

(19) **DANMARK**



Patent- og
Varemærkestyrelsen

(12)

Oversættelse af europæisk patentskrift

(10) **DK/EP 2944451 T3**

-
- (51) Int.Cl.: **B 29 C 51/38 (2006.01)** *B 29 C 51/10 (2006.01)* *B 29 C 51/26 (2006.01)*
- (45) Oversættelsen bekendtgjort den: **2017-10-23**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-07-12**
- (86) Europæisk ansøgning nr.: **14167943.1**
- (86) Europæisk indleveringsdag: **2014-05-12**
- (87) Den europæiske ansøgnings publiceringsdag: **2015-11-18**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **Geiss AG, Industriestrasse 2, 96145 Sesslach, Tyskland**
- (72) Opfinder: **Daum, Wolfgang, Georg-Danzer-Weg 8, 96106 Ebern, Tyskland**
- (74) Fuldmægtig i Danmark: **Patrade A/S, Fredens Torv 3A, 8000 Århus C, Danmark**
- (54) Benævnelse: **Termoformemaskine**
- (56) Fremdragne publikationer:
US-A- 3 704 974
US-A1- 2009 104 300
US-A1- 2010 270 696

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a thermoforming machine having a manoeuvrable table device for a forming tool.

TECHNICAL BACKGROUND

[0002] Thermoforming machines are used to produce formed parts from a flat starting material which is provided e.g. in the form of synthetic films or synthetic plates, under the effect of heat. This can be effected e.g. such that the starting material, e.g. a thermoplastic synthetic material, is initially heated using a suitable heating device and is thereby warmed and then brought to the desired shape using a suitable forming tool.

[0003] In such thermoforming machines, access to a processing region within the thermoforming machine, in which the starting material is fixedly clamped and shaped, should be possible from as many sides of the machine as possible. It may be desirable to provide access to this processing region which is as unhindered as possible, e.g. for manually inserting starting material or manually removing finished workpieces. In addition, it is also desirable to provide access which is as unrestricted as possible for heating devices and for different peripheral devices such as e.g. feeding devices for the starting material and/or feeding devices for additional parts.

[0004] Moreover, drive devices of the thermoforming machine, in particular those for movable components of

the thermoforming machine, are to be incorporated at a suitable location so that they can fulfil their function, but do not hinder access to the processing region

[0005] Previously, thermoforming machines have consequently been designed to be less compact and less space-saving than would appear to be desirable. WO2014020874, EP2586592, US2012211928, JP2002067137, JPH03184828, JPS6064825, EP0063462, EP1524094 show examples of closed chamber thermoforming machines. US2010270696, US2009104300, US3704974 show thermoforming machines having compact table drive devices.

SUMMARY OF THE INVENTION

[0006] Against this background, the object of the present invention is to provide a thermoforming machine which has a more compact design which saves more space and is preferably also more cost-effective than previous thermoforming machines. In particular, the access options for an operator and/or for peripheral devices should not be limited hereby, but should be maintained, or preferably even further improved.

[0007] This object is achieved in accordance with the invention by means of a thermoforming machine having the features of claim 1.

[0008] In accordance with the invention, a thermoforming machine is proposed, comprising

- a manoeuvrable table device for a forming tool, and
- at least one drive device.

Provision is hereby made in accordance with the invention that the at least one drive device is substantially arranged between a clamping plane, in which a starting material for a workpiece to be produced can be clamped, and a plane which is defined in an upper manoeuvring

position of the manoeuvrable table device by the lower edge of the manoeuvrable table device.

[0009] The concept forming the basis of the present invention resides in the advantageous incorporation, in a space-saving manner, of one or more drive devices, provided in the thermoforming machine, in an installation space delimited by two planes, on the one hand the clamping plane of the thermoforming machine and on the other hand the plane defined by the lower edge of the manoeuvrable table device.

[0010] The table device for the forming tool, which can include in particular a table for supporting the forming tool and sections, which can be manoeuvred with the table for applying holding and manoeuvring forces to the table, generally requires a structure which is sufficiently stable in order to be able to accommodate the loads acting thereon, in particular to be able to support the forming tool and contribute to the deformation of the heated starting material. In order to be able to accommodate the loads from the weight of the forming tool and the deformation process, the table device will thus have a certain extension in particular in a manoeuvring direction of the table device required by the table device for a sufficient mechanical bearing capacity and stiffness.

[0011] In an advantageous manner, in the invention the at least one drive device is incorporated in a space-saving manner between the clamping plane for the starting material on the one hand and the notional plane defined in its position by the lower edge of the table device in the upper manoeuvring position thereof on the other hand. In particular, the lower edge forms a delimitation of the table device remote from the clamping plane. In cases in which the table device is formed e.g. with a profile in

order to achieve the required stiffness and rigidity, the profile height of the table device can thus be used in an advantageous manner to incorporate the drive devices. The structural height of the thermoforming machine is hereby not undesirably increased by the drive device(s) because space is used for the incorporation of the drive device(s) which is provided in any case in the manoeuvring direction of the table device owing to the dimensions of the table device in the manoeuvring direction thereof. This is useful specifically in thermoforming machines for large draw depths. In addition, access to the clamping plane is not hindered by the drive device(s). The improved compactness of the thermoforming machine in accordance with the invention can also contribute to a reduction in the costs of manufacturing same.

[0012] Advantageous embodiments and developments of the invention are apparent from the dependent claims and from the description with reference to the figures in the drawing.

[0013] In accordance with the invention, the drive device is embodied as a table drive device for driving the table device so as to manoeuvre said table device, or multiple drive devices are provided which comprise a table drive device or multiple table drive devices for driving the table device so as to manoeuvre said table device. A space-saving drive of the table device and a compact design of the overall machine are hereby advantageously possible, in particular a comparatively small structural height with a comparatively large manoeuvring path of the table device. In addition, the arrangement in accordance with the invention of the table drive device(s) between the clamping plane and the plane defined by the lower edge allows the table drive

device(s) to be arranged at only a small distance from a manoeuvrable table of the table device, whereby long sections of the table device for applying manoeuvring forces to the table are avoided. In turn, this can prove to be favourable for the structural size of the table device and the material requirement thereof, since it is possible to provide smaller distances for those force application points in which the table device is subjected to a manoeuvring force using the respective table drive device, from the loads acting on the table of the table device.

[0014] In one embodiment, at least two, preferably four, table drive devices arranged between the clamping plane and the notional plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position of the table device are provided. In this manner, a force can be applied more uniformly in order to manoeuvre the table device.

[0015] In a further embodiment, the thermoforming machine comprises a manoeuvrable clamping frame for fixedly clamping the starting material in the clamping plane, wherein two or more of the drive devices are provided. In this embodiment, the drive devices comprise a table drive device or multiple table drive devices for driving the table device so as to manoeuvre said table device, and moreover comprise a clamping frame drive device or multiple clamping frame drive devices for driving the clamping frame so as to manoeuvre said clamping frame. In this manner, the incorporation of the table drive in a space-saving manner and the incorporation of the clamping frame drive in a space-saving manner are advantageously combined.

[0016] In one development, at least two, preferably four, clamping frame drive devices arranged between the

clamping plane and the notional plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position of the table device are provided. In an advantageous manner, a force for manoeuvring the clamping frame and for fixedly clamping the starting material in the clamping plane can be applied uniformly to the clamping frame.

[0017] In one embodiment, at least two, preferably four, table drive devices and also at least two, preferably four, clamping frame drive devices can be provided.

[0018] In particular, the notional plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position of the table device can extend substantially in parallel with the clamping plane.

[0019] In a preferred embodiment, the at least one drive device is located substantially entirely between the clamping plane and the plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position of the manoeuvrable table device. In this manner, the machine can be designed in an even more compact manner.

[0020] In one embodiment, the upper manoeuvring position of the manoeuvrable table device is one of the manoeuvring positions of the table device which are provided for the operation of the thermoforming machine and in which a distance of the notional plane defined by the lower edge of the manoeuvrable table device is at its smallest from the clamping plane along the manoeuvring direction of the table device. This can be in particular the uppermost manoeuvring position of the table device. This can advantageously contribute to a particularly compact design of the thermoforming machine.

[0021] In one embodiment, the plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position of the manoeuvrable table device extends substantially horizontally in relation to a floor on which the thermoforming machine can be positioned for the purpose of operating said thermoforming machine.

[0022] In one embodiment, a spindle drive, in particular a ball screw drive, is coupled to the at least one drive device in such a manner that a spindle of the spindle drive can be driven by means of the at least one drive device. This permits an effective conversion of a movement provided by the drive device into a linear movement which e.g. can be advantageously used for manoeuvring the table device or the clamping frame.

[0023] In one embodiment, the at least one drive device comprises a motor. In a preferred embodiment, the motor can be embodied in particular as an electric motor, e.g. a three-phase motor. Components to be moved can be manoeuvred or moved with a high level of precision by using a drive in the form of a motor, in particular an electric motor. This can be useful and advantageous e.g. for manoeuvring the table device for the forming tool but also for manoeuvring the clamping frame, because positions to be approached by the table device or the clamping frame in their respective manoeuvring direction can be assumed in this embodiment with an improved level of precision. In addition, by using a motor, in particular an electric motor, instead of a pneumatic or hydraulic drive, there is no need to provide a pneumatic-system or hydraulic system cabinet with valves and further pneumatic or hydraulic equipment, which in turn permits an even more compact design of the thermoforming machine.

[0024] However, in alternative embodiments, the at least one drive device could instead be formed as a pneumatic or hydraulic drive device.

[0025] In a preferred development, an axis of rotation of the motor is oriented substantially in parallel with the clamping plane. In another development, the axis of rotation extends substantially in parallel with a longitudinal direction of the thermoforming machine. An arrangement of the least one drive device which saves even more space can be achieved by the two developments mentioned above.

[0026] In a further embodiment, the at least one drive device comprises a gear, in particular an angular gear. A gear can permit a conversion of rotational speed and torque for adapting same to the requirements of the component to be driven. Additionally, by means of an angular gear, a deflection of a movement provided by the drive device, e.g. a torque provided by the motor on the output side, advantageously occurs. Such a deflection can be advantageous in particular when the drive device comprises a motor and the axis of rotation thereof is oriented substantially in parallel with the clamping plane.

[0027] In one embodiment of the invention, several of the drive devices are provided which comprise two drive devices arranged adjacent to one another. The two drive devices arranged adjacent to one another each comprise a gear, in particular an angular gear, and are arranged in such a manner that the gears point in opposite directions. In this manner, for example, a first one of the two drive devices can be embodied as a table drive device and, for this, the gear for applying the manoeuvring force as directly as possible to a table of the table device can be arranged close thereto, whilst

the adjacent second drive device is configured as a clamping frame drive device and its gear can be sufficiently spaced apart from the table device so as not to hinder loading and unloading procedures, nor the movement of other movable components, e.g. the parts of a window plate system.

[0028] In one embodiment, the thermoforming machine can comprise four table drive devices and four spindle drives for manoeuvring the table device, in particular four ball screw drives. A spindle, in particular a ball roller spindle, of an associated one of the spindle drives is coupled to each of the table drive devices on the output side in such a manner that the spindle can be driven by means of the table drive device for manoeuvring the table device. This can be advantageous in particular for manoeuvring a table device with a substantially rectangular table because for a precise and slightly resilient movement of the table device a spindle drive having an associated table drive device can be arranged in the region of each corner thereof.

[0029] In a further embodiment, the thermoforming machine can comprise four clamping frame drive devices and four spindle drives for manoeuvring the clamping frame, in particular four ball screw drives. A spindle, in particular a ball roller spindle, of one of the spindle drives is coupled to each of the clamping frame drive devices on the output side in such a manner that the spindle can be driven by means of the associated clamping frame drive device for manoeuvring the clamping frame. This can be useful in particular in the case of a substantially rectangular clamping frame in order to precisely manoeuvre the clamping frame by arranging in each case one spindle drive and one clamping frame drive

device associated therewith in the region of each corner of the clamping frame.

[0030] In a preferred development, the spindle drives for manoeuvring the clamping frame are arranged at corner points of a notional first rectangle.

[0031] In accordance with a further preferred development, the spindle drives for manoeuvring the table device are arranged at corner points of a notional second rectangle.

[0032] In one embodiment, the corner points of the second rectangle are arranged within the first rectangle. In this manner, the table drive devices can be arranged close to a table of the table device which allows the table device to be of a more lightweight design, thus saving material, whilst at the same time the spindle drives for manoeuvring the clamping frame can be arranged above the clamping plane further away from the table in order to maintain accessibility and to provide sufficient space, when inserting an adjustable window plate, for adjusting the window plate parts.

[0033] In one embodiment, the thermoforming machine can comprise two table drive devices and two spindle drives for manoeuvring the table device, in particular two ball screw drives. A spindle, in particular a ball roller spindle, of an associated one of the spindle drives can be coupled to each of the two table drive devices on the output side in such a manner that the spindle can be driven by means of the table drive device for manoeuvring the table device. The two table drive devices and the spindle drives can be arranged e.g. on opposite sides or in the region of diagonally opposite corners of a table of the table device.

[0034] In a further embodiment, the thermoforming machine can comprise two clamping frame drive devices and

two spindle drives for manoeuvring the clamping frame, in particular two ball screw drives. A spindle, in particular a ball roller spindle, of one of the spindle drives is coupled to each of the clamping frame drive devices on the output side in such a manner that the spindle can be driven by means of the associated clamping frame drive device for manoeuvring the clamping frame. The two clamping frame drive devices and the spindle drives can be arranged in this embodiment e.g. on opposite sides or in the region of diagonally opposite corners of a table of the clamping frame.

[0035] In one embodiment, the thermoforming machine is embodied as a single-station thermoforming machine. The arrangement in accordance with the invention of the least one drive device can be advantageous in particular in single-station thermoforming machines because in such machines, substantially all of the steps for thermoforming the starting material for producing the workpiece, in particular heating and forming, are performed at one and the same workstation. A single-station thermoforming machine thus takes advantage in particular of the good accessibility and compact design achieved by the invention. The thermoforming machine is embodied as a closed chamber thermoforming machine. Closed chamber thermoforming machines are those thermoforming machines which have a closed and sealed machine housing. This means that sagging of the heated starting material can be avoided by selecting a suitable internal pressure.

[0036] In one embodiment, provision can be made that the thermoforming machine comprises a machine housing having a die plate, wherein the at least one drive device can be arranged substantially between a side facing a clamping frame, in particular an upper side, of the die

plate and the notional plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position thereof. In particular, the at least one drive device can extend as far as the side of the die plate facing the clamping frame, but does not protrude therebeyond in this embodiment. This embodiment can be advantageous e.g. if a window plate is provided which lies sealingly against the die plate and the starting material is placed on movable parts of the window plate and is clamped against these parts.

[0037] In one embodiment, the at least one drive device can comprise a drive device for parts of a window plate or multiple drive devices for parts of a window plate which is/are incorporated between the clamping plane and the notional plane, in particular between the side of the die plate facing a clamping frame and the notional plane defined by the lower edge of the manoeuvrable table device in the upper manoeuvring position thereof.

[0038] The thermoforming machine can be embodied in particular as a vacuum forming machine, by means of which the starting material can be deformed by means of a vacuum and the forming tool.

[0039] The above embodiments and developments can be combined with each other in any manner if it is useful to do so. Further possible embodiments, developments and implementations of the invention also include non-explicitly-mentioned combinations of features of the invention which have been described or will be described hereinafter with reference to the exemplified embodiments. In this regard, a person skilled in the art will also add in particular individual aspects as improvements or complements to the respective basic form of the invention.

CONTENT OF THE DRAWINGS

[0040] The invention will be explained in more detail hereinafter with the aid of the exemplified embodiment indicated in the schematic figures, in which:

Figure 1 shows a plan view of a thermoforming machine in accordance with an exemplified embodiment of the invention, having a clamping frame and a manoeuvrable table device, some of the components having been omitted for improved clarity;

Figure 2 shows a view of the thermoforming machine in accordance with the exemplified embodiment of figure 1 in a cross-section A-A, as indicated in figure 1;

Figure 3 shows a view of the thermoforming machine in accordance with the exemplified embodiment of figure 1 in a cross-section B-B, as indicated in figure 1;

Figure 4 shows a view of the thermoforming machine in accordance with the exemplified embodiment of figure 1 in a longitudinal section C-C, as indicated in figure 1;

Figure 5 shows a front view of the thermoforming machine in accordance with the exemplified embodiment of figure 1 in the viewing direction D, see figure 1, wherein the clamping frame is manoeuvred upwards and the table device is manoeuvred downwards, e.g. in order to remove a finished workpiece, an exemplary forming tool arranged on a table of the table device is also shown and some parts of a machine housing have been omitted for improved visibility of components arranged therein;

Figure 6 shows a view of the thermoforming machine in accordance with the exemplified embodiment of figure 1, which corresponds to that in figure 5, but wherein the clamping frame has been omitted and the table device with

the forming tool is in its upper end position, in which thermoforming of a starting material can take place;

Figure 7 shows a schematic illustration for illustrating the arrangement of a die plate, a window plate, a clamping frame and a flat starting material with respect to each other; and

Figure 8 shows a schematically simplified illustration for illustrating the arrangement of spindle drives for manoeuvring the table device and the clamping frame.

[0041] The attached drawings should provide improved understanding of the embodiments of the invention. They illustrate embodiments and are used in conjunction with the description to explain principles and concepts of the invention. Other embodiments and many of said advantages will be apparent in view of the drawings.

[0042] In the figures of the drawings, like and functionally identical elements, features and components and elements, features and components acting in an identical manner are provided with the same reference signs, unless indicated otherwise.

[0043] The elements in the drawings are not necessarily illustrated to scale with respect to each other.

DESCRIPTION OF EXEMPLIFIED EMBODIMENTS

[0044] An exemplified embodiment of the invention is explained in more detail hereinafter with reference to figures 1 to 8. Figures 1 to 8 show a single-station thermoforming machine 1 designed according to the closed chamber principle in accordance with the exemplified embodiment, wherein some components, including e.g. parts of a machine housing, a heater, and peripheral devices

and accessories, operating devices, control cabinets, etc., have been omitted for improved clarity. In order to operate the thermoforming machine 1, it is placed onto a substantially horizontal floor 12. A horizontal direction substantially in parallel with the floor 12 is designated in the figures with reference sign H and a vertical direction substantially perpendicular to the floor 12 is designated with reference sign V.

[0045] A closed machine housing 13 which is sealed during operation of the thermoforming machine 1 and has a stable machine frame, forms a lower part of the thermoforming machine 1. An upper side of the machine housing 12 is formed by a so-called die plate 30. The die plate 30 comprises a substantially rectangular section 31 whose shape and size correspond to the shape and dimensions of a table 2a which can be manoeuvred along a manoeuvring direction 7. The table 2a is a component of a table device 2 which, in addition to the table 2a, comprises sections 2b which are provided for holding and manoeuvring the table 2a and can be manoeuvred together with the table 2a. In the illustrated exemplified embodiment, the sections 2b protrude horizontally from the table 2a and have a suitable profile for providing sufficient stiffness and rigidity, see e.g. figure 2. The table device 2 is provided for this purpose and is arranged to support a forming tool 3 for thermoforming a workpiece, not illustrated, on the table 2a, see figures 5 and 6 which also show an exemplary forming tool 3. Furthermore, the table device 2 is configured so as to be manoeuvrable together with the forming tool 3 in the manoeuvring direction 7 in relation to the machine housing 13 such that the forming tool 3 can pass through the section 31, see figures 5 and 6.

[0046] A multi-part window plate having multiple window plate parts 28, of which only one is partly schematically shown in figure 7, is arranged on an upper side 30a of the die plate 30, i.e. an upper surface of the die plate 30. The window plate parts 28 are not shown in figures 1 to 6. The window plate parts 28 can be displaced with respect to each other and are sealed with respect to the die plate 30 by means of sealing devices 32 which are only schematically indicated. The purpose of the window plate parts 28 is to partly cover the section 31 for adapting to the size of a flat starting material 27 to be processed, which starting material can be a thermoplastic synthetic film or synthetic plate.

[0047] The starting material 27 is supported on an upper side 28a of the window plate parts 28, wherein again a sealing device 33 produces the sealing tightness with respect to the window plate parts 28, see figure 7. A clamping frame 10 which is arranged above the machine housing 13 and can be manoeuvred in a manoeuvring direction 34 upwards and downwards with respect to the machine housing 13 is provided to fixedly clamp the flat starting material 27 with respect to the upper side 28a of the window plate parts 28. The upper side 28a thus forms a clamping plane 5 in which the starting material 27 for the workpiece to be produced by thermoforming is clamped. After clamping the starting material 27, this can be heated by means of a heating device, not shown. By way of the design principle of the closed chamber thermoforming machine having a sealed, closed machine housing 13, it is possible to avoid sagging of the heated and thus plastically formable synthetic plate or synthetic film under its own weight. The heated starting material 27 is brought to the desired target shape by

means of the forming tool 3, in particular using a vacuum.

[0048] The manoeuvring direction 7 of the table device 2 and the manoeuvring direction 34 of the clamping frame 10 each extend substantially in parallel with the vertical direction V and substantially perpendicular to the clamping plane 5 and the upper sides 28a and 30a.

[0049] In order to be able to manoeuvre the table device 2 and thus the table 2a in the manoeuvring direction 7, the thermoforming machine 1 comprises four drive devices 4 which are designated hereinafter as table drive devices 9. The thermoforming machine 1 further comprises four other drive devices 4 which are designated hereinafter as clamping frame drive devices 11 and are used to manoeuvre the clamping frame 10. By means of the table drive devices 9, the table device 2 with the table 2a can thus be driven so as to move in the manoeuvring direction 7, whereas the clamping frame 10 can be driven by means of the clamping frame drive devices 11 so as to move in the manoeuvring direction 34.

[0050] Each of the table drive devices 9 comprises an electric motor 23, e.g. a three-phase motor, having an axis of rotation 24 oriented in parallel with the clamping plane 5 and thus also in parallel with the horizontal direction H, and comprises an angular gear 25 coupled to the electric motor 23. In order to be able to drive the table device 2 for the manoeuvring movement in the manoeuvring direction 7, each of the angular gears 25 is coupled on the output side to a ball roller spindle 18 mounted in the machine housing 13 and oriented substantially in the vertical direction V. Therefore, each of the electric motors 23 is able to cause an associated one of the ball roller spindles 18 to rotate, wherein the rotational movement provided by the electric

motor 23 is deflected by 90 degrees by the angular gear 25. An associated nut 19, in particular a recirculating ball nut, fixed to the table device 2, in the illustrated exemplified embodiment to the sections 2b, cooperates with each of the ball roller spindles 18, said nut being only schematically illustrated in the figures. The table 2a can be moved up and down by means of a synchronous rotation of the four ball roller spindles 18. In each case a nut 19 and a ball roller spindle 18 associated therewith thus form a ball screw drive 17 coupled to the associated table drive device 9 for manoeuvring the table device 2. The angular gear 25 can be configured such that the angular gear 25 effects a conversion of torque and rotational speed provided by the electric motor 23.

[0051] Each of the clamping frame drive devices 11 comprises an electric motor 20, e.g. a three-phase motor, having an axis of rotation 21 oriented in parallel with the clamping plane 5 and thus also in parallel with the horizontal direction H, and comprises an angular gear 22 coupled to the electric motor 20. In order to drive the clamping frame 10 to manoeuvre same in the manoeuvring direction 34, each of the angular gears 22 is coupled on the output side to a ball roller spindle 15 protruding from the machine housing 13 substantially in parallel with the vertical direction V upwards through the clamping plane 5. Each of the electric motors 20 is hereby able to cause an associated one of the four ball roller spindles 15 to rotate. The rotational movement provided by the electric motor 20 is deflected by 90 degrees by the angular gear 22. An associated nut 16, in particular a recirculating ball nut, cooperates with each of the ball roller spindles 15, whereby the clamping frame 10 can be moved up and down by means of a synchronous rotation of the four ball roller spindles 15.

In each case a nut 16 fixed to the clamping frame 10 and a ball roller spindle 15 associated therewith thus form a ball screw drive 14 coupled to the associated clamping frame drive device 11 for manoeuvring the clamping frame 10. The angular gear 22 can also be used to convert rotational speed and torque provided by the electric motor 20.

[0052] The table drive devices 9 and the clamping frame drive devices 11 are each fixedly coupled to the machine housing 13. This can be effected by way of example by screwing the respective angular gear 22, 25 with the machine housing 13 and/or die plate 30 and further screwing a housing of the respective electric motor 20, 23 with the associated angular gear 22 or 25.

[0053] A notional plane 6, see figures 2 to 7, extends below the clamping plane 5 substantially in parallel with the clamping plane 5 and is spaced apart from the clamping plane 5 in the manoeuvring direction 7 of the table device 2. The position of the notional plane 6, which is thus substantially horizontal relative to the floor 12, is fixed in the manoeuvring direction 7, i.e. the position of the plane in the vertical direction V, by a lower edge 8, remote from the clamping plane 5, of the manoeuvrable table device 2 in the uppermost manoeuvring position of the table device 2 in the manoeuvring direction 7 which is intended to be taken up by the table device 2 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. The lower edge 8 defining the position of the plane 6 is the delimitation of the table device 2 furthest away from the clamping plane 5 in the manoeuvring direction 7 in the uppermost manoeuvring position of the table device 2. This means that the lower edge 8 can lie in the region of

the table 2a or the sections 2b or, if the table 2 and sections 2b terminate at the same height, in the region of both the table and the sections. As shown in figure 2, in the exemplified embodiment the notional plane 6 is defined by the lower edge - in other words, a lower border - of supports 36 which also form the sections 2b. By means of the supports 36, in the illustrated exemplified embodiment manoeuvring and holding forces can be introduced into the table 2a using the spindles 18. In the illustrated exemplified embodiment, the lower edge of the supports 36 corresponds to the lower edge 8 of the table device 2. It is also clear from figure 2 that the table 2a can be smaller in height in a central region 2a'. However, in variations of the exemplified embodiment, the table 2a could comprise in the central region 2a' a lower edge which e.g. is at the same height as the lower edge of the supports 36.

[0054] This upper manoeuvring position of the table device 2, as shown in figures 2 to 4 and 6, can be in particular a forming position in which the thermoforming is performed using the forming tool 3. In this manoeuvring 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 notional plane 6 are at a minimum, as measured in the manoeuvring direction 7. In addition, in this manoeuvring position, a distance of the lower edge 8 from the upper surface of the die plate 30 designated as the upper side 30a is also at a minimum, as measured in the manoeuvring direction 7.

[0055] Starting from the manoeuvring position of the table device 2 shown in figure 4, provision is made that the table device 2 can then be manoeuvred downwards in the manoeuvring direction 7 during operation of the

thermoforming machine 1, whereby the lower edge 8 is further away from the clamping plane 5. With regard to the notional plane 6 fixed by the uppermost manoeuvring position of the table device 2, it shall be assumed that this maintains its position. However, in the other manoeuvring positions which the table device 2 can assume during operation of the thermoforming machine 1, the drive devices 4 in the illustrated exemplified embodiment are also always arranged between the clamping plane 5 and a further notional plane 6', which is substantially in parallel with the clamping plane and whose position is fixed in the manoeuvring direction 7 by the lower edge 8 of the table device 2 in its respective current manoeuvring position. The plane 6' is shown by way of example for the lower end position of the table device 2 in figure 5.

[0056] The drive devices 4 - in other words, the four table device devices 9 having the electric motors 23 and the angular gears 25, and the four clamping frame drive devices 11 having the electric motors 20 and the angular gears 22 - are thus each located between the clamping plane 5 and the notional plane 6. In this manner, for the incorporation of the drive devices 4 space is advantageously used which would be added to the required manoeuvring path of the table device 2 anyway owing to the required height 35 of the table structure, in particular the support height required for accommodating the loads acting thereon, for determining the structural height of the machine housing 13.

[0057] As can be seen from the figures, the electric motors 23 and the angular gears 25 of the table drive devices 9 and the electric motors 20 and the angular gears 22 of the clamping frame drive devices 11 are substantially completely incorporated between the

clamping plane 5 and the notional plane 6. Arranging the table and clamping frame drive devices 9, 11 between the planes 5 and 6 thus avoids an undesired extension of the height of the machine housing 13 in order to incorporate the drive devices.

[0058] As can be seen in figures 1, 4 and 6, the axes of rotation 21, 24, oriented substantially in parallel with the clamping plane 5, of the electric motors 20, 23 are also each oriented substantially in parallel with a longitudinal direction L of the thermoforming machine 1, see figure 1. In this manner, every two adjacent drive devices - in the illustrated exemplified embodiment a table drive device 9 and a clamping frame drive device 11, designated by way of example with reference signs 4b and 4a - having the respective electric motor and gear are incorporated in a space-saving manner. The angular gears 22, 25 of the two mutually adjacent drive devices 4a, 4b point in opposite directions 26a, 26b in the longitudinal direction L.

[0059] In the exemplified embodiment illustrated in the figures, 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 notional plane 6. However, in variations of the exemplified embodiment, the table drive devices 9 and the clamping frame drive devices 11 could instead also be oriented in a different manner, so long as it is ensured that they are incorporated between the clamping plane 5 and the notional plane 6 and that there is no collision with other movable or non-movable components of the thermoforming machine 1 which are not illustrated in further detail here. Figure 1 shows how, in a variation of the exemplified embodiment shown as dashed lines in figure 1, the table drive device 9 can alternatively be

installed in a manner rotated about the longitudinal axis of the spindle 18 by +90 degrees or -90 degrees. Two table drive devices in accordance with this variation are illustrated in figure 1 and are designated with the reference sign 109. In other variations, for example, the clamping frame drive devices 11 could be rotated about the vertical direction V by 180 degrees in each case, so long as there is no collision with other components. However, the arrangement in figure 1 is preferred because the illustrated arrangement of the spindles accommodates the space requirement of the window plate system.

[0060] The thermoforming machine 1 in accordance with the exemplified embodiment illustrated in the figures comprises four parallel ball roller spindles 15, four parallel ball roller spindles 18, four nuts 16 and four nuts 19. Therefore, the table device 2 can be driven by way of the cooperation of the four table drive devices 9 with the four spindle drives 17 formed with the ball roller spindles 18 and the 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 with the ball roller spindles 15 and the nuts 16.

[0061] In the preferred exemplified embodiment, the spindle drives 14, formed with the ball roller spindles 15 and the nuts 16, for manoeuvring the clamping frame 10 are arranged at corner points of a notional first rectangle 37. In addition, the spindle drives 17, formed with the ball roller spindles 18 and the nuts 19, for manoeuvring the table device 2 are arranged at corner points of a notional second rectangle 38. See in this respect figure 8 in which the arrangement of the spindle drives 14, 17, as illustrated in a plan view of the thermoforming machine 1 in accordance with the

exemplified embodiment, is shown in a schematically simplified manner. The corner points of the second rectangle 38 are arranged within the first rectangle 37, wherein the arrangement is selected such that the arrangement of the corner points of each of the rectangles 37, 38 is symmetrical in relation to the longitudinal direction L and the transverse direction Q of the thermoforming machine 1. In addition, as apparent from figures 1 to 6, the arrangement of the table drive devices 9 and the clamping frame drive devices 11 is also preferably substantially symmetrical in relation to the longitudinal direction L and the transverse direction Q.

[0062] The arrangement proposed for the exemplified embodiment has the advantage that the table drive devices 9 and the spindles 18 coupled thereto in each case can be arranged close to the table 2a, i.e. with a small horizontal distance 39 to the table 2a. By avoiding large distances which the supports 36 would have to cover, the sections 2b can be kept short and the supports 36 and thus also the table device 2 can be designed in a comparatively compact and lightweight manner, saving on material.

[0063] As already mentioned, the thermoforming machine 1 in accordance with the exemplified embodiment comprises adjustable window plate parts 28. So as not to impair the movement of the parts in the horizontal direction in parallel with the upper side 30a of the die plate 30 facing the clamping frame 10, the drive devices 4 can be arranged in particular such that they do not protrude beyond the upper side 30a of the die plate 30, in other words that the drive devices 4 including the table drive devices 9 and the clamping frame drive devices 11 are incorporated substantially between a plane which extends substantially in parallel with the clamping plane 5 and

whose position is defined by the upper side 30a of the die plate 30, and the notional plane 6.

[0064] In addition, drive devices - not illustrated in the figures - for the window plate parts 28 can be incorporated in the installation space between the clamping plane 5 and the notional plane 6 or between the plane formed by the upper side 30a of the die plate 30 and the notional plane 6.

[0065] Although the invention has been fully described hereinabove with the aid of a preferred exemplified embodiment, it is not limited thereto and may be modified in a variety of ways.

[0066] In particular, the number of provided drive devices can be adapted to the requirements of the thermoforming machine, e.g. to the size and weight of the table, of the forming tool and/or of the clamping frame.

[0067] In addition, e.g. trapezoidal screw drives could be used instead of ball screw drives.

List of reference signs

[0068]

- 1 Thermoforming machine
- 2 Table device
- 2a Table (table device)
- 2a' Central region (table)
- 2b Section (table device)
- 3 Forming tool
- 4 Drive device
- 4a Drive device
- 4b Drive device
- 5 Clamping plane
- 6 Notional plane
- 6' Further notional plane
- 7 Manoeuvring direction (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 drive
- 23 Electric motor

24	Axis of rotation
25	Angular drive
26a	Direction
26b	Direction
27	Starting material
28	Window plate part
28a	Upper side (window plate part)
30	Die plate
30a	Upper side (die plate)
31	Section
32	Sealing device
33	Sealing device
34	Manoeuvring direction (clamping frame)
35	Height (table)
36	Support (table)
37	First notional rectangle
38	Second notional rectangle
39	Distance
40	Distance
109	Table drive device (variation)
V	Vertical direction
H	Horizontal direction
L	Longitudinal direction (thermoforming machine)
Q	Transverse direction (thermoforming machine)

PATENTKRAV

1. En termoformemaskine (1) med lukket-kammer omfattende:
et forskydeligt bordapparat (2) til et formningsværktøj (3), og
mindst en drivanordning (4),
- 5 hvor drivanordningen (4) er udformet som en borddrivanordning (9) til at drive bordapparatet (2) for at forskyde nævnte bordapparat, eller flere drivanordninger (4) er tilvejebragt, som omfatter en borddrivanordning (9) eller flere borddrivanordninger (9) til at drive bordapparatet (2) for at forskyde nævnte bordapparat, **kendetegnet ved, at** den mindst ene drivanordning (4) er i det væsentlige arrangeret mellem et fastgørelsesplan (5), hvor et startmateriale (27) til et arbejdsemne, der skal produceres, kan
- 10 fastgøres, og et plan (6) defineret af den nedre kant (8) af det bevægelige bordapparat (2) i det bevægelige bordapparats (2) øvre forskydningsposition.
2. Termoformemaskine ifølge krav 1, **kendetegnet ved, at** termoformemaskinen (19)
- 15 yderligere omfatter en forskydelig fastgørelsesramme (10) til at fastgøre startmaterialet i fastgørelsesplanet (5), og at der er tilvejebragt to eller flere drivanordninger (4), hvor drivanordningerne (4) omfatter en borddrivanordning (9) eller flere borddrivanordninger (9) til at drive bordapparatet (2) for at forskyde nævnte bordapparat, og hvor drivanordningerne (4) yderligere omfatter et fastgørelsesrammedrivanordning (11)
- 20 eller flere fastgørelsesrammedrivanordninger (11) til at drive fastgørelsesrammen (10) for at forskyde nævnte fastgørelsesrammen.
3. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** planet (6), der er defineret af den nedre kant (8) af det forskydelige bordapparat (2) i det bevægelige bordapparats (2) øvre forskydningsposition, i det væsentlige forløber parallelt med fastgørelsesplanet (5).
- 25
4. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den mindst ene drivanordning (4) er placeret i det væsentlige fuldstændigt
- 30 mellem fastgørelsesplanet (5) og planet (6), der er defineret af den nedre kant (8) af det forskydelige bordapparat (2) i det bevægelige bordapparats (2) øvre forskydningsposition.

5. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den øvre forskydningsposition af det forskydelige bordapparat (2) er en af de forskydningspositioner af bordapparatet (2), der er tilvejebragt til styring af termoformemaskinen (1), og i hvilken en afstand (40) af planet (6), der er defineret af den nedre kant (8) af det forskydelige bordapparat (2), er kortest fra fastgørelsesplanet (5) langs en forskydningsretning (7) af bordapparat (2).

6. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** planet (6), der er defineret af den nedre kant (8) af det forskydelige bordapparat (2) i det forskydelige bordapparats (2) øvre forskydningsposition, strækker sig i det væsentlige horisontalt i forhold til basen (12) på hvilken termoformemaskinen (1) kan placeres med det formål at betjene nævnte termoformemaskine.

7. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** et spindeldrev (14, 17), især en kugleskrue (14, 17), er koblet til den mindst ene drivanordning (4), således at en spindel (15, 18) af spindeldrevet (14, 17) kan drives ved hjælp af den mindst ene drivanordning (4).

8. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den mindst ene drivanordning (4) omfatter en motor (20, 23), især en elektromotor (20, 23).

9. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** motorens (20, 23) rotationsakse (21, 24) er orienteret i det væsentlige parallelt med fastgørelsesplanet (5).

10. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den mindst ene drivanordning (4) omfatter et gear (22, 25), især et vinkelgear (22, 25).

11. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** der er tilvejebragt flere drivanordninger (4), som omfatter to drivanordninger (4a, 4b), der er placeret ved siden af hinanden, hvor de to drivanordninger (4a, 4b), der er placeret ved siden af hinanden hver for sig omfatter et gear (22, 25), især et

vinkelgear (22, 25), og de to drivanordninger (4a, 4b) er placeret således, at gearene (22, 25) peger i modsatrettede retninger (26a, 26b).

12. Termoformemaskine ifølge et hvilket som helst af de foregående krav, **kendeteg-**
5 **net ved, at** termoformemaskinen er udformet som en enkeltstation-
termoformemaskine.

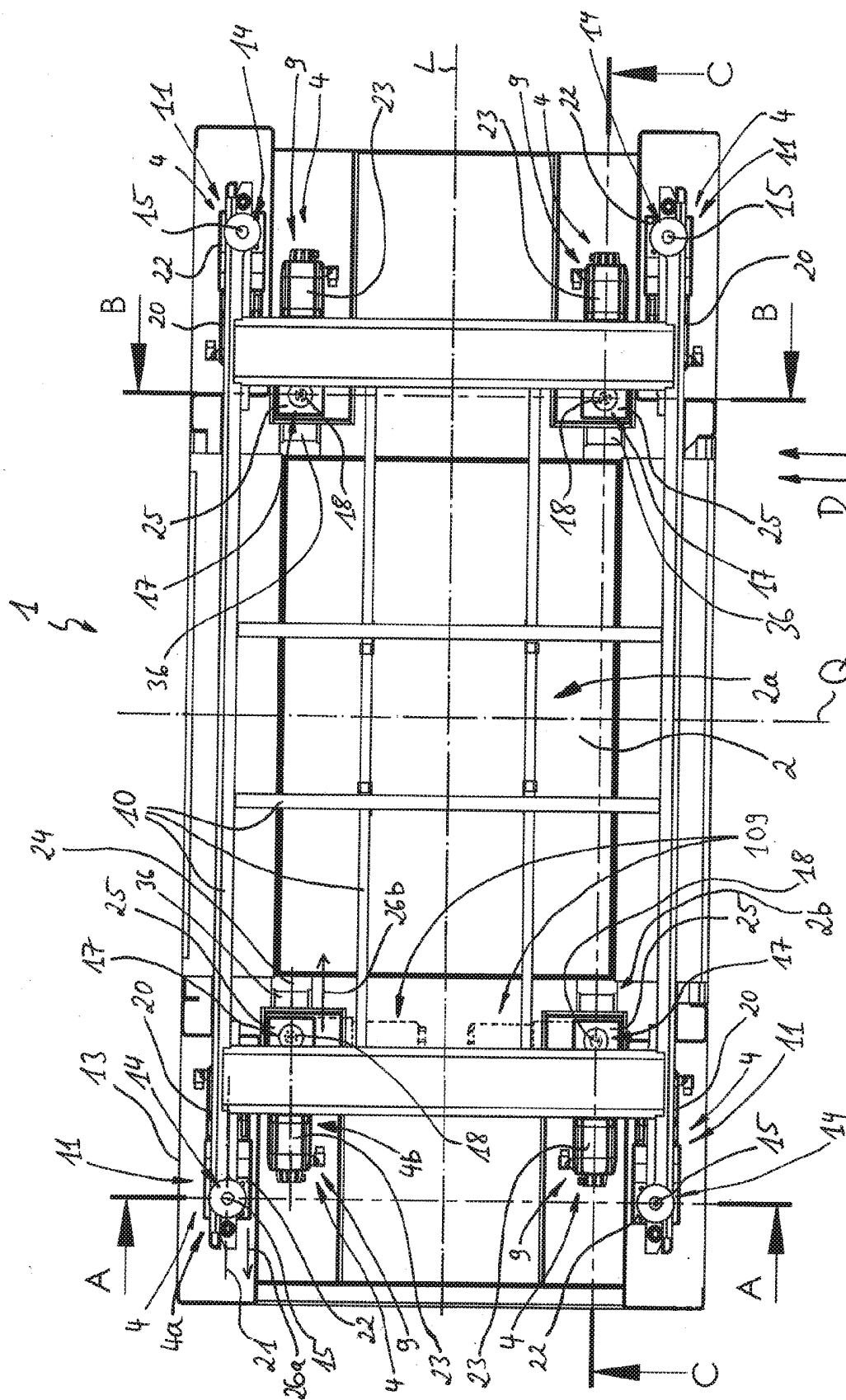


Fig. 1

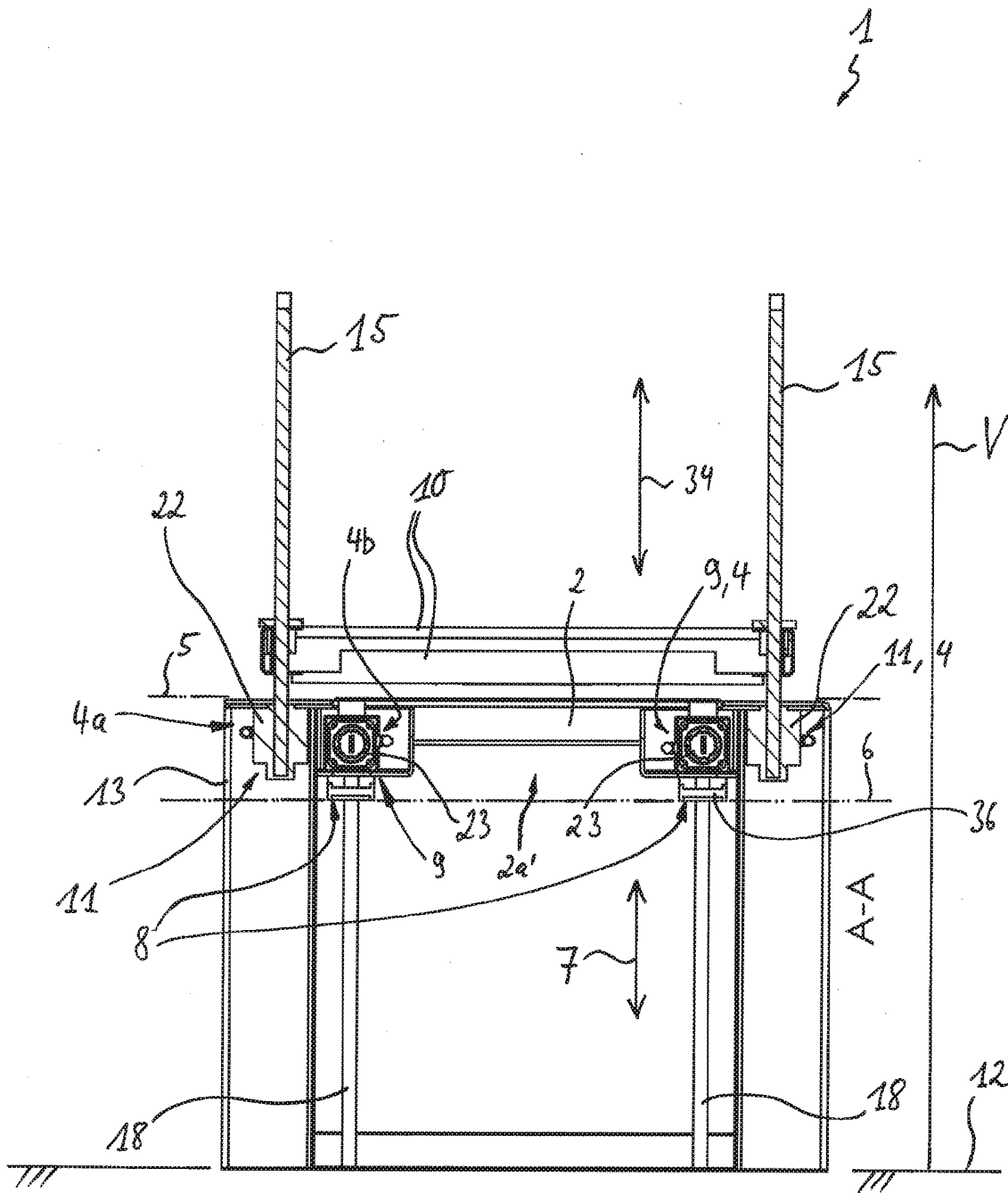


Fig. 2

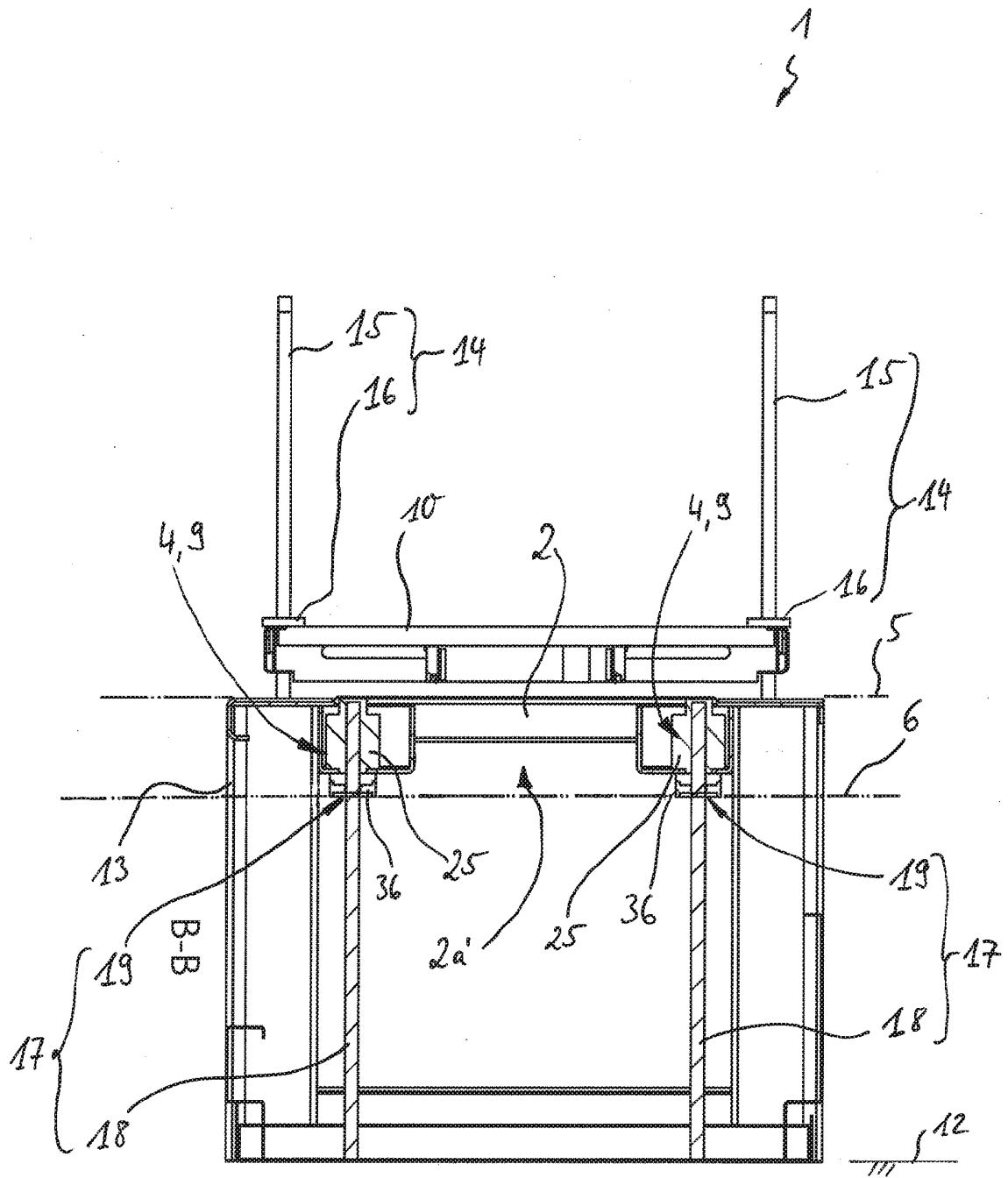
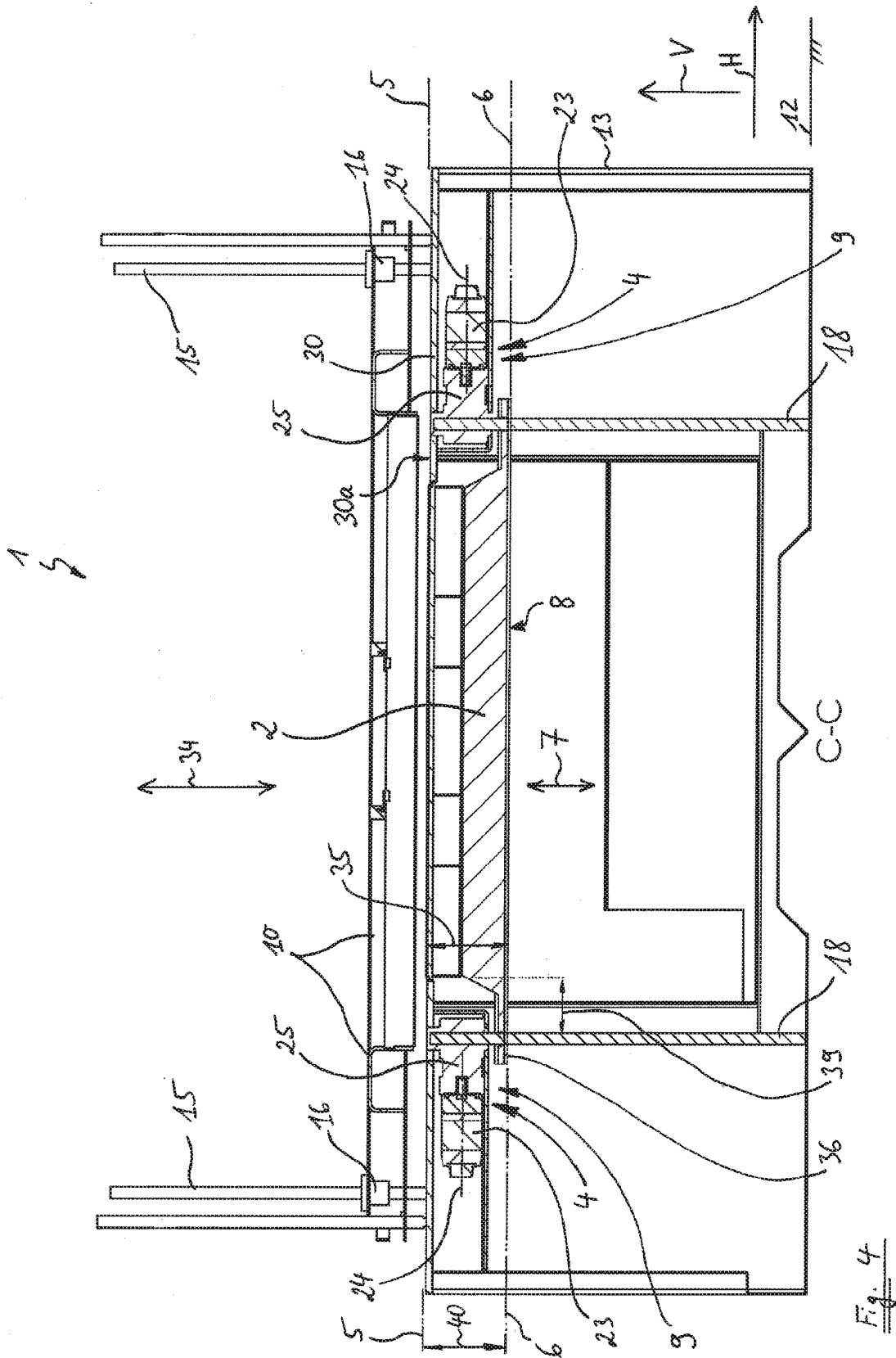
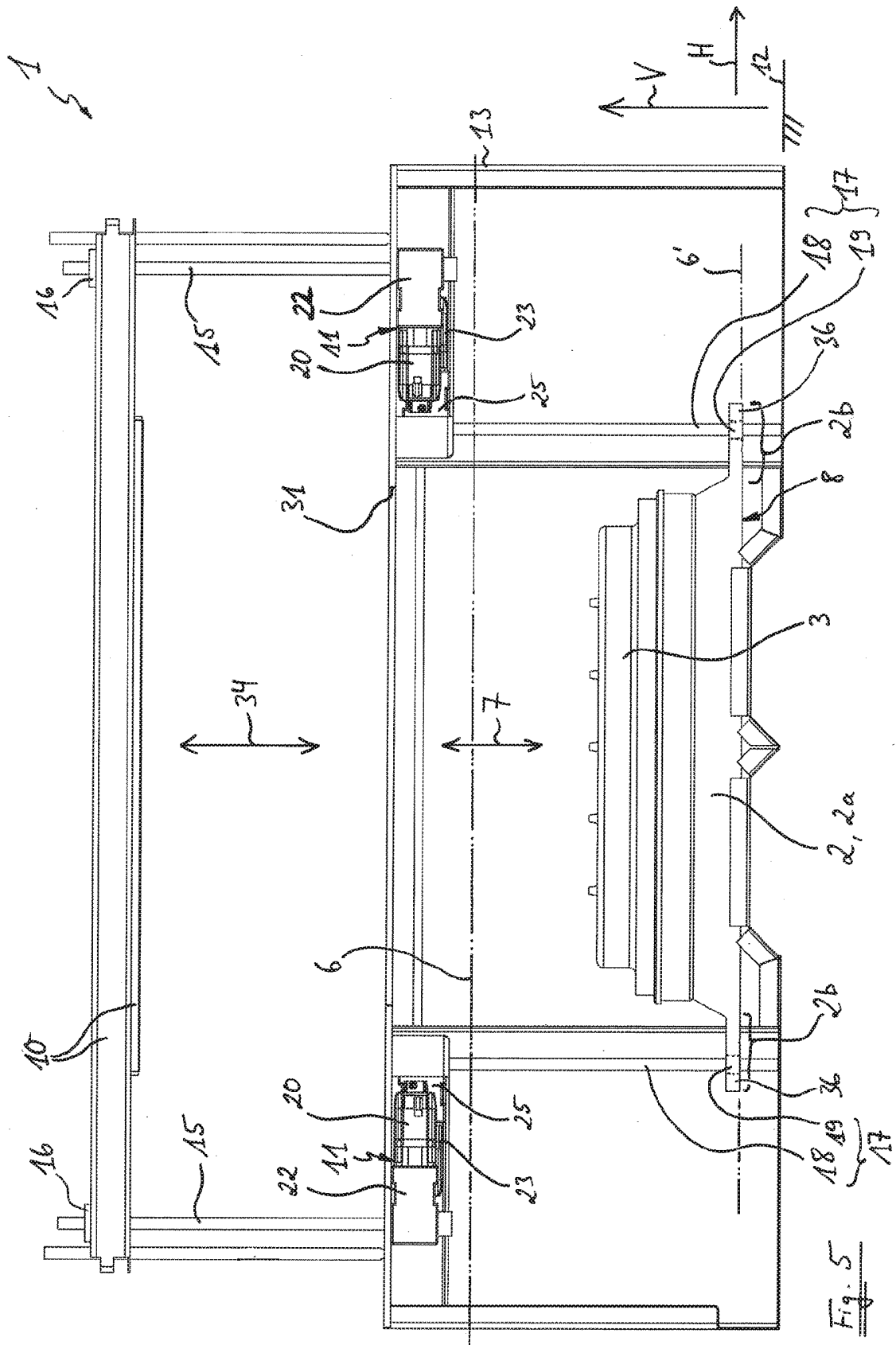


Fig. 3





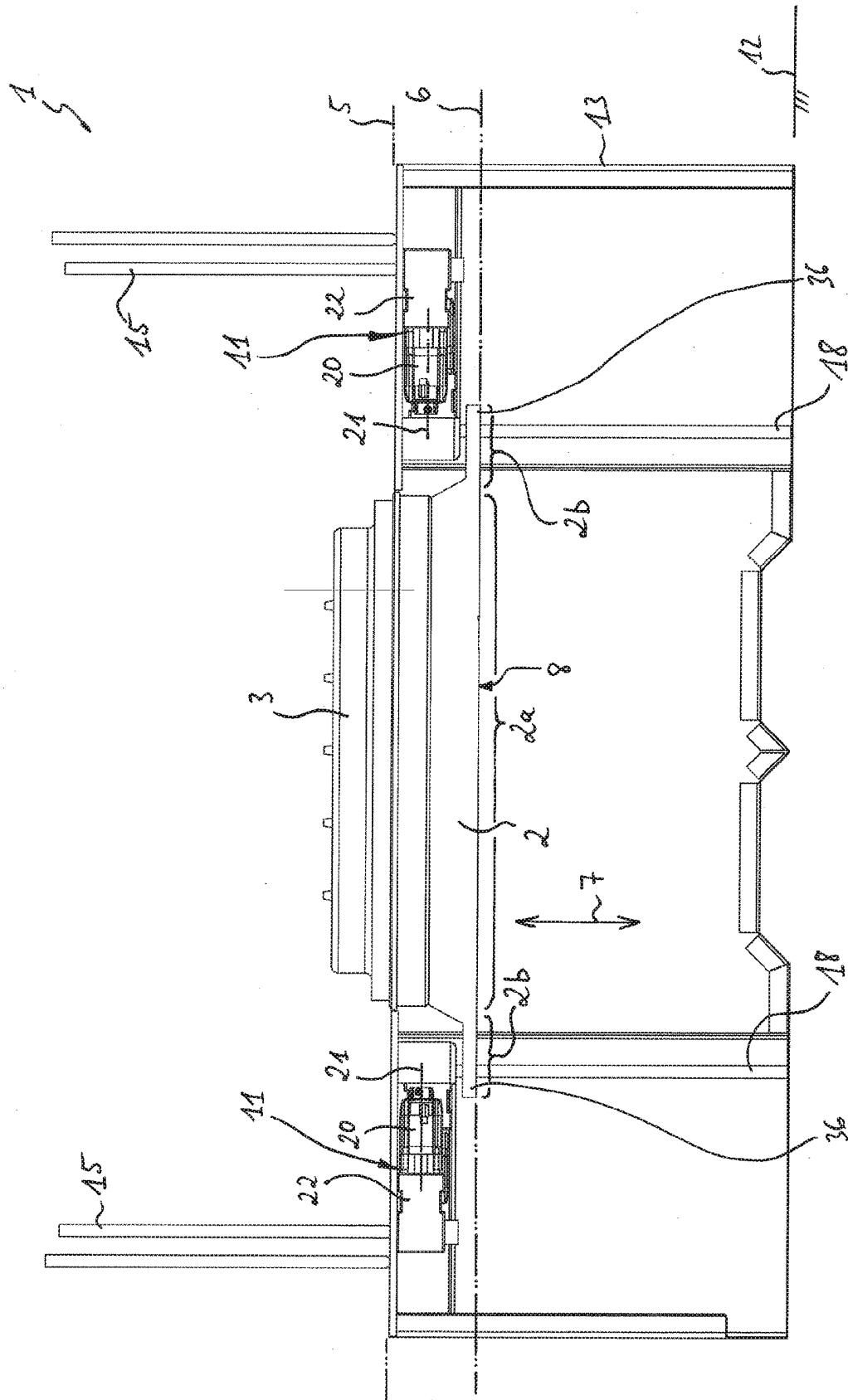


Fig. 6

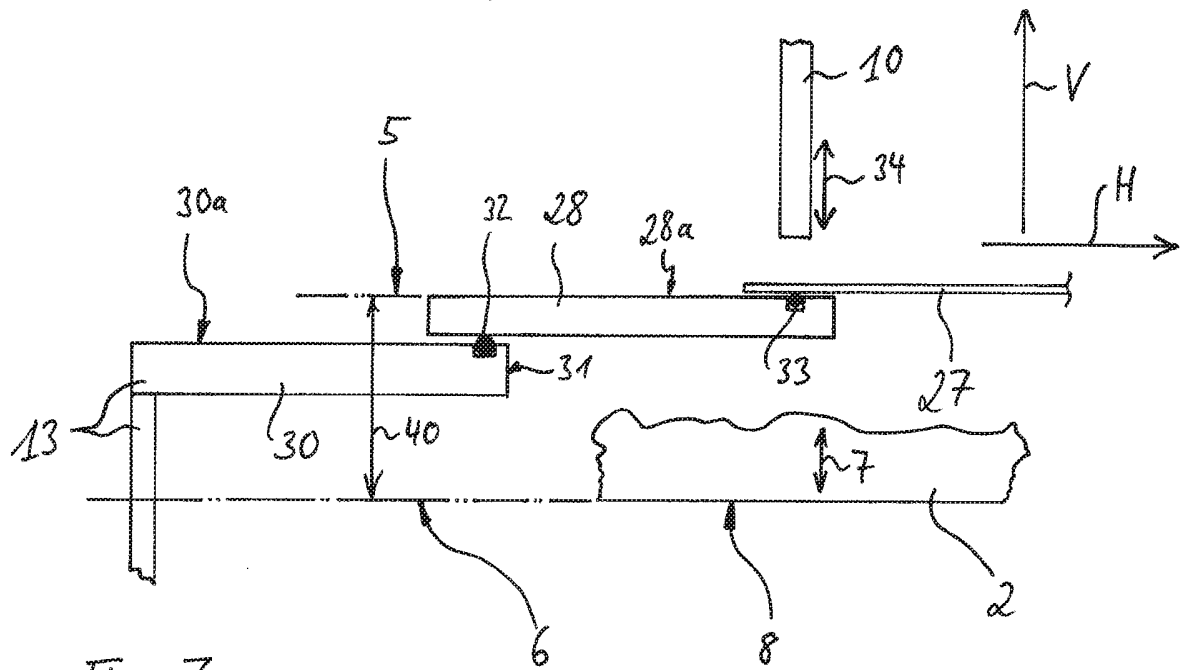


Fig. 7

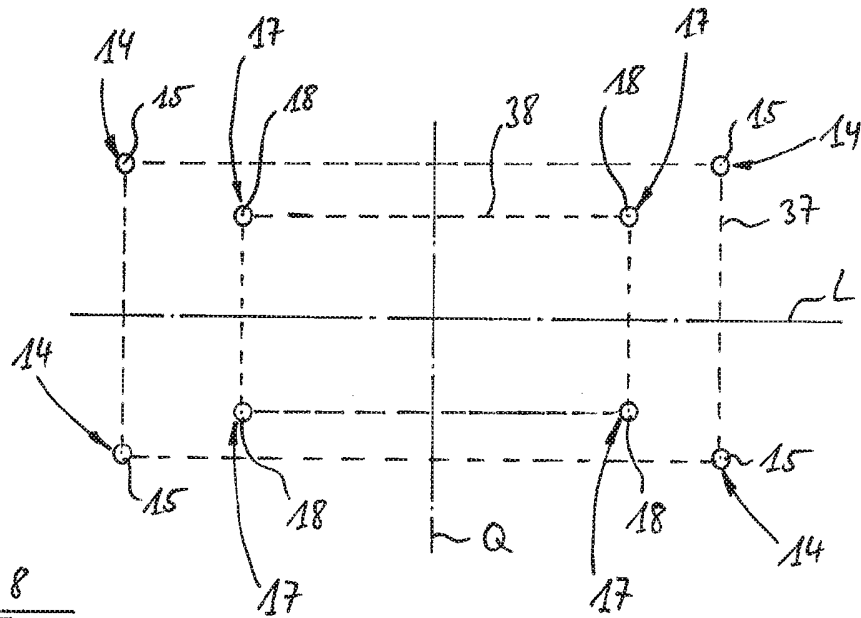


Fig. 8