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Description

FIELD OF THE INVENTION

The present invention relates to a thermoforming machine comprising a displaceable table device for a forming tool.

TECHNICAL BACKGROUND

Thermoforming machines are for producing shaped parts from a planar starting material, which is provided for example in the form of plastics material films or plastics material plates, using the action of heat. This may for example take place in that the starting material, for example a thermoplastic plastics material, is initially subjected to heat using a suitable heating device, and thus heated, and subsequently brought into the desired shape using a suitable forming tool.

In thermoforming machines of this type, a working region within the thermoforming machine, in which the starting material is clamped in place and shaped, should be accessible from as many sides of the machine as possible. Maximally unimpeded access to this working region may for example be desirable for manual introduction of starting material or manual removal of finished workpieces. In addition, maximally unrestricted access is sought for heating devices and for various peripheral devices, such as loading devices for the starting material and/or loading devices for additional parts.

US 2003 235637 A1 discloses a thermoforming machine comprising a displaceable table device for a forming tool and at least one drive device; wherein the thermoforming machine further has a displaceable clamping frame for clamping a starting material for a workpiece to be produced in place in a clamping plane; and wherein the drive device is formed as a clamping frame drive device for driving the clamping frame for displacement thereof and is arranged substantially between the clamping plane in which the starting

material can be clamped and a plane defined by the lower edge of the displaceable table device in an upper displacement position of the displaceable table device.

US 2005 236744 A1, EP 1 880 828 A1, US 6 250 909 B1 and US 3 570 064 A describe similar devices.

Moreover, drive devices of the thermoforming machine, in particular those for movable components of the thermoforming machine, should be accommodated at a suitable point so that they can fulfil their purpose but do not impede access to the working region.

Thus far, thermoforming machines are therefore less compact and less space-saving in construction than would appear desirable.

SUMMARY OF THE INVENTION

Against this background, an object of the present invention is to provide a thermoforming machine which has a more compact, more space-saving and preferably also more cost-effective construction than previous thermoforming machines. In particular, in this context, the access options for a user and/or for peripheral devices should not be restricted, but rather maintained or preferably even further improved.

This object is achieved according to the invention by a thermoforming machine having the features of claim 1.

The idea behind the present invention involves accommodating one or more drive devices, with which the thermoforming machine is equipped, in an advantageous and space-saving manner in an installation space delimited by two planes, on the one hand by the clamping plane of the thermoforming machine and on the other hand by the plane defined by the lower edge of the displaceable table device.

The table device for the forming tool, which may in particular comprise a table for carrying the forming tool and portions displaceable together with the table for applying holding and displacement forces to the table, generally requires a structure which is formed sufficiently stably to be able to absorb the acting loads, in particular to carry the forming tool and also if required to be able to contribute to the deformation of the heated starting material. So as to be able to absorb the loads from the weight of the forming tool and from the shaping process, the table device will thus have a particular extent, in particular in a displacement direction of the table device, which is required by the table device for sufficient mechanical carrying capacity and rigidity.

Advantageously, in the invention, the at least one drive device is accommodated in a space-saving manner between the clamping plane for the starting material, on the one hand, and the imaginary plane positionally defined in the upper displacement position thereof by the lower edge of the table device, on the other hand. In particular, in this context, the lower edge forms a delimitation of the table device remote from the clamping plane. In cases where the table device is formed for example with a profile to achieve the required rigidity and strength, the profile height of the table device can thus advantageously be used for accommodating the drive devices. In this way, the construction height of the thermoforming machine is not undesirably increased by the drive device(s), since space which is present in any case in the displacement direction of the table device as a result of the dimensions of the table device in the displacement thereof is used for accommodating the drive device(s). This is useful specifically in thermoforming machines for large drawing depths. In addition, access to the clamping plane by the drive device(s) is not impeded. The improved compactness of the thermoforming machine according to the invention can also contribute to a reduction in the production costs thereof.

Advantageous embodiments and developments of the invention can be derived from the dependent claims and from the description with reference to the drawings.

In one embodiment, a plurality of the drive devices may be provided, the drive devices comprising a table drive device or a plurality of table drive devices for driving the table device to displace it. This embodiment advantageously makes space-saving driving of the table device and a compact construction of the overall machine possible, in particular a comparatively low installation height for a comparatively large displacement distance of the table device. In addition, arranging the table drive device(s) between the clamping plane and the plane defined by the lower edge makes it possible to arrange the table drive devices at only a small distance from a displaceable table of the table device, avoiding long portions of the table device for applying the displacement forces to the table. This in turn may have a favourable effect on the installation size of the table device and the material requirement thereof, since small distances of the force application points, at which a force for displacement is applied to the table device using the associated table drive device, from the loads acting on the table of the table device are made possible.

In one embodiment, at least two, preferably four, table drive devices arranged between the clamping plane and the imaginary plane defined by the lower edge of the displacement table device in the upper displacement position of the table device are provided. In this way, a force for displacing the table device can be applied more uniformly.

According to the invention, the thermoforming machine further comprises a displaceable clamping frame for clamping the starting material in place in the clamping frame. In this context, the drive device is formed as a clamping frame drive device for driving the clamping frame for displacement thereof. Alternatively, a plurality of the drive devices may be provided, which comprise a clamping frame drive device or a plurality of clamping frame drive devices for driving the clamping frame for displacement thereof. The clamping frame can thus be driven in a space-saving manner, in turn resulting in a more compact thermoforming machine being achieved.

In one development at least two, preferably four, clamping frame drive devices arranged between the clamping plane and the imaginary plane defined by the lower edge of the displacement table device in the upper displacement position of the table device are provided. As a result, a force for displacing the clamping frame and for clamping the starting material in the clamping plane can be applied to the clamping frame uniformly.

In a further embodiment, the thermoforming machine comprises the displaceable clamping frame for clamping the starting material in the clamping plane, two or more of the drive devices being provided. In this embodiment, the drive devices comprise a table drive device or a plurality of table drive devices for driving the table device for displacement thereof and further comprise the clamping frame drive device or a plurality of clamping frame drive devices for driving the clamping frame for displacement thereof. In this way, the compact accommodation of the table drive is advantageously combined with the space-saving accommodation of the clamping frame drive.

In one embodiment, at least two, preferably four, table drive devices and moreover at least two, preferably four, clamping frame drive devices may be provided.

In particular, the imaginary plane defined in the upper displacement position of the table device by the lower edge of the displaceable table device may extend substantially parallel to the clamping plane.

In a preferred embodiment, the at least one drive device is located substantially completely between the clamping plane and the plane defined by the lower edge of the displaceable table device in an upper displacement position of the displaceable table device. In this way, the machine can be made even more compact.

In one embodiment, the upper displacement position of the displaceable table device is one of the displacement positions of the table device which are provided for the operation of the thermoforming machine, a distance of the plane defined by the lower edge of the displaceable table device from the clamping plane along the displacement of

the table device being at a minimum in said position. In particular, this may be uppermost possible displacement position of the table device. This may advantageously contribute to a particularly compact construction of the thermoforming machine.

In one embodiment, the plane defined by the lower edge of the displaceable table device in the upper displacement position of the displaceable table device extends substantially horizontally with respect to a floor on which the thermoforming machine can be set up for the operation thereof.

In one embodiment, a spindle drive, in particular a ball screw drive, is coupled to the at least one drive device in such a way that a spindle of the spindle drive can be driven by means of the at least one drive device. This makes possible effective conversion of a movement provided by the drive device into a linear movement, which can for example advantageously be used for displacing the table device or the clamping frame.

In one embodiment, the at least one drive device comprises a motor. In a preferred embodiment, the motor may be formed in particular as an electric motor, for example a three-phase motor. By means of a motor drive, in particular electric motor drive, components to be moved can be displaced or moved at a high precision. This may for example be useful and advantageous for the displacement of the table device for the shaping tool, but also for the displacement of the clamping frame, since positions to be approached by the table device or the clamping frame along the associated displacement directions thereof can be adopted at an improved precision in this embodiment. In addition, as a result of the use of a motor, in particular an electric motor, instead of a pneumatic or hydraulic drive, a pneumatic or hydraulic cabinet, comprising valves and further pneumatic or hydraulic equipment, can be dispensed with, and this in turn makes an even more compact construction of the thermoforming machine possible.

In alternative embodiments, however, the at least one drive device could instead be formed as a pneumatic or hydraulic drive device.

In a preferred development, an axis of rotation of the motor is orientated substantially parallel to the clamping plane. In a further development, the axis of rotation extends substantially parallel to a longitudinal direction of the thermoforming machine. As a result of the two aforementioned developments, an even more space-saving arrangement of the at least one drive device can be achieved.

In a further embodiment, the at least one drive device has a transmission, in particular an angular gear. A transmission can enable modulation of rotational speed and torque to adapt them to the requirements of the components to be driven. By means of an angular gear, deflection of a movement provided by the drive device, for example of a torque provided by the motor on the driven side, is additionally advantageously achieved. Deflection of this type may be advantageous in particular if the drive device has a motor and the axis of rotation thereof is orientated substantially parallel to the clamping plane.

In one embodiment of the invention, a plurality of the drive devices are provided, and comprise two mutually adjacently arranged drive devices. In this context, the two mutually adjacently arranged drive devices each have a transmission, in particular an angular gear, and the two drive devices are arranged in such a way that the transmissions point in opposite directions. In this way, for example a first of the two drive devices may be formed as a table drive device, and for this purpose the transmission may be arranged close to a table of the table device for as direct as possible an action of the adjusting force thereon, while the adjacent second drive device may be configured as a clamping frame drive device and arranged with the transmission thereof sufficiently spaced apart from the table device so as not to impede loading and unloading process and the movement of further movable components, for example the parts of a window plate system.

In one embodiment, the thermoforming machine may have four table drive devices and four spindle drives for displacing the table device, in particular four ball screw drives. A spindle, in particular a ball screw, of an associated one of the spindle drives is coupled to each of the table drive devices, in such a way that the spindle is drivable by means of

the table drive device for displacement of the table device. This may be advantageous in particular for displacing a table device having a substantially rectangular table, since in this case, for precise and inelastic movement of the table device, a spindle drive comprising an associated table drive device can be arranged in the region of each corner thereof.

In a further embodiment, the thermoforming machine may have four clamping frame drive devices and four spindle drives for displacing the clamping frame, in particular four ball screw drives. In this context, a spindle, in particular a ball screw, of one of the spindle drives is connected to each of the clamping frame drive devices on the driven side, in such a way that the spindle is drivable by means of the associated clamping frame drive device for displacing the clamping frame. This may be useful in particular in a clamping frame which is formed substantially rectangular, so as to achieve precise displacement of the clamping frame by arranging a spindle drive and a clamping frame drive device associated therewith in the region of each corner of the clamping frame.

In a preferred development, the spindle drives for displacing the clamping frame are arranged at corner points of an imaginary first rectangle.

In a further preferred development, the spindle drives for displacing the table device are arranged at corner points of an imaginary second rectangle.

In one embodiment, the corner points of the second rectangle are arranged within the first rectangle. In this way, the table drive devices can be arranged close to a table of the table device, making a simpler and material-saving construction of the table device possible, while simultaneously the spindle drives for displacing the clamping frame may be arranged above the clamping plane, further away from the table, so as to maintain the accessibility and, if an adjustable window plate is used, to provide sufficient space for adjusting the window plate parts.

In one embodiment, the thermoforming machine may have two table drive devices and two spindle drives for displacing the table device, in particular two ball screw drives. A spindle, in particular a ball screw, of an associated one of the spindle drives may be coupled to each of the two table drive devices on the driven side, in such a way that the spindle can be driven by means of the table drive device for displacing the table device. The two table drive devices and the spindle drives may for example be arranged on opposite sides or in the region of diagonally opposite corners of a table of the table device.

In a further embodiment, the thermoforming machine may have two clamping frame drive devices and two spindle drives for displacing the clamping frame, in particular two ball screw drives. In this context, a spindle, in particular a ball screw, of one of the spindle drives is coupled to each of the clamping frame drive devices on the driven side, in such a way that the spindle can be driven by means of the associated clamping frame drive device for displacing the clamping frame. In this embodiment, the two clamping frame drive devices and the spindle drives may for example be arranged on opposite sides or in the region of diagonally opposite corners of the clamping frame.

In one embodiment, the thermoforming machine is formed as a single-station thermoforming machine. The arrangement according to the invention of the at least one drive device may be advantageous in particular in single-station thermoforming machines, since in machines of this type substantially all steps during thermoforming of the starting material to produce the workpiece, in particular the heating and forming, are carried out at one and the same workstation. A single-station thermoforming machine therefore benefits particularly from the good accessibility and compact construction which are made possible by the invention.

The thermoforming machine is formed as a closed-chamber thermoforming machine. Thermoforming machines which have a closed, sealed machine housing are referred to as closed-chamber thermoforming machines. This makes it possible to prevent sagging of the heated starting material by selecting a suitable internal pressure.

In one embodiment, it may be provided that the thermoforming machine has a machine housing comprising a forming plate, it being possible for the at least one drive device to be arranged substantially between a face, in particular an upper face, which faces a clamping frame, of the shaping plate and the imaginary plane defined by the lower edge of the displaceable table device in the upper displacement position thereof. In particular, the at least one drive device may reach as far as the face of the forming plate which faces the clamping frame, but in this embodiment does not project beyond it. This embodiment may be advantageous for example if a window plate is provided, which seals against the forming plate, and the starting material is laid on movable parts of the window plate and clamped against said parts.

In one embodiment, the at least one drive device may comprise a drive device for parts of a window plate or a plurality of drive devices for parts of a window plate, which is or are accommodated between the clamping plane and the imaginary plane, in particular between the face of the forming plate facing the clamping frame and the imaginary plane defined by the lower edge of the displaceable table device in the upper displacement position thereof.

The thermoforming machine may in particular be formed as a vacuum forming machine, by means of which the starting material can be deformed using a vacuum and the forming tool.

The above embodiments and developments may be combined with one another as desired, within reason. Further possible embodiments, developments and implementations of the invention also include combinations not explicitly mentioned of features of the invention which are described above or below with reference to the embodiments. In this context, a person skilled in the art will in particular also add individual aspects to each basic form of the invention as improvements or supplements.

CONTENTS OF THE DRAWINGS

Hereinafter, the invention is described in greater detail with reference to the embodiment set out in the schematic drawings, in which:

Fig. 1 is a plan view of a thermoforming machine in accordance with an embodiment of the invention, comprising a clamping frame and a displaceable table device, some components being omitted for improved clarity;

Fig. 2 is a view of the thermoforming machine in accordance with the embodiment of Fig. 1, in a cross section A-A as indicated in Fig. 1;

Fig. 3 is a view of the thermoforming machine in accordance with the embodiment of Fig. 1, in a cross section B-B as indicated in Fig. 1;

Fig. 4 is a view of the thermoforming machine in accordance with the embodiment of Fig. 1, in a cross section C-C as indicated in Fig. 1;

Fig. 5 is a front view of the thermoforming machine in accordance with the embodiment of Fig. 1, in a viewing direction D (see Fig. 1), the clamping frame being displaceable upwards and the table device downwards, for example so as to remove a finished workpiece, an example forming tool arranged on a table of the table device additionally being shown, and some parts of a machine housing having been omitted for improved visibility of components arranged therein;

Fig. 6 is a view of the thermoforming machine in accordance with the embodiment of Fig. 1, which corresponds to that of Fig. 5, but with the clamping frame omitted and the table device along with the forming tool being located in the upper end position thereof, in which a starting material can be thermoformed;

Fig. 7 is a schematic illustration illustrating the arrangement of a forming plate, a window plate, a clamping frame and a planar starting material with respect to one another; and

Fig. 8 is a schematically simplified drawing illustrating the arrangement of spindle drives for displacing the table device and the clamping frame.

The accompanying drawings are intended to convey further understanding of the embodiments of the invention. They illustrate embodiments and serve, in conjunction with the description, to explain principles and concepts of the invention. Other embodiments and many of the aforementioned advantages are apparent from the drawings.

In the drawings, like, functionally equivalent and equivalently operating elements, features and components are provided with the same reference signs in each case, unless stated otherwise.

The elements of the drawings are not necessarily shown to scale with one another.

DESCRIPTION OF EMBODIMENTS

An embodiment of the invention is described in greater detail hereinafter, referring to Fig. 1 to 8. Fig. 1 to 8 show a single-station thermoforming machine 1 according to the invention, constructed using the closed-chamber principle, some components, including for example parts of a machine housing, a heating system, and peripheral and accessory devices, operating devices, control cabinets etc., being omitted for improved clarity. For the purpose of operating the thermoforming machine 1, it is placed on a substantially horizontal floor 12. A horizontal direction substantially parallel to the floor 12 is denoted in the drawings by reference sign H, and a vertical direction substantially perpendicular to the floor 12 is denoted by reference sign V.

A closed machine housing 13, sealed off during operation of the thermoforming machine 1 and comprising a stable machine frame, forms a lower part of the thermoforming machine 1. An upper face of the machine housing 13 is formed by a forming plate 30. The forming plate 30 has a substantially rectangular clearance 31, the shape and size of which correspond to the shape and dimensions of a table 2a displaceable along a displacement direction 7. The table 2a is part of a table device 2, which in addition to the table 2a has portions 2b which are provided for holding and displacing the table 2a and are displaceable together with the table 2a. In the embodiment shown, the portions 2b protrude horizontally from the table 2a and have a suitable profile (see for example Fig. 2) for sufficient rigidity and strength. The table device 2 is provided and set up for carrying a forming tool 3 for thermoforming a workpiece (not shown) on the table 2a (see Fig. 5 and 6, which also show an example forming tool 3). Further, the table device 2 is also formed for being displaced together with the forming tool 3 in the displacement direction 7 with respect to the machine housing 13, in such a way that the forming tool 3 can pass through the clearance 31 (see Fig. 5 and 6).

A multi-part window plate comprising a plurality of window plate parts 28, of which one is schematically shown in part only in Fig. 7, is arranged on an upper face 30a of the forming plate 30, in other words an upper surface of the forming plate 30. The window plate parts 28 are displaceable with respect to one another and sealed off from the forming plate 30 by means of sealing devices 32 (only indicated schematically). The purpose of the window plate part 28 is to cover in part the clearance 31 for adaptation to the size of a planar starting material 27 to be processed, which may be a thermoplastic plastics material film or plastics material plate.

The starting material 27 is positioned on an upper face 28a of the window plate parts 28, a sealing device 33 again providing sealing from the window plate parts 28 (see Fig. 7). A clamping frame 10, arranged above the machine housing 13 and displaceable up and down along a displacement direction 34 with respect to the machine housing 13, is provided for clamping the planar starting material 27 in place against the upper face 28a of the window plate parts 28. The upper face 28a thus forms a clamping plane 5 in which

the starting material 27 for the workpiece to be produced by thermoforming is clamped. Once the starting material 27 is clamped, it can be heated using a heating device (not shown). As a result of the closed-chamber thermoforming machine construction principle, comprising a sealed-off, closed machine housing 13, it is possible to prevent sagging of the heated and thus plastically deformable plastics material plate or plastics material film under its own weight. The heated starting material 27 is brought into the desired target form using the forming tool 3, in particular with the use of a vacuum.

The displacement direction 7 of the table device 2 and the displacement direction 34 of the clamping frame 10 each extend substantially parallel to the vertical direction V and substantially perpendicular to the clamping plane 5 and the upper faces 28a and 30a.

So as to be able to displace the table device 2 and thus the table 2a along the displacement direction 7, the thermoforming machine 1 has four drive devices 4, referred to hereinafter as table drive devices 9. The thermoforming machine 1 further has four further drive devices 4, referred to hereinafter as clamping frame drive devices 11 and serving to displace the clamping frame 10. Thus, by means of the table drive device 9, the table device 2 comprising the table 2a can be driven to move it along the displacement direction 7, while the clamping frame 10 can be driven by means of the clamping frame drive devices 11 to move it along the displacement direction 34.

Each of the table drive devices 9 has an electric motor 23, for example a three-phase motor, comprising an axis rotation 24 orientated parallel to the clamping plane 5 and thus also parallel to the horizontal direction H, and an angular gear 25 coupled to the electric motor 23. So as to be able to drive the table device 2 for the displacement movement along the displacement direction 7, each of the angular gears 25 is coupled, on the driven side, to a ball screw 18, which is mounted in the machine housing 13 and orientated substantially along the vertical direction V. Thus, each of the electric motors 23 is capable of setting an associated one of the ball screws 18 in rotation, the rotational movement provided by the electric motor 23 being deflected through 90 degrees by the angular gear 25. An associated nut 19 (only shown schematically in the drawings), in

particular a recirculating ball nut, fixed to the table device 2, in the embodiment shown to the portions 2b, cooperates with each of the ball screws 18. By means of synchronous rotation of the four ball screws 18, the table 2a can be moved up and down. In each case, a nut 19 and an associated ball screw 18 thus form a ball screw drive 17, coupled to the associated table drive device 9, for displacing the table device 2. The angular gear 25 may be configured in such a way that the torque and rotational speed provided by the electric motor 23 are modulated by means of the angular gear 25.

Each of the clamping frame drive devices 11 has an electric motor 20, for example a three-phase motor, comprising an axis of rotation 21 orientated parallel to the clamping plane 5 and thus also parallel to the horizontal direction H, and an angular gear 22 coupled to the electric motor 20. For driving the clamping frame 10 to displace it along the displacement direction 34, each of the angular gears 22 is coupled on the driven side to a ball screw 15, which protrudes upwards from the machine housing 13, substantially parallel to the vertical direction V, through the clamping plane 5. As a result, each of the electric motors 20 is capable of setting an associated one of the four ball screws 15 in rotation. The rotational movement provided by the electric motor 20 is deflected through 90 degrees by the angular gear 22. An associated nut 16, in particular a recirculating ball nut, cooperates with each of the ball screws 15, meaning that the clamping frame 10 can be moved up and down by way of synchronous rotation of the four ball screws 15. Thus, in each case, a nut 16 fixed to the clamping frame 10 and a ball screw 15 associated with said nut form a ball screw drive 14, coupled to the associated clamping frame drive device 11, for displacing the clamping frame 10. Rotational speed and torque provided by the electric motor 20 can also be modulated by means of the angular gear 22.

The table drive devices 9 and the clamp drive devices 11 are each coupled rigidly to the machine housing 13. This may take place for example by screwing the associated angular gear 22, 25 to the machine housing 13 and/or to the forming plate 30 and further screwing a housing of the associated electric motor 20, 23 to the associated angular gear 22 or 25.

An imaginary plane 6 (see Fig. 2 to 7) extends below the clamping plane 5 substantially parallel to the clamping plane 5 and is spaced apart from the clamping plane 2 along the displacement direction 7 of the table device 2. The position of the imaginary plane 6, which is thus substantially horizontal with respect to the floor 12, along the displacement direction 7, in other words the position of the plane in the vertical direction V, is established by a lower edge 8, remote from the clamping plane 5, of the displaceable table device 2 in the uppermost displacement position of the table device 2 along the displacement device 7 which the table device 2 is intended to assume during operation of the thermoforming machine 1. The lower edge 8 thus forms a delimitation of the table device 2 remote from the clamping plane 5. In this context, the lower edge 8, which defines the position of the plane 6, is the delimitation of the table device 2 furthest away from the clamping plane 5 along the displacement direction 7 in the uppermost displacement position of the table device 2. This means that the lower edge 8 may be positioned in the region of the table 2a or of the portions 2b or, if the table 2 and the portions 2b end at the same height, in the region of both. As can be seen from Fig. 2, in the embodiment the imaginary plane 6 is delimited by the lower edge – in other words, a lower boundary – of carriers 36, which also form the portions 2b. By means of the carriers 36, in the embodiment shown, displacement and holding forces can be introduced to the table 2a using the spindles 18. In the embodiment shown, the lower edge of the carriers 36 corresponds to the lower edge 8 of the table device 2. It is also clear from Fig. 2 that the table 2a can be formed less high in a central region 2a'. In variants of the embodiment, however, in the central region 2a', the table 2a may for example be built at the same height as the lower edge of the carriers 36.

This upper displacement position of the table device 2, shown in Fig. 2 to 4 and 6, may in particular be a forming position, in which the thermoforming is carried out using the forming tool 3. In this displacement position of the table device 2, the distance between the lower edge 8 and the clamping plane 5, and thus also the distance 40 between the clamping plane 5 and the imaginary plane 6, as measured along the displacement direction 7, is smallest. In addition, in this displacement position, a distance of the lower

edge 8 from the upper surface of the forming plate 30 referred to as an upper face 30a, as measured along the displacement direction 7, is smallest.

Starting from the displacement position shown in Fig. 4 of the table device 2, it is provided that the table device 2 can be displaced downwards along the displacement direction 7 again during operation of the thermoforming machine 1, causing the lower edge 8 to be further away from the clamping plane 5. It should be assumed that the imaginary plane 6, established by the uppermost provided displacement position of the table 2, maintains its position in this context. However, even in the other displacement positions which the table device 2 can assume during operation of the thermoforming machine 1, in the embodiment shown the drive devices 4 are always arranged between the clamping plane 5 and a further imaginary plane 6' substantially parallel thereto, the position of which along the displacement direction 7 is established by the lower edge 8 of the table device 2 in the associated current displacement position thereof. In Fig. 5, the plane 6' is shown by way of example for the lower end position of the table device 2.

The drive devices 4, in other words the four table drive devices 9 comprising the electric motors 23 and the angular gears 25 and the four clamping frame drive devices 11 comprising the electric motors 20 and the angular gears 22, are thus in each case located between the clamping plane 5 and the imaginary plane 6. In this way, advantageously, the space which is added onto the required displacement path of the table device 2 for determining the installation height of the machine housing 13 in any case, as a result of the required height 35 of the table construction, in particular the carrier height required for absorbing the acting loads, is used for accommodating the drive devices 4.

As can be seen from the drawings, the electric motors 23 and angular gears 25 of the table drive devices 9 and the electric motors 20 and angular gears 22 of the clamping frame drive devices 11 are accommodated substantially completely between the clamping plane 5 and the imaginary plane 6. The arrangement of the table and clamping frame drive devices 9, 11 between the planes 5 and 6 thus prevents an undesirable

increase in the height of the machine housing 13 as a result of accommodating the drive devices.

As can be seen from Fig. 1, 4 and 6, the axes of rotation 21, 24, orientated substantially parallel to the clamping plane 5, of the electric motors 20, 23 are also in each case orientated substantially parallel to a longitudinal direction L of the thermoforming machine 1 (see Fig. 1). In this way, in each case two adjacent drive devices, in the embodiment shown a table drive device 9 and a clamping frame drive device 11 in each case, denoted by way of example by reference signs 4b and 4a, are accommodated in a space-saving manner with the associated electric motor and transmission. In this context, the angular gears 22, 25 of the two mutually adjacently arranged drive devices 4a, 4b point along the longitudinal direction L in opposite directions 26a, 26b.

In the embodiment shown in the drawings, the table drive devices 9 and the clamping frame drive devices 11 are arranged in a preferred orientation between the clamping plane 5 and the imaginary plane 6. In variants of the embodiment, however, the table drive devices 9 and the clamping frame drive devices 11 may instead be orientated differently, as long as it is ensured that they are accommodated between the clamping plane 5 and the imaginary plane 6 and that there is no collision with other moving or stationary components (not shown in greater detail here) of the thermoforming machine 1. Fig. 1 shows how, in a variant of the embodiment which is shown dashed in Fig. 1, the table drive device 9 may alternatively be installed rotated through +90 degrees or −90 degrees about the longitudinal axis of the spindle 18. Two table drive devices in accordance with this variant are shown in Fig. 1 and denoted by reference number 109. In further variants, the clamping frame drive devices 11 could for example each be rotated through 180 degrees about the vertical direction V, as long as there is no collision with other components. However, the arrangement of Fig. 1 is preferred, since the shown arrangement of the spindles is in accordance with the space requirement of the window plate system.

The thermoforming machine 1 according to the embodiment shown in the drawings has four ball screws 15 orientated parallel, four ball screws 18 orientated parallel, four nuts 16 and four nuts 19. The table device 2 can thus be driven by way of the cooperation of the four table drive devices 9 with the four spindle drives 17 formed using the ball screws 18 and nuts 19. In addition, the clamping frame 10 can be driven by way of the cooperation of the four clamping frame drive devices 11 with the four spindle drives 14 formed using the ball screws 15 and the nuts 16.

In the preferred embodiment, the spindle drives 14, formed using the ball screws 15 and nuts 16, for displacing the clamping frame 10 are arranged at corner points of an imaginary first rectangle 37. In addition, the spindle drives 17, formed using the ball screws 18 and nuts 19, for displacing the table device 2 are arranged at corner points of an imaginary second rectangle 38. On this point, see Fig. 8, which shows in a schematically simplified manner the arrangement of the spindle drives 14, 17 as it appears in a plan view of the thermoforming machine 1 according to the embodiment. The corner points of the second rectangle 38 are arranged within the first rectangle 37, the arrangement being selected in such a way that the arrangement of the corner points of each of the rectangles 37, 38 is symmetrical about the longitudinal direction L and transverse direction Q of the thermoforming machine 1. Preferably, in addition, as can be seen from Fig. 1 to 6, the arrangement of the table drive devices 9 and clamping frame drive devices 11 is also substantially symmetrical about the longitudinal direction L and transverse direction Q.

The arrangement proposed for the embodiment has the advantage that the table drive devices 9 and the spindles 18 respectively coupled thereto can be arranged close to the table 2a, in other words at a slight horizontal distance 39 from the table 2a. By avoiding large distances to be bridged by the carriers 36, the portions 2b can be kept short, and the carriers 36, and thus also the table device 2, can be built in a comparatively compact, light and material-saving manner.

As stated previously, the thermoforming machine 1 according to the embodiment has adjustable window plate parts 28. So as not to impede the movability thereof in the horizontal direction parallel to the upper face 30a, facing the clamping frame 10, of the forming plate 30, the drive devices 4 may in particular be arranged in such a way that they do not protrude beyond the upper face 30a of the forming plate 30, in other words in such a way that the drive devices 4, which comprise the table drive devices 9 and the clamping frame drive devices 11, are accommodated substantially between a plane which extends substantially parallel to the clamping plane 5, and whose position is defined by the upper face 30a of the forming plate 30, and the imaginary plane 6.

In the installation space between the clamping plane 5 and the imaginary plane 6 or between the plane formed by the upper face 30a of the forming plate 30 and the imaginary plane 6, drives devices (not shown in the drawings) for the window plate parts 28 may additionally be accommodated.

Although the invention has been described completely in the above by way of preferred embodiments, it is not limited thereto but can be modified in numerous ways.

In particular, the number of provided drive devices can be adapted to the requirements of the thermoforming machine, for example to the size and weight of the table, forming tool and/or clamping frame.

In addition, instead of the ball screw drives, for example trapezoidal thread drives may be used.

List of reference signs

1	Thermoforming machine
2	Table device
2a	Table (table device)
2a’	Central region (table)
2b	Portion (table device)
3	Forming tool
4	Drive device
4a	Drive device
4b	Drive device
5	Clamping plane
6	Imaginary plane
6’	Further imaginary plane
7	Displacement device (table device)
8	Lower edge (table device)
9	Table drive device
10	Clamping frame
11	Clamping frame drive device
12	Floor
13	Machine housing
14	Ball screw drive
15	Spindle (ball screw drive)
16	Nut (ball screw drive)
17	Ball screw drive
18	Spindle (ball screw drive)
19	Nut (ball screw drive)
20	Electric motor
21	Axis of rotation
22	Angular gear

23	Electric motor
24	Axis of rotation
25	Angular gear
26a	Direction
26b	Direction
27	Starting material
28	Window plate part
28a	Upper face (window plate part)
30	Forming plate
30a	Upper face (forming plate)
31	Clearance
32	Sealing device
33	Sealing device
34	Displacement device (clamping frame)
35	Height (table)
36	Carrier (table)
37	First imaginary rectangle
38	Second imaginary rectangle
39	Distance
40	Distance
109	Table drive device (variant)

V	Vertical direction
H	Horizontal direction

L	Longitudinal direction (thermoforming machine)
Q	Transverse direction (thermoforming machine)

PATENTKRAV

1. Lukket-kammer termoformningsmaskine (1) med:

En bordanordning (2), som kan forskydes i en forskydningsretning (7) for et formningsværktøj (3); og

mindst en drivindretning (4);

hvorved termoformningsmaskinen (1) omfatter et lukket maskinhus, som er tætnet under driften af termoformningsmaskinen (1), og dette gør det muligt at hindre nedhængning af et opvarmet udgangsmateriale (27) for et arbejdsemne, der skal fremstilles, ved valg af et passende indre tryk;

hvorved termoformningsmaskinen (1) ydermere omfatter en spænderamme (10), der er arrangeret oven over maskinhuset (13), og som kan forskydes i en forskydningsretning (34) med henblik på fastspænding af udgangsmaterialet (27) i et indspændingsplan (5);

hvorved henholdsvis forskydningsretningen (7) for bordanordningen (2) og forskydningsretningen (34) for spænderammen (10) strækker sig i det væsentlige parallelt med en vertikal retning (V) og i det væsentlige vinkelret på indspændingsplanet (5);

hvorved drivindretningen (4) er dannet som en spænderamme-drivindretning (11) til drivning af spænderammen (10) med henblik på forskydning deraf, eller der er tilvejebragt et antal drivindretninger (4), og omfatter en spænderamme-drivindretning (11) eller en flerhed af spænderamme-drivindretninger (11) til drivning af spænderammen (10) med henblik på at forskyde den; og

hvorved den mindst ene drivindretning (4) i det væsentlige er anbragt mellem indspændingsplanet (5), i hvilket udgangsmaterialet (27) kan indspændes, og

et plan (6), der er defineret i en øvre forskydningsstilling for den forskydelige bordanordning (2) ved hjælp af underkanten (8) af den forskydelige bordanordning (2).

2. Termoformningsmaskine ifølge krav 1,

kendetegnet ved, at der er tilvejebragt to eller flere af drivindretningerne (4), hvorved drivindretningerne (4) omfatter en bord-drivindretning (9) eller en flerhed af bord-drivindretninger (9) til drivning af bordanordningen (2) med henblik på forskydning af samme, og hvorved drivindretningerne (4) ydermere omfatter spænderamme-drivindretningen (11) eller flerheden af spænderamme-drivindretninger (11) til drivning af spænderammen (10) med henblik på at forskyde den.

3. Termoformningsmaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** planet (6), defineret af den nedre kant (8) af den forskydelige bordanordning (2) i den øvre forskydningsposition for den forskydelige bordanordning (2), strækker sig i det væsentlige parallelt med indspændingsplanet (5).

4. Termoformningsmaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den mindst ene drivindretning (4) befinder sig i det væsentlige helt mellem indspændingsplanet (5) og planet (6), der er defineret af underkanten (8) af den forskydelige bordanordning (2) i en øvre forskydningsposition for den forskydelige bordanordning (2).

5. Termoformningsmaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den øvre forskydningsposition for den forskydelige bordanordning (2) er en af forskydningspositionerne for bordanordningen (2), som er tilvejebragt med henblik på driften af termoformningsmaskinen (1), i hvilken en afstand (40) for planet (6), som er defineret af underkanten (8) af den forskydelige bordanordning (2), fra indspændingsplanet (5) langs forskydningsretningen (7) for bordanordningen (2), er mindst.

6. Termoformningsmaskine ifølge et af de foregående krav, **kendetegnet ved, at** planet (6), som er defineret af underkanten kant (8) af den forskydelige bordanordning (2), i den øvre forskydningsposition for den forskydelige bordanordning (2) strækker sig i det væsentlige horisontalt i forhold til gulvet (12), på hvilket termoformningsmaskinen (1) kan opstilles med henblik på drift af samme.

7. Termoformningsmaskine ifølge et af de foregående krav,
kendetegnet ved, at et spindeldrev (14, 17), navnlig et kuglegevinddrev (14, 17), er koblet til mindst én drivindretning (4) på en sådan måde, at en spindel (15, 18) i spindeldrevet (14, 17) kan drives ved hjælp af den mindst ene drivindretning (4).

8. Termoformningsmaskine ifølge et af de foregående krav,
kendetegnet ved, at den mindst ene drivindretning (4) omfatter en motor (20, 23), navnlig en elektromotor (20, 23).

9. Termoformningsmaskine ifølge krav 8,
kendetegnet ved, at en rotationsakse (21, 24) i motoren (20, 23) i det væsentlige er orienteret parallelt med indspændingsplanet (5).

10. Termoformningsmaskine ifølge et af de foregående krav,
kendetegnet ved, at den mindst ene drivindretning (4) omfatter et gear (22, 25), navnlig et vinkelgear (22, 25).

11. Termoformningsmaskine ifølge et af de foregående krav,
kendetegnet ved, at der er tilvejebragt en flerhed af drivindretninger (4), som omfatter to, arrangeret grænsende op til hinanden, drivindretninger (4a, 4b), hvorved de to respektive, arrangeret grænsende op til hinanden, drivindretninger (4a, 4b), omfatter et gear (22, 25), navnlig et vinkelgear (22, 25), og de to drivindretninger (4a, 4b) er arrangeret således, at gearene (22, 25) er orienteret i modsatte retninger (26a, 26b).

12. Termoformningsmaskine ifølge et af de foregående krav,
kendetegnet ved, at termoformningsmaskinen (1) er udformet som en enkeltstation-termoformningsmaskine.

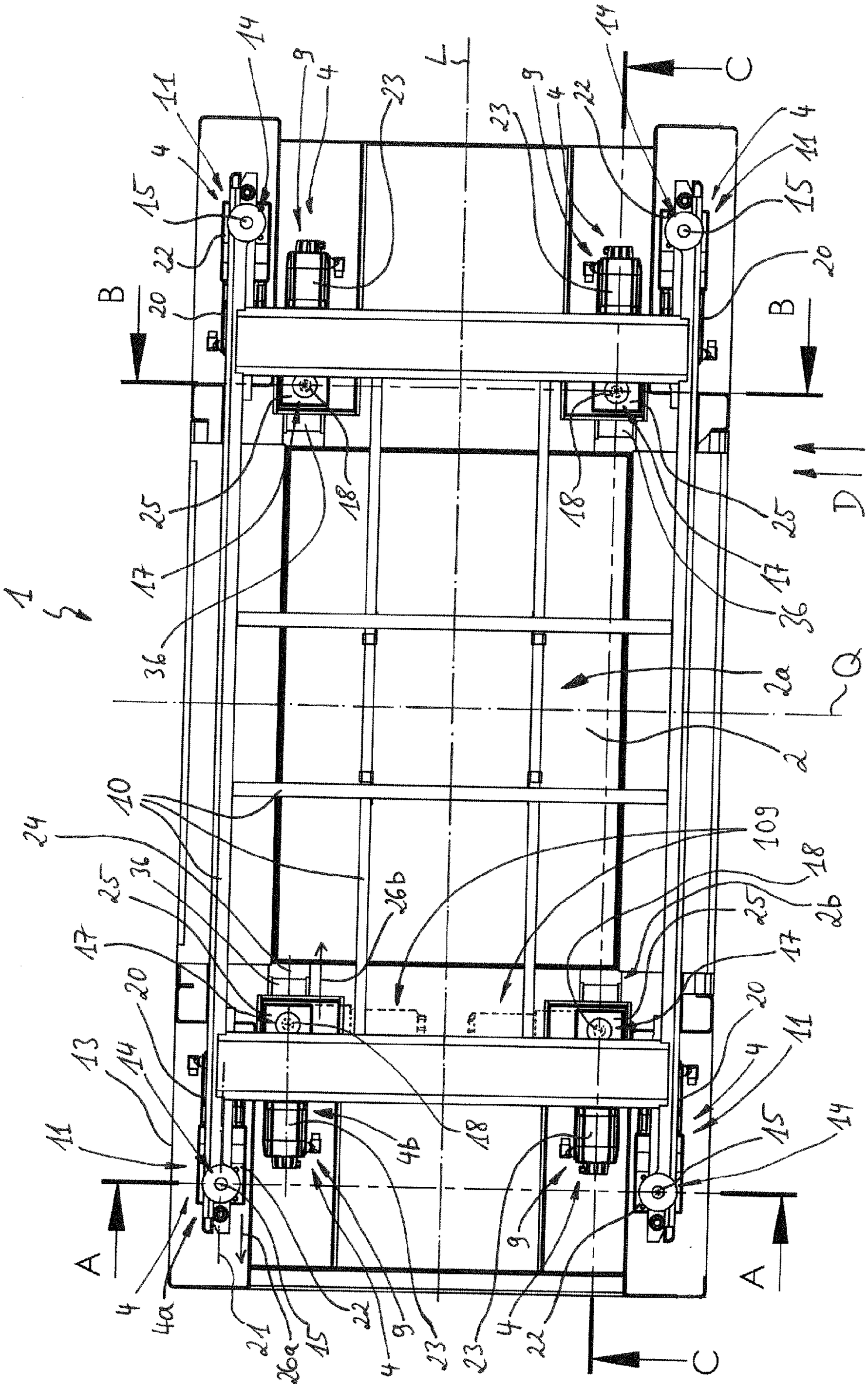
14
9
4
23
L
14
C
11
4
15
22
B
20
23
9
4
22
4
11
15
20
B
25
18
18
25
D
17
36
17
36
1
5
2a
Q
2
10
24
109
18
25
36
26b
17
2b
20
17
13
14
20
4
11
11
4b
18
15
14
9
A
A
4
4a
21
26a
15
22
9
13
23
4
22
C

Fig. 1

1
5

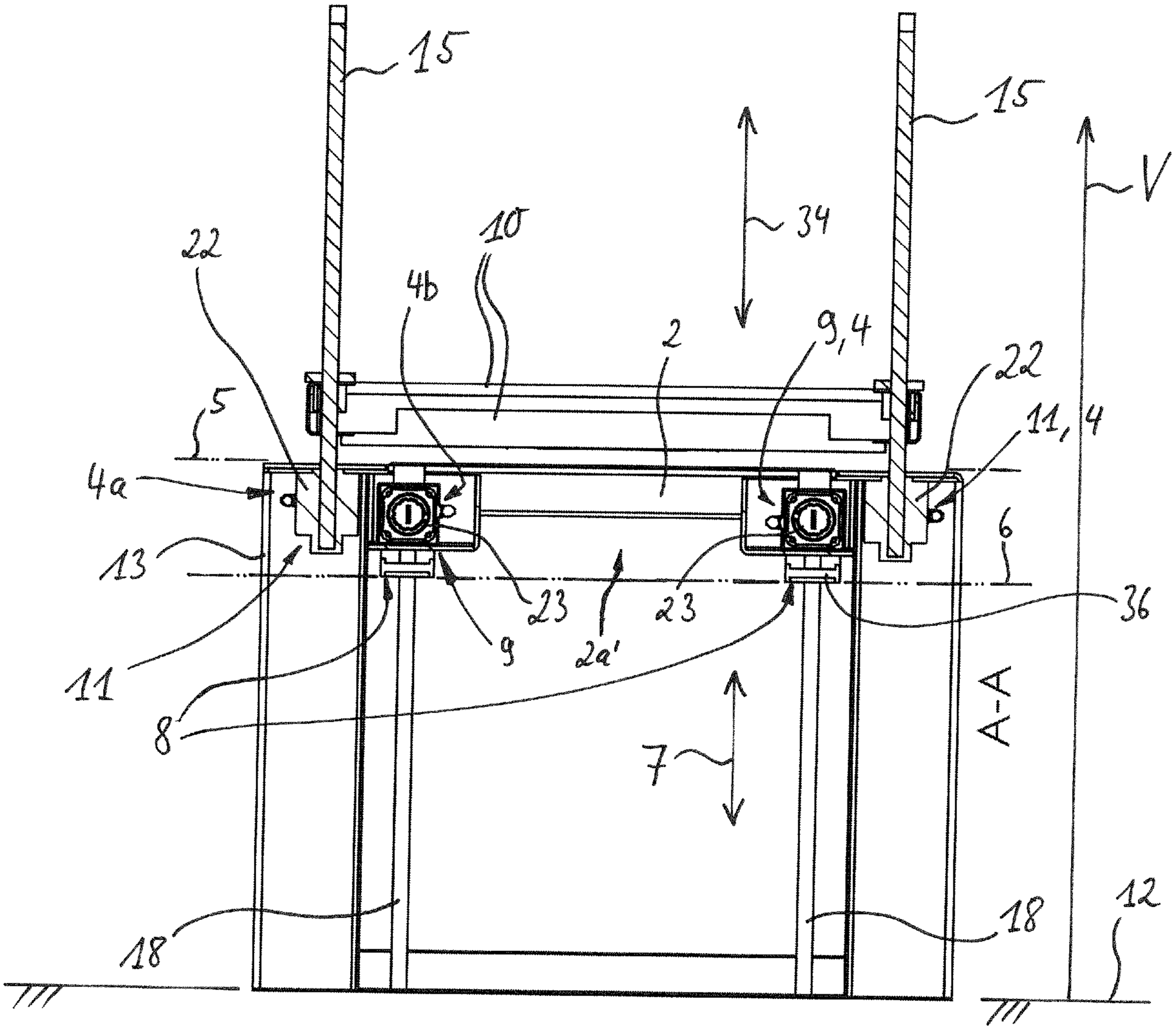
15
15
V
34
22
10
4b
2
9,4
22
5
11, 4
4a
6
13
23
23
36
9
2a'
11
8
7
A-A
18
18
12
III
III

Fig. 2

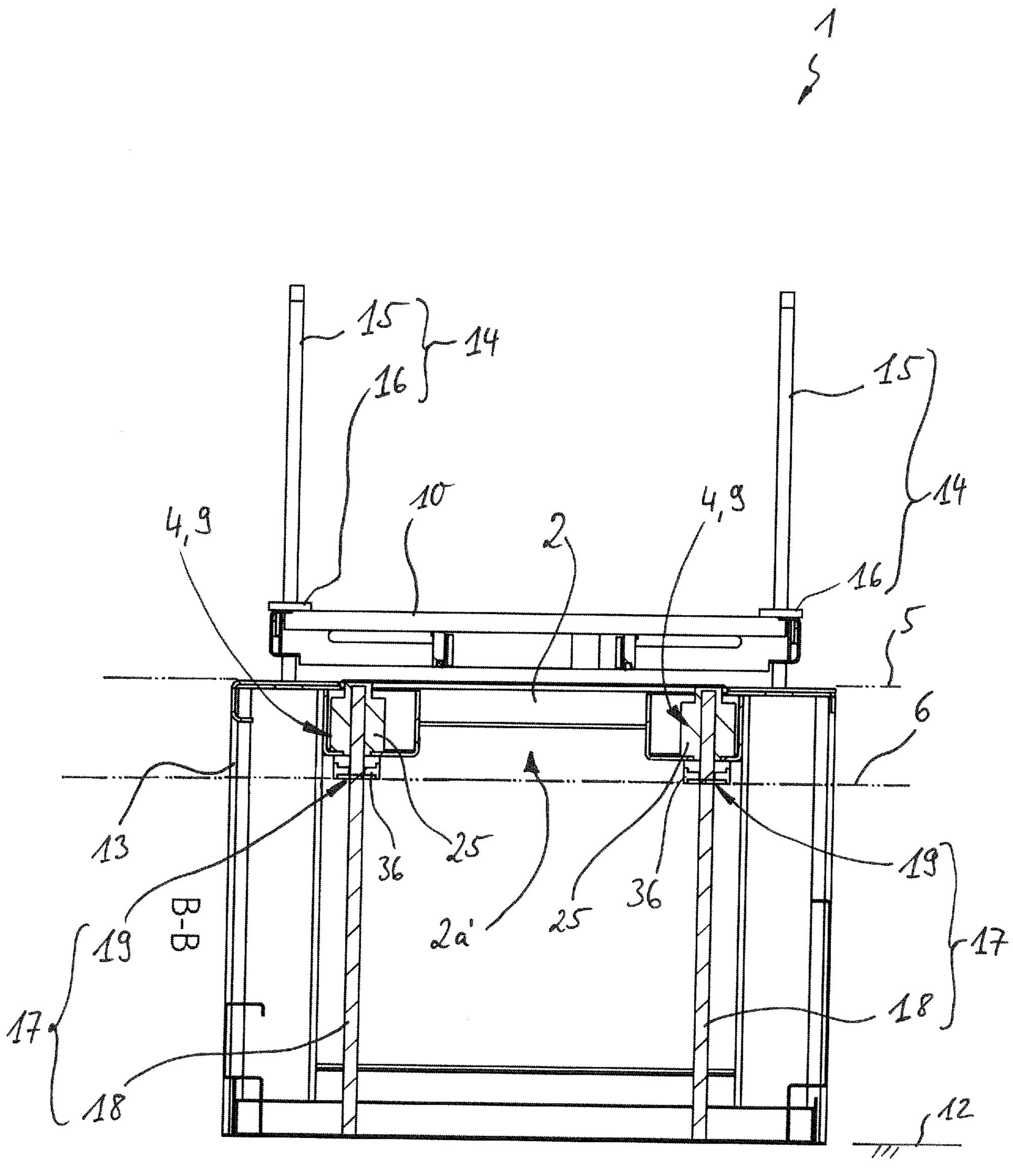

Fig. 3

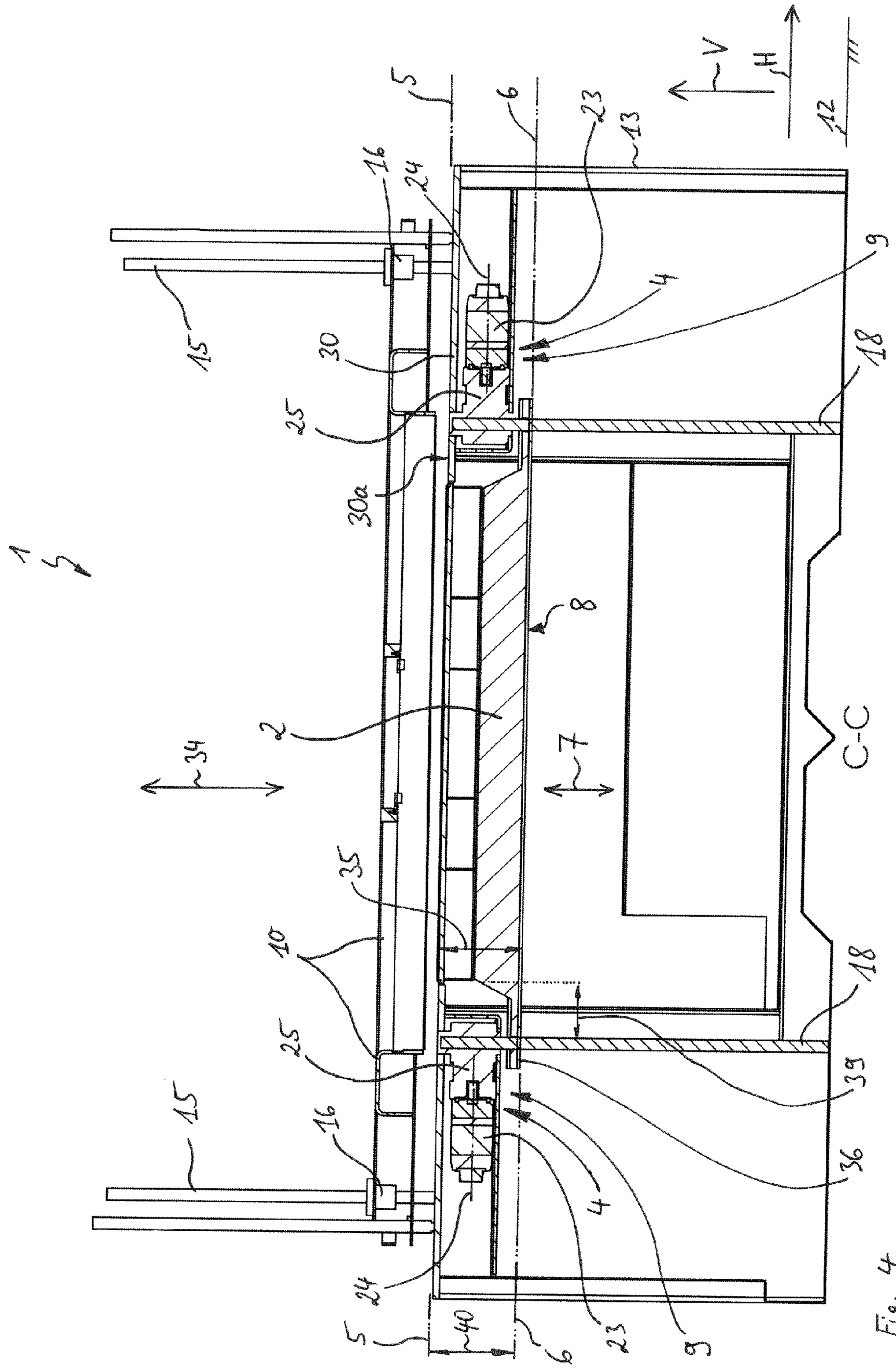
V
H
III
5
6
23
13
12
16
24
15
30
4
9
25
18
30a
1
8
2
34
7
C-C
35
10
25
18
33
15
16
36
4
24
5
40
6
23
9

Fig. 4

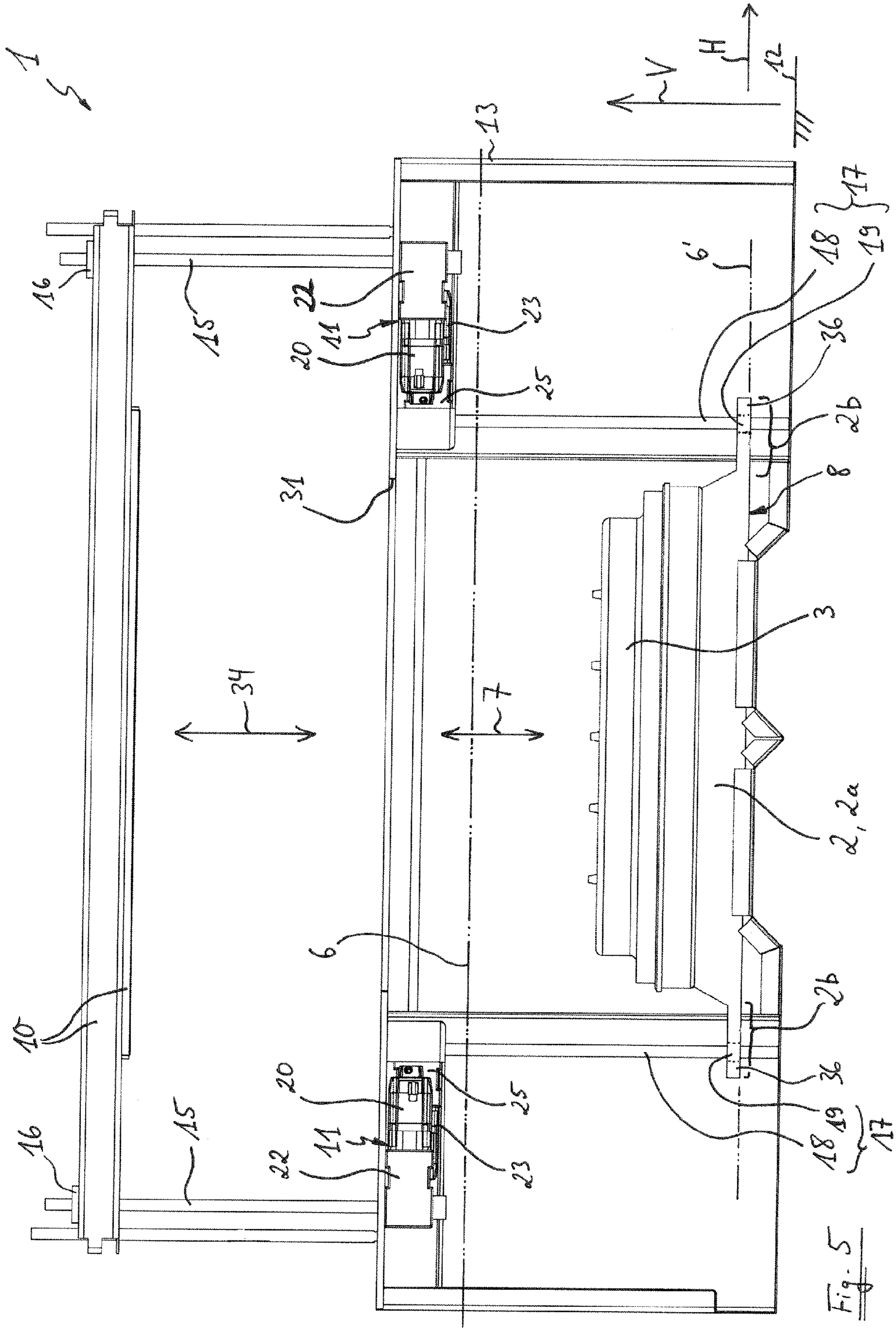

Fig. 5

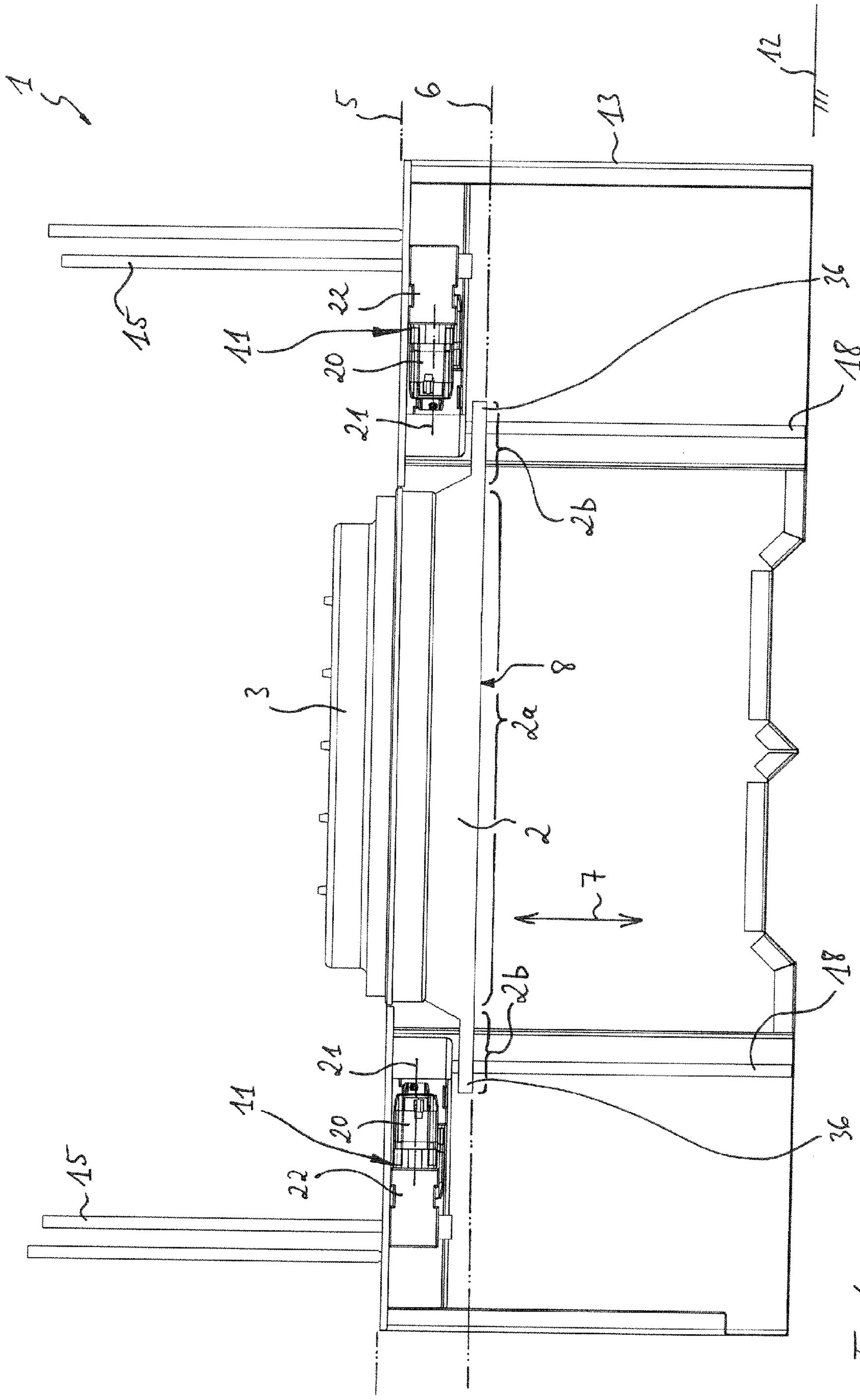

Fig. 6

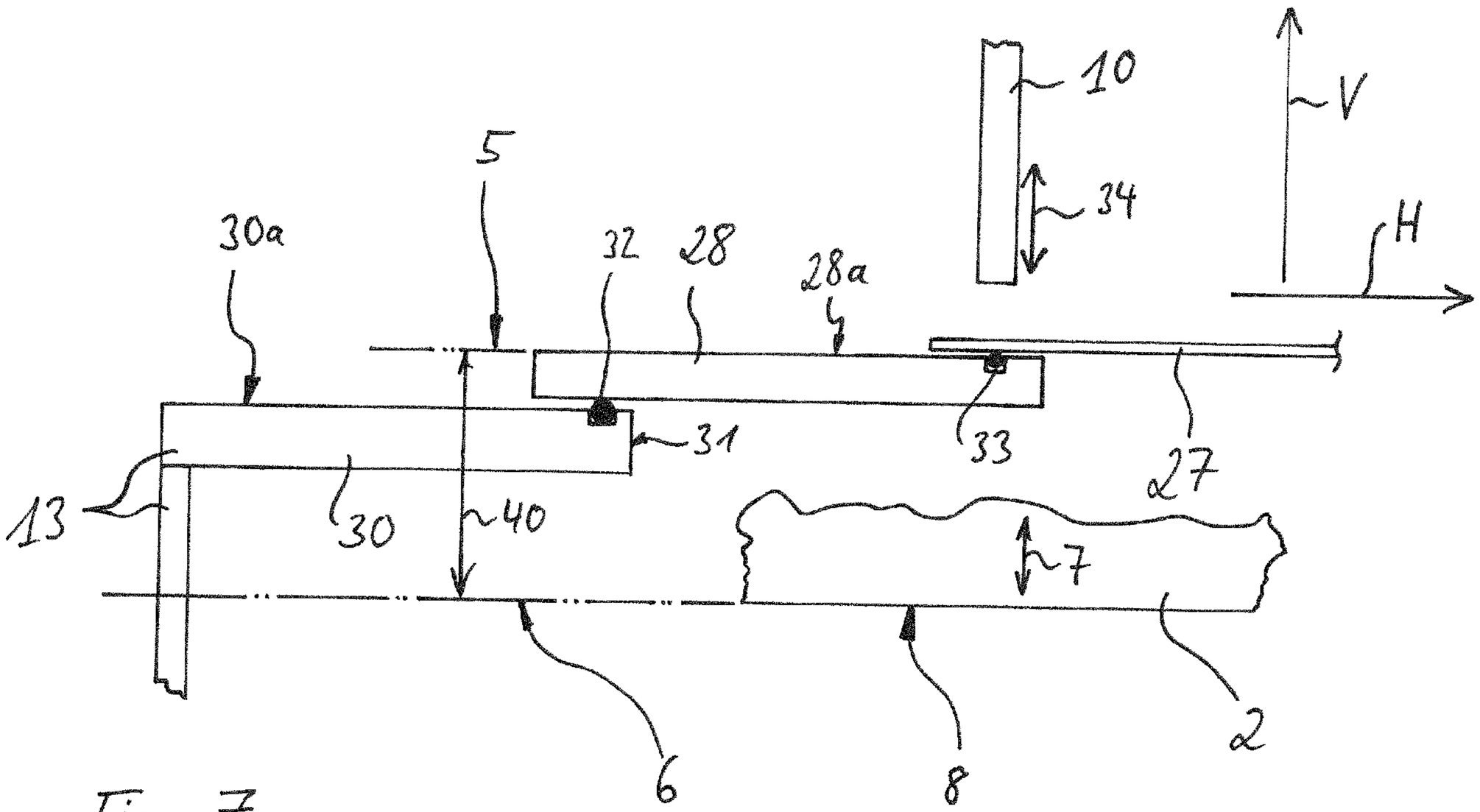

Fig. 7

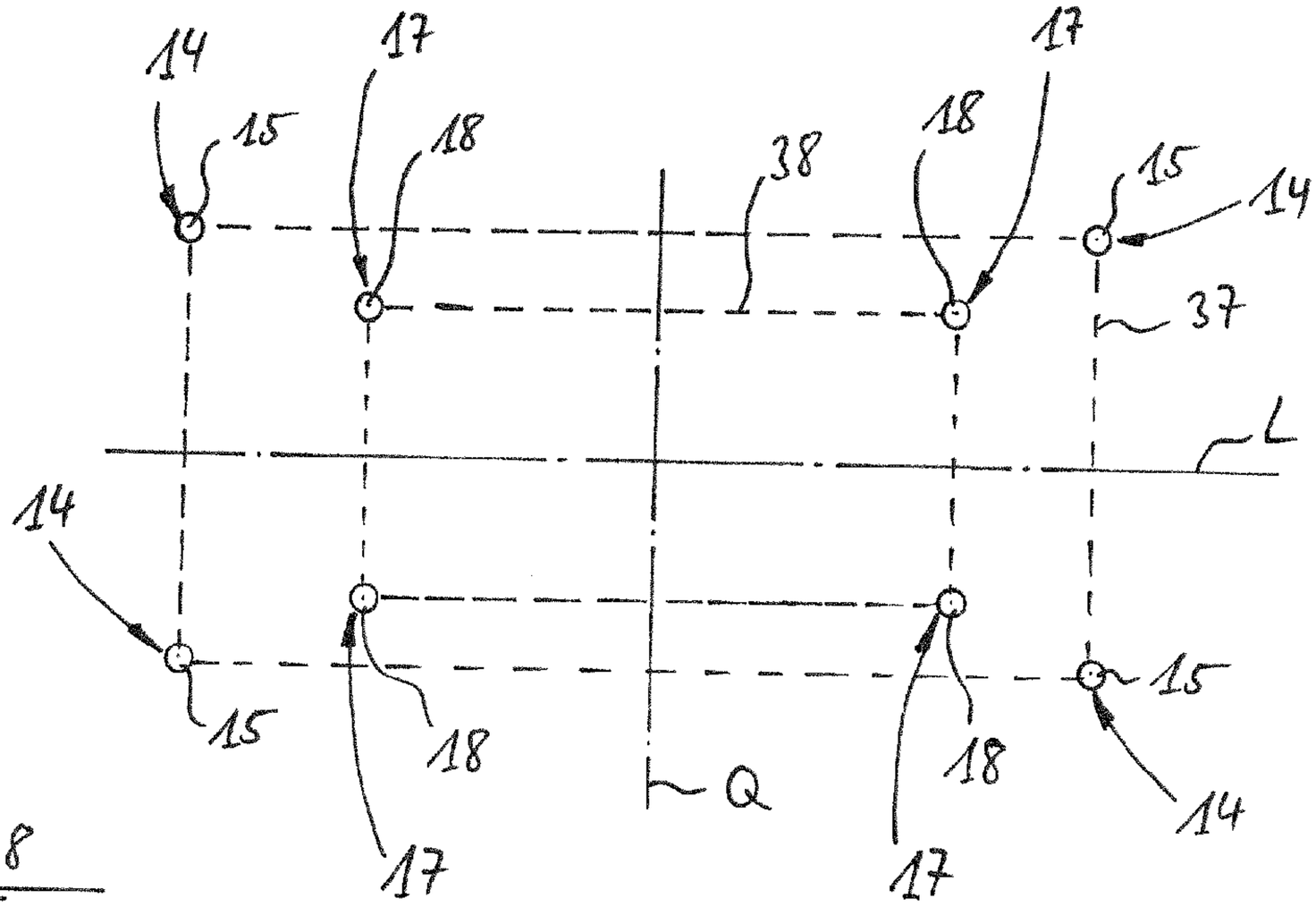

Fig. 8