'entraînement en fonction de la course effectuée.

**8.** Dispositif de manoeuvre (1) selon une ou plusieurs des revendications précédentes, comprenant un boîtier de logement (100) pour les unités de fonctionnement qui est de la même taille qu'une traverse et est apte à être installé comme une traverse.

**9.** Dispositif de manoeuvre selon une ou plusieurs des revendications précédentes, dans lequel une surface extérieure du dispositif de manoeuvre (1) est pourvue d'un couvercle sur au moins une partie de celle-ci, ledit couvercle consistant de matériaux possédant des caractéristiques de surface d'interface avec le ballast, analogues au béton.

**10.** Procédé d'utilisation d'un dispositif de manoeuvre (1) destiné à des aiguilles de voies ferrées, de tramway ou analogues, ledit dispositif de manoeuvre (1) comprend au moins un actionneur de commande d'aiguilles (2), ledit actionneur (2) déplaçant lesdites aiguilles, par des moyens d'entraînement d'actionnement, entre deux positions limite, l'une desdites positions étant nommée position normale et l'autre desdites deux positions étant nommée position inverse, et dans lesquelles positions chacune des deux aiguilles est engagée ou dégagée par rapport au rail le plus proche, de façon alternée avec l'autre aiguille, la course de manoeuvre des aiguilles entre lesdites deux positions ayant une longueur préétablie, correspondant à une course d'actionnement donnée dudit actionneur (2), et par des moyens de verrouillage/déverrouillage pour verrouiller/déverrouiller lesdites aiguilles dans l'une desdites positions limite, appelés moyens de verrouillage d'aiguillage, lesdits moyens de verrouillage d'aiguillage étant entraînés dans leur état de déverrouillage par ledit actionneur (2), au moyen d'une surcourse d'actionnement initiale, dont l'extrémité coïncide avec l'état de déverrouillage d'aiguillage, et avec le moment de début de ladite course d'actionnement d'aiguillage, alors que l'extrémité de la course d'actionnement d'aiguillage, dans laquelle l'une des aiguilles est déplacée d'une position de dégagement à une position d'engagement par rapport au rail le plus proche et l'autre aiguille est déplacée d'une position d'engagement à une position de dégagement par rapport au rail le plus proche, coïncide avec le moment d'une surcourse d'actionnement finale, par laquelle ledit actionneur (2) entraîne lesdits moyens de verrouillage d'aiguillage dans leur état de verrouillage, **caractérisé en ce qu'**il comprend les étapes consistant à :

a) actionner ledit actionneur (2) de manière qu'il puisse exercer une première force préétablie pendant la surcourse d'actionnement initiale afin de déverrouiller lesdits moyens de verrouillage d'aiguillage ;
b) actionner par ailleurs ledit actionneur (2), de manière qu'il puisse exercer une deuxième force d'actionnement préétablie pendant ladite course d'actionnement d'aiguillage ;
c) actionner par ailleurs ledit actionneur (2) de manière qu'il puisse exercer une troisième force préétablie pendant la surcourse d'actionnement finale afin de verrouiller lesdits moyens de verrouillage d'aiguillage.

**11.** Procédé selon la revendication 10, dans lequel ladite première force préétablie est supérieure à ladite deuxième force préétablie et à ladite troisième force préétablie.

**12.** Procédé selon la revendication 11, dans lequel ladite deuxième force préétablie et ladite troisième force préétablie sont égales.

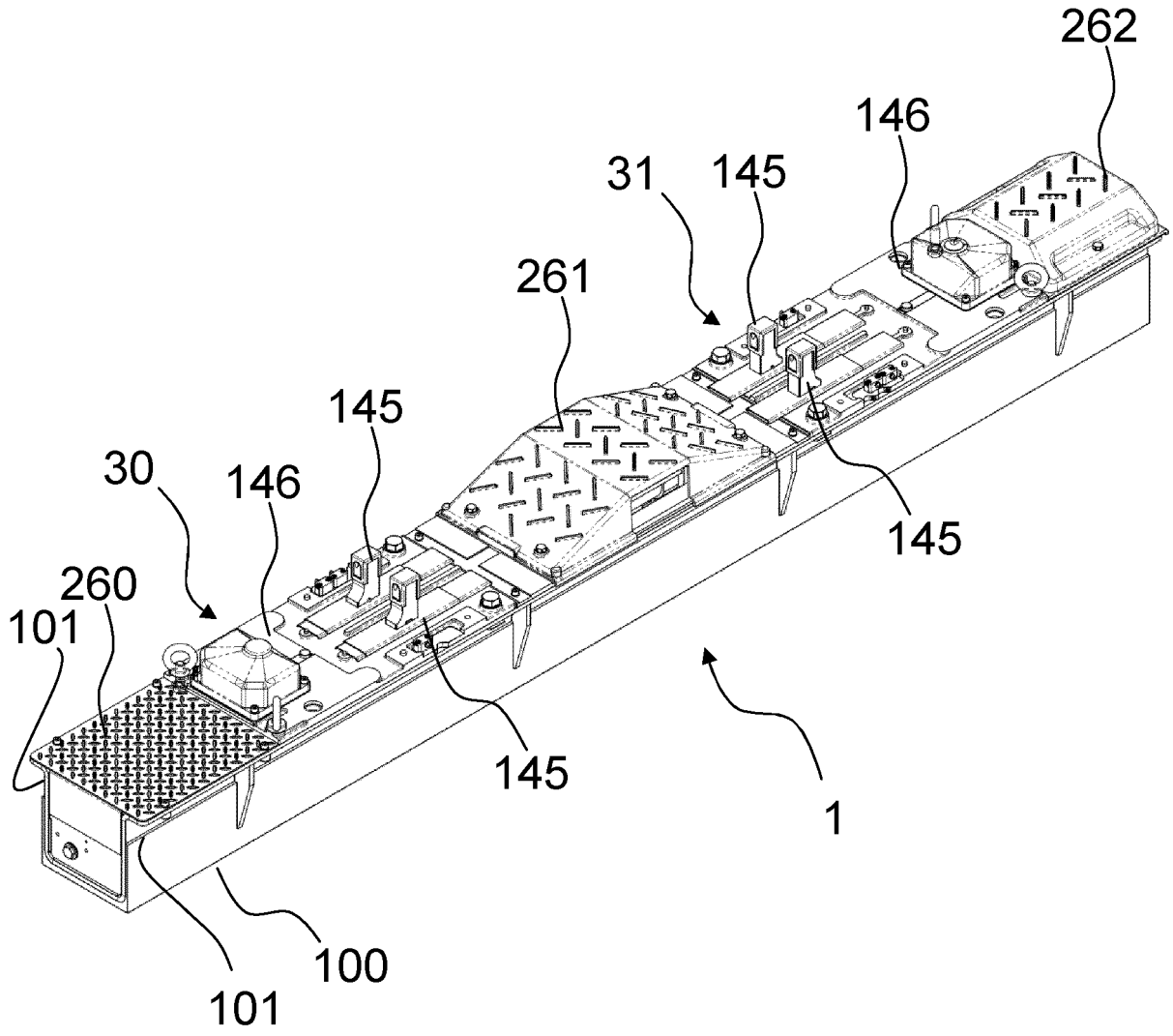


Fig. 1

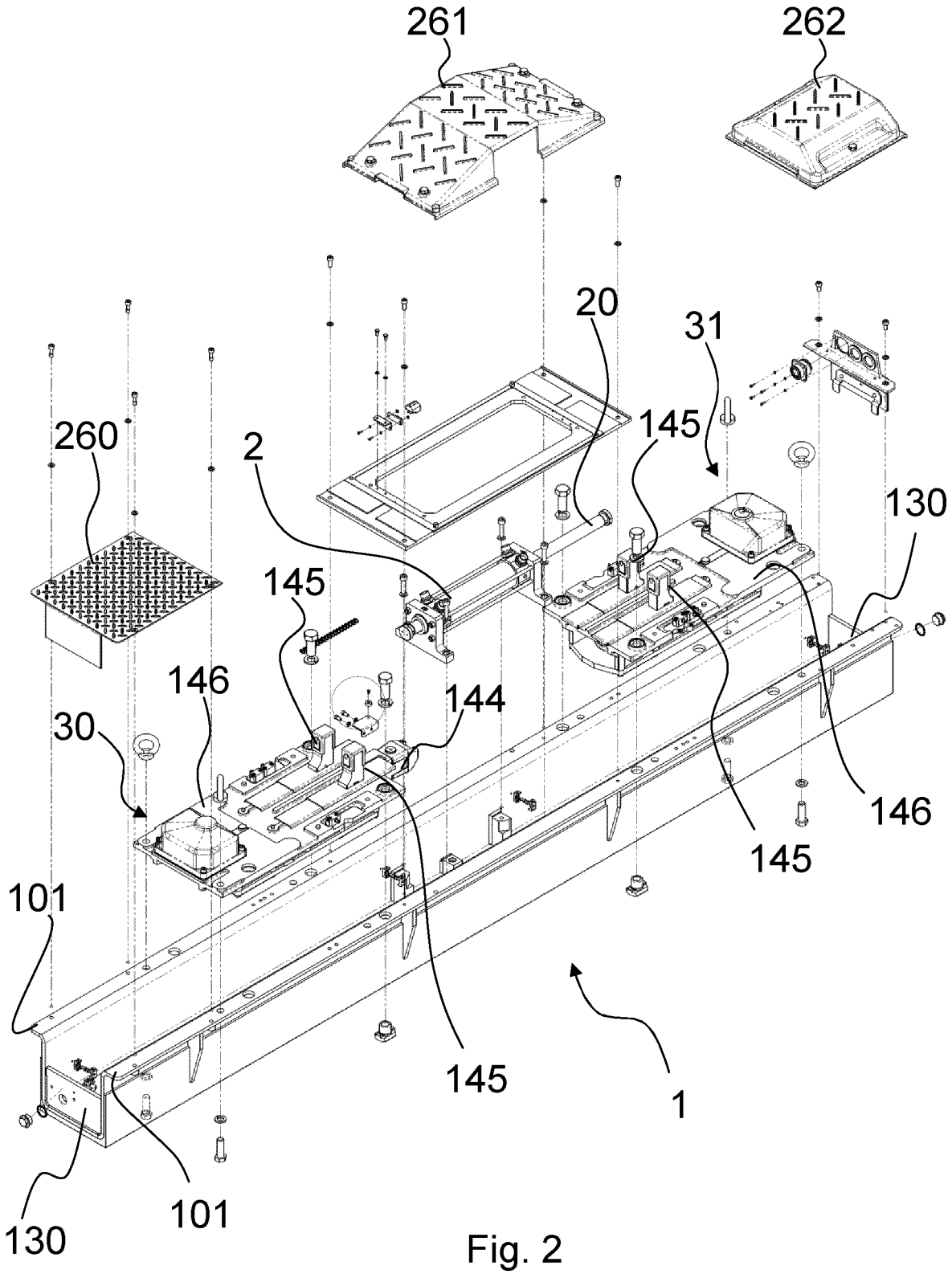
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Fig. 2

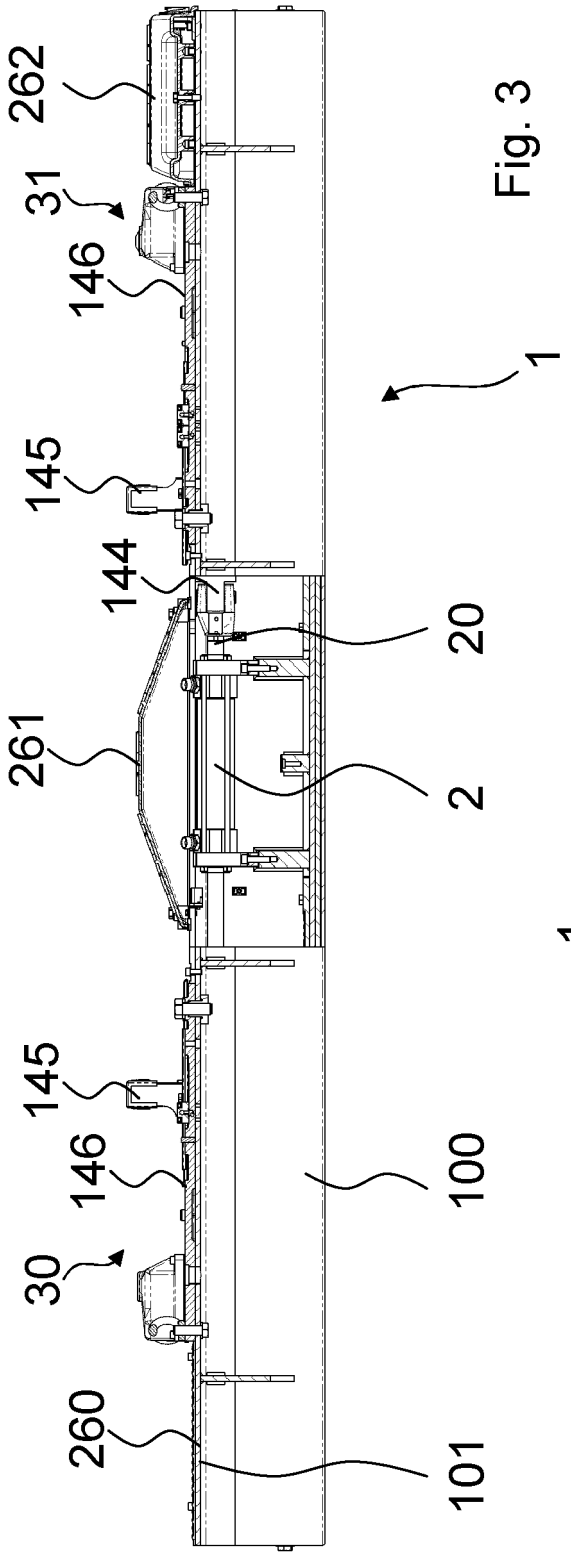
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Fig. 3

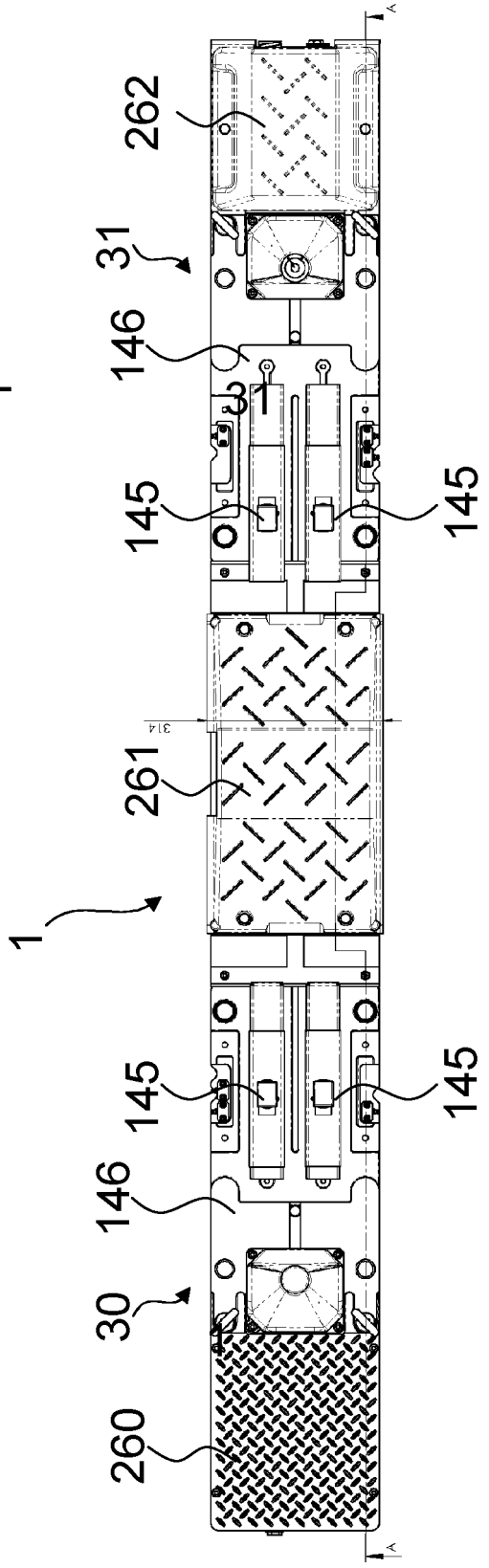
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Fig. 4

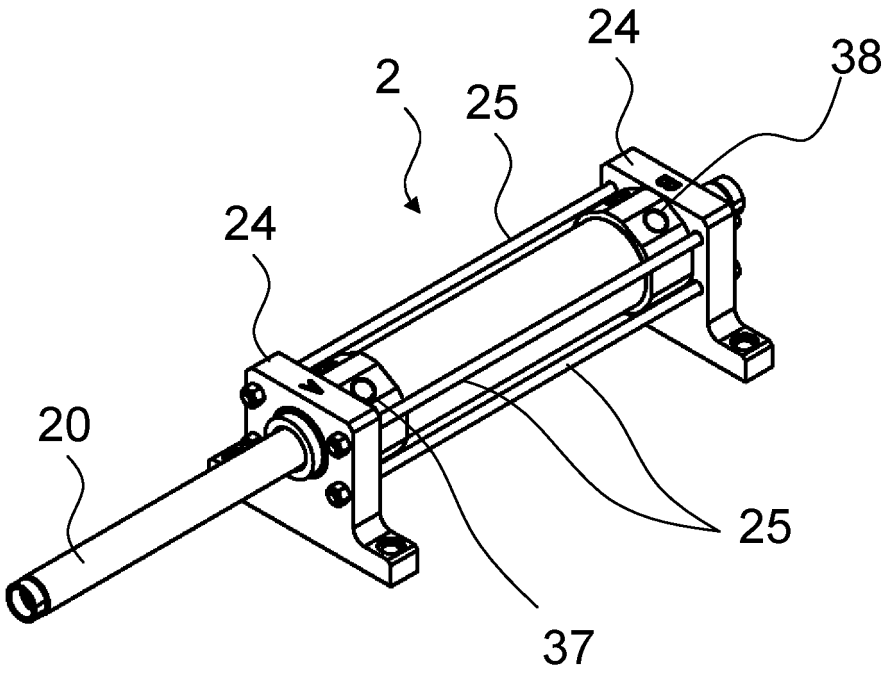


Fig. 5

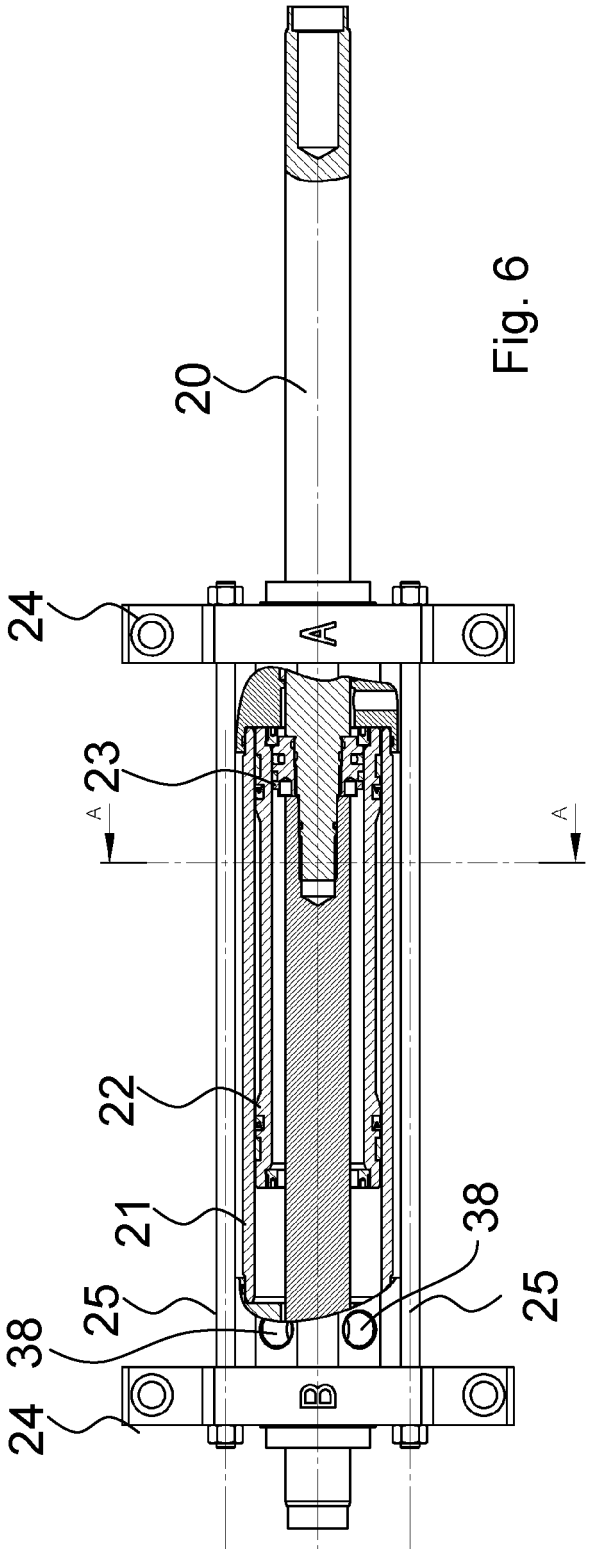


Fig. 6

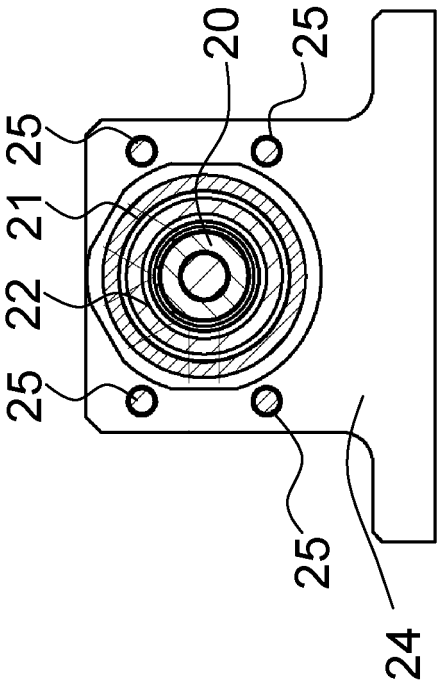


Fig. 7

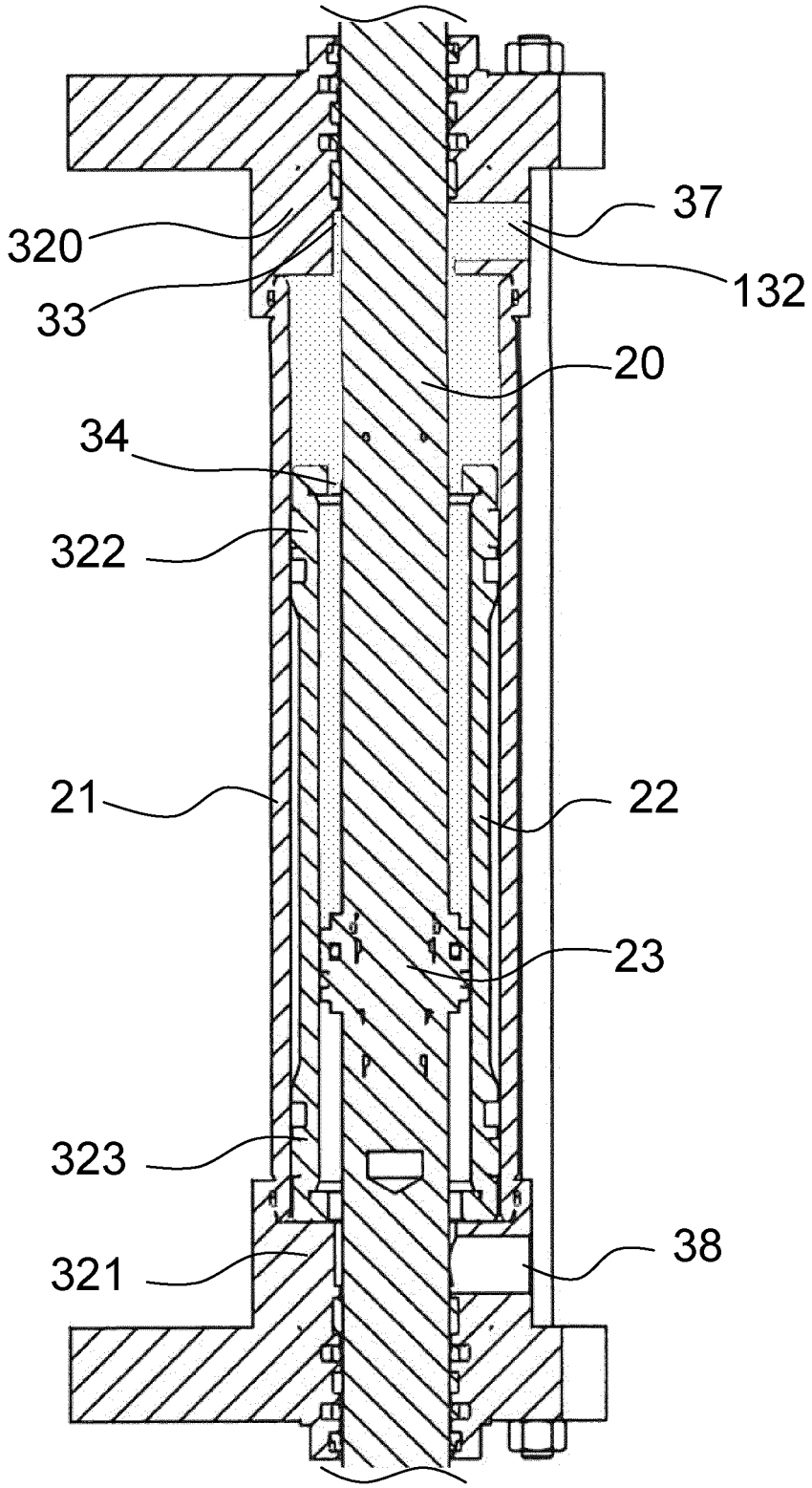


Fig. 8

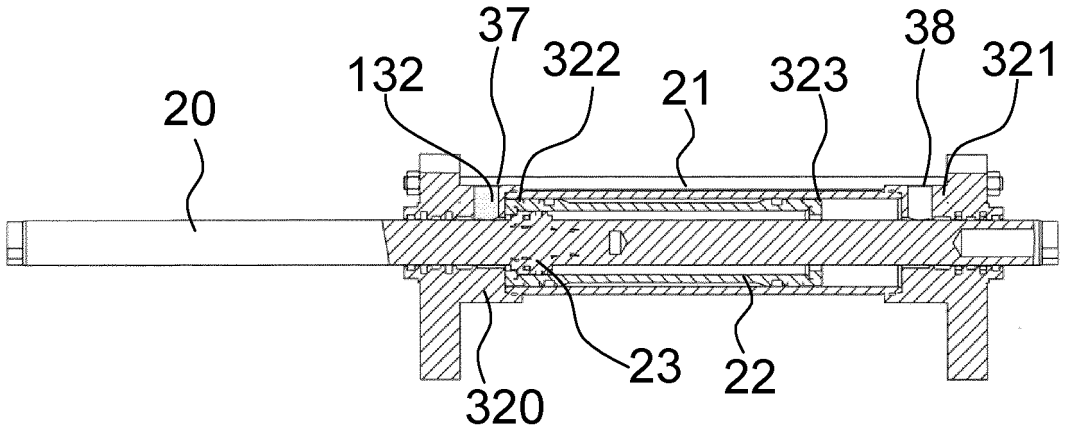


Fig. 9a

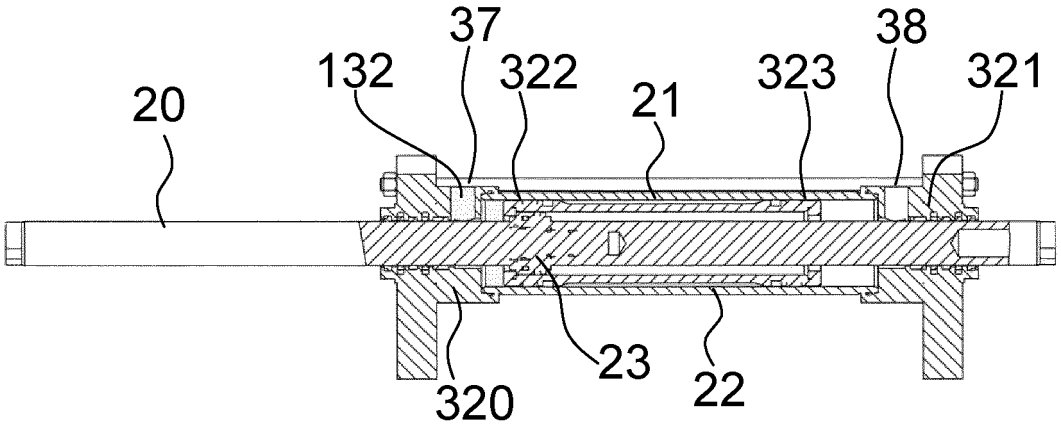


Fig. 9b

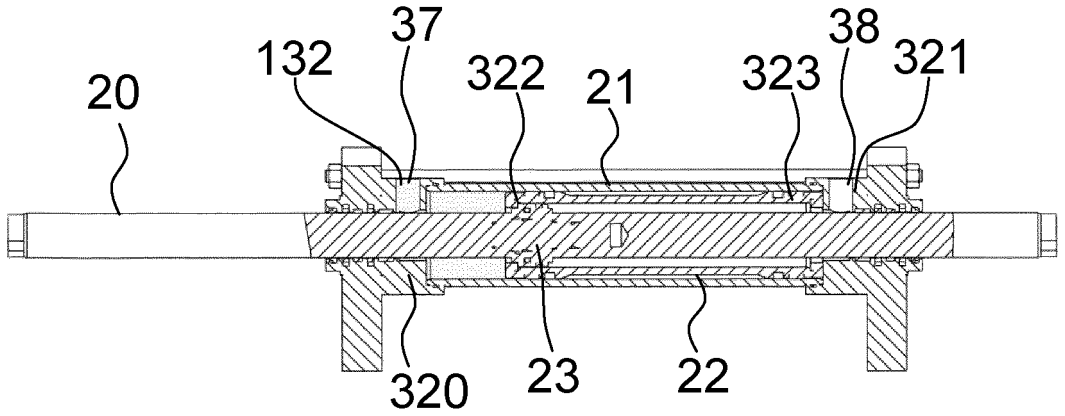


Fig. 9c

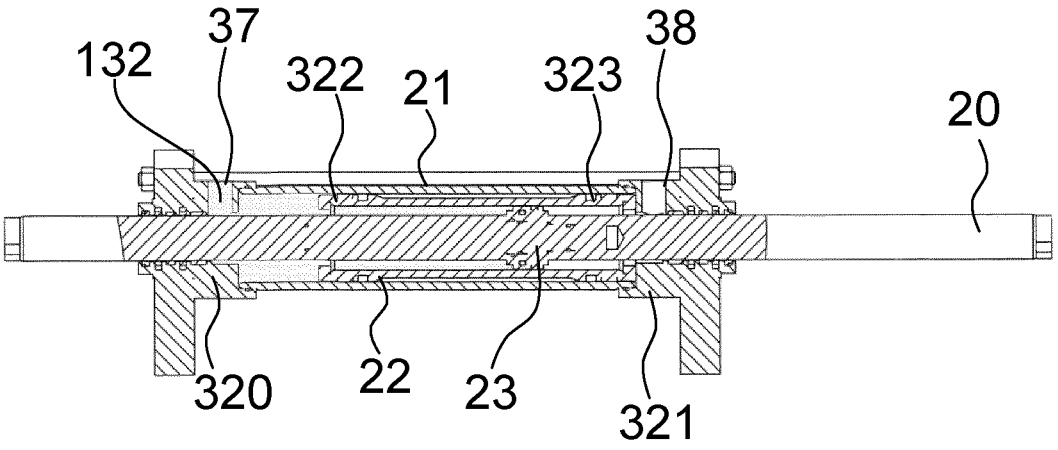
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Fig. 9d

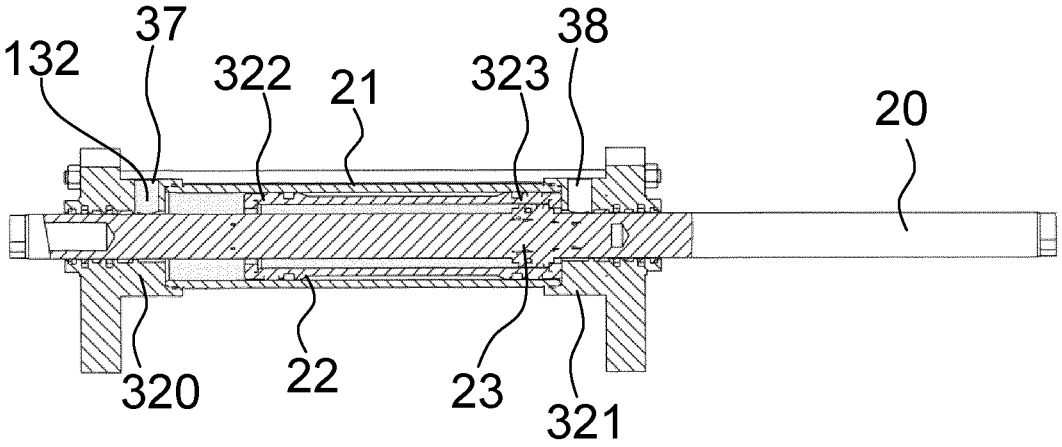
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Fig. 9e

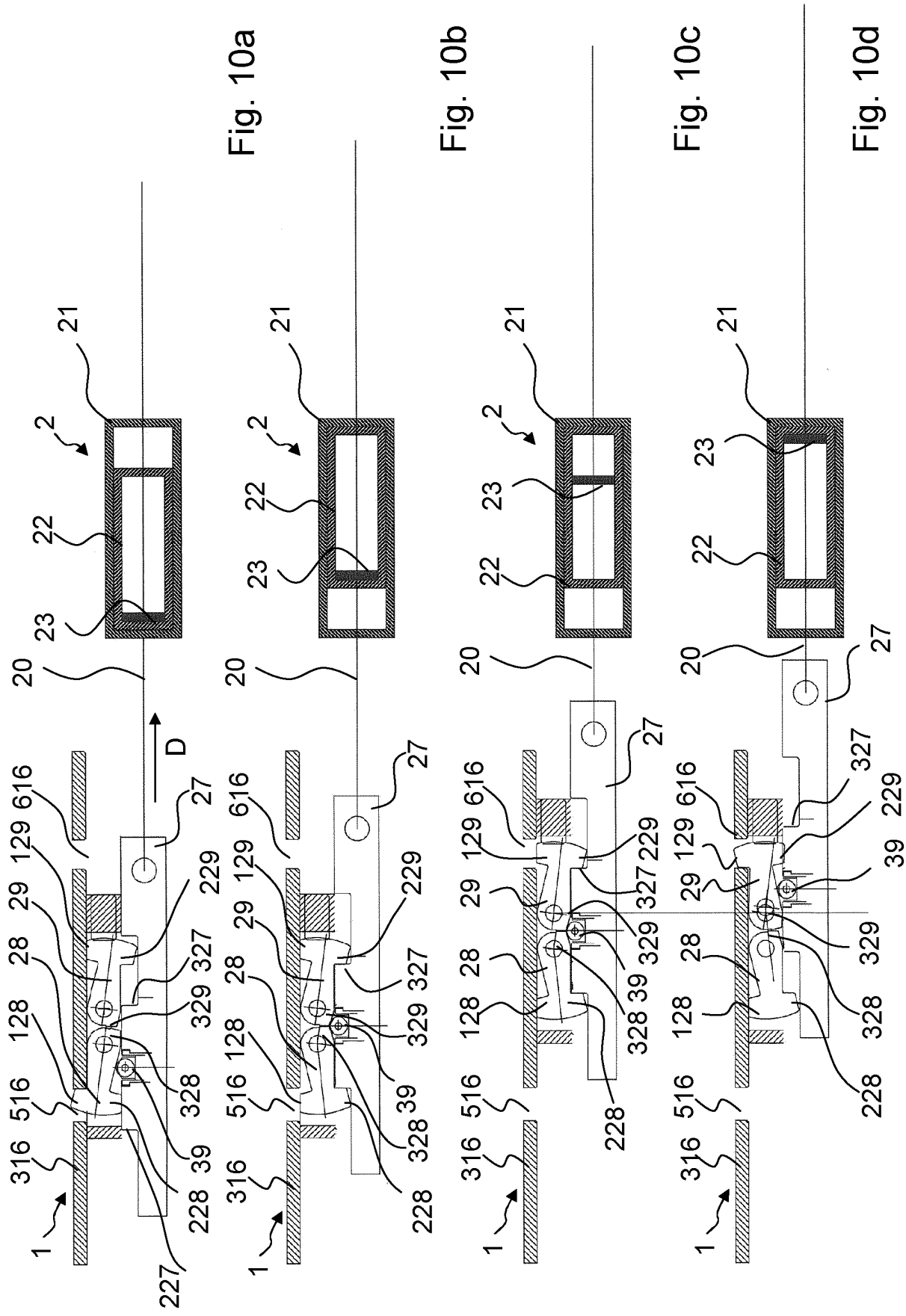
Fig. 10a
Fig. 10b
Fig. 10c
Fig. 10d
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## REFERENCES CITED IN THE DESCRIPTION

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