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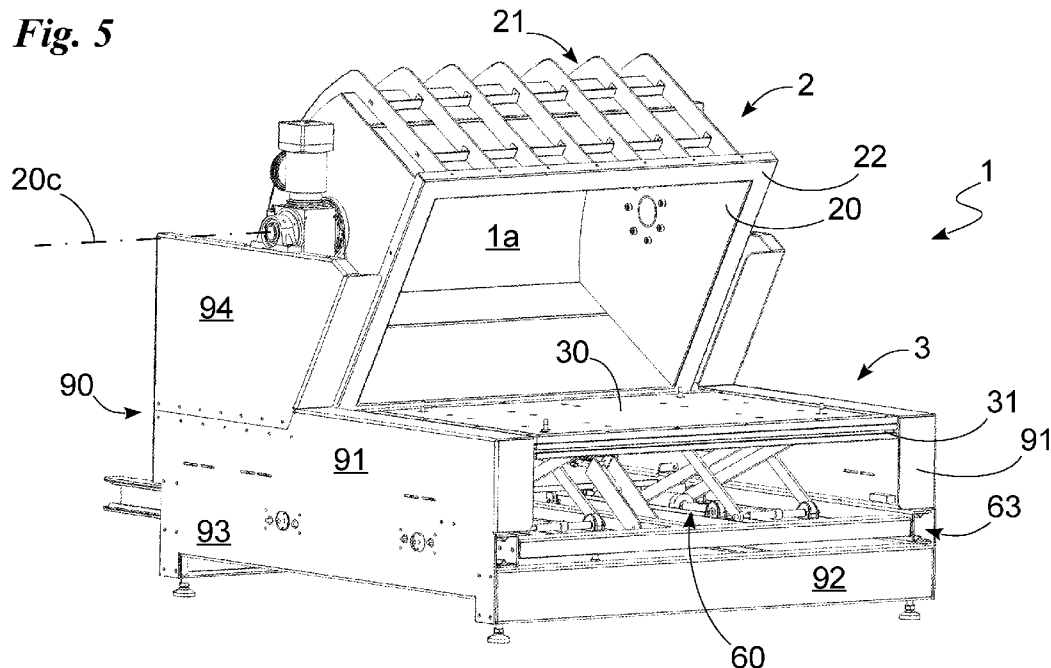
(71) Applicant: **HELIUM TECHNOLOGY SRL** [IT/IT]; Via
Saliceto 13, 40010 Bentivoglio (Bologna) (IT).

(72) Inventors: **VAL, Riccardo**; Via G. Verdi, 2, 27022 Casorate Primo (Pavia) (IT). **AUSENDA, Giovanni**; Via Capo Di Vico, 12, 27022 Casorate Primo (Pavia) (IT).

(74) Agent: **LUNATI & MAZZONI SRL**; Via Carlo Pisacane, 36, 20129 Milano (IT).

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(54) Title: VACUUM CHAMBER AND PLANT COMPRISING SAID VACUUM CHAMBER



(57) Abstract: A plant (100) comprising a vacuum chamber (1) and means of movement (50) for moving the vacuum chamber (1) is provided, the vacuum chamber (1) comprising: a first portion (2) comprising a bottom opening (20), a second portion (3) adapted to be coupled to the first portion (2), which define a gas-tight internal volume (1a) and a loading plane (30), a fixed structure (90) supportable by the ground, wherein the means of movement (50) are adapted to move the vacuum chamber (1) with respect to the fixed structure (90) and comprise an articulated quadrilateral (60) comprising: two lower hinges (61) attached to the fixed structure (90), two upper hinges (62) attached to the second portion (3), two rods (63) that connect the lower hinges (61) to the upper hinges (62) in a crossed configuration, and motorised means (70) comprising a first actuator device (73) adapted to internally move the articulated quadrilateral (60), changing the mutual inclinations of the rods (63).



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DESCRIPTION

VACUUM CHAMBER AND PLANT COMPRISING SAID VACUUM CHAMBER

The present invention relates to a vacuum chamber, and a plant comprising said vacuum chamber of the type described in the preamble of the first claim.

5 Vacuum chambers are known in the current state of the art.

Similar devices are described in patent application EP-A-0586894.

Vacuum chambers are closable gas-tight chambers suitable to allow the creation, in their interior, of an environment at a pressure lower than the ambient pressure by the removal of the gases contained inside them and which can therefore be
10 approximately defined as “vacuum chambers”.

The vacuum chambers are used industrially for various currently known purposes.

The most common of these are in testing the leakproofness of various components such as the cooling coils of refrigeration equipment like, for example, air conditioners and refrigerators, or the leakproofness of still other components.

15 The said components must ensure a fluid-tight seal for several years and, in order to be tested in a reasonable period of time and with the required accuracy, must be analysed at very low pressures.

The means for opening and closing the chamber are also motorised and generally allow omnidirectional movements with a large radius of action at the production plant
20 of the vacuum chamber user.

The prior art described above has some significant drawbacks.

In particular, vacuum chambers are subject to high compression forces on their walls due to the pressure difference between the external environment and the internal chamber.

25 They are therefore generally equipped with walls, edges, and flanges made of a

high-performance material in terms of strength, such as steel, of considerable thicknesses that can sometimes even reach values of a few centimetres.

As is known from the state of the art, the high strength materials commonly used in the industry, as in the present case of steel, are unfortunately also characterised by
5 a volumetric density which is higher than that of other lower performance materials, making them very heavy materials.

In particular, the flange that surrounds the opening of the vacuum chamber is very bulky and, for this reason, results in a considerable encumbrance in terms of weight.

The flange is also machined from solid by machine tools, with high processing costs.

10 Finally, the means of movement for the opening are very expensive because they must be made in different ways depending on the uses for which the vacuum chamber is intended.

In these circumstances, the technical task underlying the present invention is to devise a vacuum chamber capable of substantially remedying the said drawbacks.

15 Within the scope of said technical task an important objective of the invention is to achieve a vacuum chamber that is strong and light.

Another important objective of the invention is to achieve a vacuum chamber that is economical.

A further important objective of the invention is to achieve a vacuum chamber plant
20 which allows an economic movement of the chamber regardless of the necessary customisation depending on the plant.

The technical task and the specified objectives are achieved as claimed in the appended claim 1.

Examples of preferred embodiments are described in the dependent claims.

25 The characteristics and benefits of the invention will be clarified in the following

detailed descriptions of some preferred embodiments of the invention, with reference to the accompanying drawings, in which:

Fig. 1 shows the vacuum chamber according to the invention in a first three-dimensional view;

5 **Fig. 2** shows the vacuum chamber according to the invention in a second three-dimensional view;

Fig. 3 is a portion of the vacuum chamber according to the invention;

Fig. 4 shows a portion of the vacuum chamber according to the invention;

Fig. 5 shows the plant according to the invention in three-dimensional view
10 and in a first position;

Fig. 6 shows the plant according to the invention in a first cross-section;

Fig. 7 shows the plant according to the invention in a second cross-section;

Fig. 8a schematises the movement of the plant according to the invention in a first configuration;

15 **Fig. 8b** schematises the movement of the plant according to the invention in a second configuration;

Fig. 8c schematises the movement of the plant according to the invention in a third configuration;

Fig. 8d schematises the movement of the plant according to the invention in
20 a fourth configuration.

In the present document, the measures, values, shapes and geometric references (such as perpendicularity and parallelism), when associated with words like “about” or other similar terms such as “almost” or “substantially”, are to be understood as smaller than measurement errors or inaccuracies due to production and/or
25 manufacturing defects and, especially, to less than a slight difference from the value

of the measure, of the shape or of the geometric reference with which it is associated. For example, these terms, if associated with a value, preferably indicate a difference of not more than 10% of the value itself.

Furthermore, when used, terms such as "first", "second", "upper", "lower", "main" and "secondary" do not necessarily identify an order, a priority relationship or a relative position, but can simply be used to distinguish more clearly the different components from each other.

With reference to the Figures, the vacuum chamber according to the invention is indicated as a whole with the number **1**.

The latter is beneficially incorporated into a plant or system **100** comprising the said vacuum chamber **1**, means of movement **50** of said chamber **1** and of the auxiliary equipment, for example a vacuum pump, means of control for the plant **100**, preferably of the electronic type, and other equipment. The latter are well known and are not shown in the figures.

The chamber comprises, in summary, a first portion **2**, and a second portion **3**, adapted to couple with said first portion **2** defining a gas-tight internal volume **1a**.

The first portion **2** comprises a bottom opening **20**, preferably flat and defining an opening plane **20a**, constituted by the plane of the prevailing extension of said opening, a longitudinal direction **20b**, parallel to the plane **20a** and constituted by, or from a direction of prevailing extension of the opening **20** and a transverse direction **20c**, parallel to the plane **20a** and perpendicular to the longitudinal direction **20b**. The bottom opening **20** is also preferably rectangular and suitable to be closed by the second portion **3**.

The first portion **2** also comprises a concave portion **21** made of sheet metal and a flange **22** that surrounds the bottom opening **20** and also made of sheet metal.

The term sheet also defines a portion of prevalent extension with two-dimensional thickness of preferably less than 2 cm, more preferably of 1 cm, and made from metal, preferably steel.

The concave portion 21 defines the bottom opening 20 and at least part of the internal volume 1a and preferably comprises: an upper plate **21a**, opposite the bottom opening 20, preferably substantially vault-shaped and in particular having a portion being preferably an approximately cylindrical angular sector of a circle with its axis parallel to the longitudinal direction 20b.

The upper plate 21a is preferably connected by vertical walls **21b** to the bottom opening 20, in particular by means of two longitudinal vertical walls **21c**, parallel to the longitudinal direction 20b and two transverse vertical walls **21d**, parallel to the transverse direction 20c.

In particular, the longitudinal vertical walls 21c are structurally continuous with the upper vault-shaped plate 21a and preferably at least in part in one piece with the same. The transverse vertical walls 21d also have an appropriate thickness greater than that of the longitudinal vertical walls 21c and preferably extend at least partly inside the volume defined by the vertical walls 21d and the upper plate 21a, so as to hinder their implosion.

The flange **22** is located at the bottom of the concave portion 21 and surrounds the bottom opening 20. The flange consists of a folded metal sheet defining a shoulder portion **22a**, opposite and spaced with respect to said concave portion 21 near said bottom opening 20. In particular, the shoulder portion 22a defines portions of the vertical walls, preferably some centimetres high, and preferably at a distance of a few centimetres from the vertical walls 21b described above.

Between the shoulder 22a and the bottom opening 20 there is a connecting portion

22b, preferably parallel to the opening plane 20a. This connecting portion 22b is appropriately suitable to house, on its rear face, gaskets or similar for gas-tight sealing of the internal volume 1a.

The first portion 2 also comprises first reinforcement elements **23**, consisting of
5 arched elements surrounding the concave portion 21. They are preferably made of sheet metal and have, in normal cross-section, a prevalent extension in a direction perpendicular to the wall that they surround.

The first reinforcement elements 23 are attached at least to the flange 22 at two areas substantially opposite with respect to the bottom opening 20. In particular,
10 they are fastened by fastening means **23a**, preferably of a releasable type, such as screws, bolts, studs or similar. Said fastening means 23a are also in tension and tend to draw together the first reinforcement elements 23 and the shoulder portion 22a. They are preferably two-headed bolts or studs, one head of which is fitted into a recess comprising a counterbore for the head and extending into the interior of the
15 first reinforcement elements 23. The vertical portion that subdivides the head housing portion from the shank housing portion acts as an abutment wall for the head itself. The second head preferably abuts the shoulder 22a (Fig. 3).

The first reinforcement elements 23 also preferably occupy all the concave portion of the flange 22, i.e. the whole of, or substantially the whole of, the distance between
20 the shoulder 22a and the vertical walls 21b. They are also preferably in contact with the connecting portion 22b.

The first reinforcement elements 23 are equally spaced and preferably mutually aligned in the longitudinal direction 1b.

Finally, the first reinforcement elements 23 may be fastened to the upper plate 21a
25 and the vertical walls 21b by means of releasable fastening means such as screws

or bolts or welding or glueing or other.

The concave portion 21 also preferably comprises second reinforcement elements **24**, contiguous and preferably perpendicular to the first reinforcement elements 23, and suitable to reciprocally connect them. Finally, the second reinforcement elements 24 are preferably fastened to the upper plate 21a and the vertical walls 21b by means of releasable fastening means such as screws or bolts or welding or glueing or other. The second reinforcement elements 24 are also made of sheet metal and may have folds or similar.

The second portion 3 is substantially a flat plate, suitable to be laid over the bottom opening 20. It is in particular arranged in juxtaposition to the gaskets or similar and may have, in turn, its own gaskets or similar. It defines a loading plane **30**, potentially with couplings, for objects that must be inserted into the vacuum chamber 1.

The second portion 3 preferably comprises, in the lower part opposite to the one coupled to the first portion 2, couplings for means of movement as described below.

It may also comprise reinforced edges **31**, for example made of extruded aluminium or similar.

Structurally, the vacuum chamber 1, or at least a portion of the same, is made from a metal sheet **200** (Fig. 4).

Said sheet 200 is, for example, of rectangular shape and is cut along a central portion in the longitudinal direction 20b for its entire length with the exception of a peripheral portion constituting the flange 22, this cut being called the longitudinal cut **201**.

At the ends of the longitudinal cut 201 two transverse cuts **202** are formed in the transverse direction 20c, running along the entire length of the metal sheet 200 with the exception of a peripheral portion constituting the flange 22.

Two rectangular portions are thus formed that can be folded by 90°, using a folding machine, along first fold lines **203** connecting the ends of the transverse cuts 202. They are thus formed in the longitudinal vertical walls 21c.

The edges are then folded, along peripheral folding lines **204** parallel to the said edges, to make the flanges 22. The folded portions form the shoulder portions 22a, while a portion of the unfolded perimeter unaffected by cutting lines forms the connecting portion 22b.

Corner cuts **205** can also be made to facilitate the making of the flange 22, and the shoulder portions 22a are preferably welded together.

If sufficient, the longitudinal vertical walls 21c can be folded to form the upper plate 21a and welded together. Alternatively, an additional portion made of sheet metal is welded or bolted to the metal sheet 200, preferably along the longitudinal vertical walls 21c and in the longitudinal direction 20b.

Transverse vertical walls 21d are then added and welded to the flange 22, to the longitudinal vertical walls 21c, and to the upper plate 21a.

Finally, as previously described, the first reinforcement elements 23 are added, preferably fastened by releasable fastening means 23a to the shoulder portion 22a, and the second reinforcement elements 24, in turn fastened to the first reinforcement elements 23 and/or to the sheet 200 or the sheet 206.

The means of movement 50 of the chamber 1 preferably comprise first means of movement **51**, suitable to move the first portion 2, and second means of movement **52** designed to move the second portion 3.

The means of movement 50 are also supported in a fixed structure **90**, appropriately substantially in the horizontal plane, and preferably supported by the ground. The said fixed structure 90 comprises a frame comprising two lateral sides **91** and

connecting trusses **92** between the two side walls 91. The two sides comprise a lower portion **93** of smaller height and larger dimensions in the horizontal plane and an upper portion **94** preferably arranged in one half of the portion in the horizontal plane of greater height than the lower portion.

- 5 The first means of movement 51 are preferably suitable to rotate said first portion 2 around an axis, preferably a longitudinal axis 20b or a transverse axis 20c.

They preferably comprise bearings or bushings **51a**, attached to the fixed structure 90, preferably to the upper portion 94, defining an axis of rotation **51C**, preferably parallel to the horizontal plane 100a. The first means of movement 51 also comprise

- 10 first motorised means **71** suitable to carry out the said rotation around the axis 51c. The first means of movement 51 comprise a movement piston **51B**, preferably hydraulic or electric with worm gear or still other gear, suitable to rotate said first portion 2 around said axis of rotation 51c and connected at some distance from the axis 51c, so as to facilitate movement.

- 15 The second means of movement 52 are, in contrast, more complex. They are borne by the fixed structure 90, preferably at a height lower than the first means of movement 51, and also by the second portion 3.

- The second means of movement 52 are suitable to allow, in said second portion 3, preferably a rotation along an axis appropriately parallel to the axis of rotation 51c, preferably a translation in the vertical direction (perpendicular to the ground), and
- 20 preferably a translation in the direction perpendicular to the axis of rotation 51c and parallel to the ground.

- The second means of movement 52 accordingly comprise an articulated quadrilateral **60**, between the fixed structure 90 and the second portion 3, defining
- 25 said degrees of freedom. The quadrilateral comprises two lower hinges **61**,

connected to the fixed structure 90 and two upper hinges **62**, connected to the second portion 3.

The articulated quadrilateral 60 also comprises two rods **63**, which connect the lower hinges 61 to the upper hinges 62 in a crossed configuration. As can be seen in the figures, the right-hand hinge is connected to the left-hand hinge of the next support and vice versa. Said articulated quadrilateral 60 approximates, or preferably substantially is, a known Chebyshev linkage which is however only used in the straight part with the crossed rods 63.

The rods 63 also preferably have similar lengths that vary at most by 30% from each another, while the upper hinges 62 are spaced apart by a distance which is different and preferably smaller than the spacing between the lower hinges 61, when the loading plane 30 is in the horizontal position. In its rest position, the articulated quadrilateral 60 substantially defines an approximately isosceles trapezoid, preferably with the rods 63 defining the diagonals and preferably with the larger base constituted by the lower base.

The articulated quadrilateral 60 has been previously described ideally and conceptually, and structurally consists of multiple crossbars and hinges, as shown for example in the appended figures. In particular, the articulated quadrilateral 60 is preferably composed of two parallel and aligned structures with hinges preferably comprising rods which form part of the hinges on both structures.

The lower hinges 61 of the articulated quadrilateral 60 are also preferably translatable, preferably independently, in a direction perpendicular to the axis of rotation 51c, i.e. in a direction in which said two portions 2 and 3 move towards or away from each other, and parallel to the ground 100a.

Independent translation of the lower hinges 61 is preferably carried out by means of

a first carriage **65**, suitable to translate simultaneously the entire quadrilateral 60 and the two lower hinges 61, in a direction in which the two portions 2 and 3 move towards or away from each other, and a second carriage **66** suitable to translate only one of the two lower hinges 61, preferably the one furthest from the first portion

5 2, towards or away from the other lower hinge 61.

The simultaneous translation of the two lower hinges 61 thus follows an identical translation of the second portion 3, whereas the translation of a single lower hinge 61 towards or further away with respect to the other lower hinge 61 follows respectively a raising or lowering of the second portion 3.

10 Structurally, the first carriage 65 comprises a supporting plate **65a** and first shoes **65b** attached to the supporting plate 65a and to the side walls 91. The said supporting plate 65a preferably occupies substantially the entire bottom surface and supports the articulated quadrilateral 60 and the second portion 3. It is structurally formed from crossbar elements. The first shoes 65b are suitable to allow the

15 movement of the supporting plate 65a, preferably comprising tracks, suitably attached to the plate 65a, and wheels, suitably attached to the side walls 91.

The second carriage 66 is instead preferably housed entirely inside the supporting plate 65a. It comprises tracks **66a** arranged integral to the supporting plate 65a and wheels or shoes **61a** preferably arranged at or near the movable lower hinge 61.

20 The means of movement 50 comprise motorised means **70** suitable to move the chamber 1. In particular, the first motorised means 71 are suitable to move the first portion 2 and the second motorised means **72** are suitable to move the second portion 3.

The second motorised means 72 comprise at least a first actuator device **73** suitable

25 to internally move the articulated quadrilateral 60, changing the mutual inclinations,

and the rods 63 with respect to the ground 100a. This movement defines a rotation parallel to the axis of rotation 51c. The first actuator device 73 preferably comprises a linear actuator, and preferably not more than one linear actuator, connected to both rods 63 not in correspondence with the lower hinges 61, so as to be able to act
5 simultaneously and in opposite directions on both rods 63.

The linear actuator is preferably connected to both rods in the same portion to the right or to the left, and is connected to the rod 63, which in the rest configuration is located below that point, at a distance of between half and one eighth of the same rod 63. At this distance, it is possible to control the lower rod and move it in an
10 appropriate manner.

The linear actuator, is also preferably connected to the upper rod 63 in correspondence with the upper hinge 62.

The linear actuator is appropriately connected to the structural part of the quadrilateral by means of hinges. The linear actuator is also preferably supported
15 on a crossbar that connects two parallel structures constituting an articulated quadrilateral.

Finally, the linear actuator is preferably a worm screw driven by an electric motor preferably with permanent magnets. Alternatively, it can be of a fluid-dynamic type.

The second motorised means 72 comprise a second actuator device **74** suitable to
20 move the first carriage 65 and thus preferably to translate the entire supporting plate 65a including the articulated quadrilateral 60.

The second actuator device 74 is preferably constituted by a gear wheel driven by an electric motor with the shaft integral with the first carriage 65. The second actuator device 74 preferably also comprises a rack which is rigidly coupled to a
25 side 91.

The second motorised means 72 also comprise, preferably, a third actuator device **75**, suitable to move the second carriage 66. The second motorised means are suitable to move the shoes 61a and consequently the second hinges 61 mutually closer or further away. The third actuator device 75 comprises a piston attached, by means of hinges, to one end of the fixed portion and thus to the supporting plate 65a and at the other end to the articulated quadrilateral 60 and in particular to the second carriage 66, in detail to the shoes 61a.

Finally, the third linear actuator 75 is preferably a worm screw driven by an electric motor preferably with permanent magnets. Alternatively, it can be of a fluid-dynamic type.

The operation of the system 100 comprising the said chamber 1, previously described in structural terms, is the following.

The plant is used to test a component **300**, such as an air conditioner, a refrigerator or other.

In a first condition (Fig. 8a) the second portion 3 is at a distance from the first. In this configuration, the second portion may have a loading plane 30 and be flat or inclined in the opposite direction with respect to the first portion, to facilitate loading, or other. The positions are in fact customisable by the user.

To start the operation of the plant, it is necessary to bring together the two portions 2 and 3 and close the chamber 1.

By means of the second actuator device 74, the second portion 3, and in particular the loading plane 30 supporting the component 300, is brought near to the first portion 2.

The second portion 3 is then raised (Fig. 8b) through the actuation of the third actuator device 74, the loading plane 30 supporting the component 300 being

moved upwards.

If the loading plane 30 must only move vertically then it is necessary to correct, using the first actuator device 73, the inclination of the loading plane to keep it horizontal.

In any case, the first actuator device 73 can vary the inclination of the loading plane
5 and combine its motion with the third actuator device 74 (Fig. 8c).

At the same time, the first motorised means move the first portion 2 and bring it nearer to the first portion 2, closing the chamber 1 to a gas-tight seal (Fig. 8d).

The vacuum chamber 1 is then placed under vacuum and its structure withstands even very great pressures, acting from the outside towards the inside, without
10 problems.

The plant or system 100 and the vacuum chamber 1 according to the invention achieve important benefits.

The vacuum chamber 1 is substantially entirely made from folded sheet metal and still has substantial and more than sufficient strength.

15 It is therefore economical and does not require complex machining, only known and widely implemented folding, shearing, and welding.

These processing methods therefore make it possible to make the vacuum chamber 1 with metal sheets defined by typical reduced thicknesses, with respect to the thicknesses usually encountered in conventionally made vacuum chambers, which
20 beneficially reduces the mass. A further significant benefit comes from the fact that the system allows a significant freedom of positioning of the loading plane 30. There is therefore no need for custom means of movement, instead it is sufficient to select the adjustable positions of the loading plane 30 correctly.

Another important benefit comes from the special means of movement 50, in
25 particular from the articulated quadrilateral 60. The Chebyshev linkage, or similar

articulated quadrilaterals with crossed arms, are in fact known to obtain a perfect roto-translation along a horizontal line of the median point of the upper side, i.e. the loading plane 30. The platform itself does not therefore rise substantially from its initial position but always remains at the same level and optimises the positioning of
5 the centre of mass, substantially without variation, so as to maintain a constant or in any case always appropriate position and to be able to optimise the practice of the forces to be applied by the first motorised means 71 and in particular by means of the first actuator device 73.

The invention is subject to variations falling within the scope of the inventive concept
10 as defined by the claims.

In this context all the details are replaceable by equivalent elements and the materials, shapes and dimensions can be any.

CLAIMS

1. A plant (100) comprising a vacuum chamber (1) and means of movement (50) for moving said vacuum chamber (1),
said vacuum chamber (1) comprising:

- a first portion (2), comprising a bottom opening (20),
- a second portion (3), suitable to be coupled to said first portion (2) defining a gas-tight internal volume (1a) and a loading plane (30),
- a fixed structure (90) supportable by the ground,

and **characterised in that**

- said means of movement (50) are adapted to move said vacuum chamber (1) with respect to said fixed structure (90) and comprise an articulated quadrilateral (60) comprising:

- two lower hinges (61), attached to said fixed structure (90),
- two upper hinges (62), attached to said second portion (3),
- two rods (63) which connect said lower hinges (61) to said upper hinges (51) in a crossed configuration,
- and motorised means (70) comprising a first actuator device (73) adapted to internally move said articulated quadrilateral (60), changing the mutual inclinations of said rods (63).

2. Plant (100) according to claim 1, wherein said articulated quadrilateral (60), said rods (63) have lengths that vary from one another by fractions lower than 30%, while said upper hinges (6) have a mutual distance which is different from the distance between said lower hinges (50) when said loading plane (30) is in the horizontal position.

3. Plant (100) according to at least one of the preceding claims, wherein said

articulated quadrilateral (5) is a Chebyshev linkage.

4. Plant (100) according to at least one of the preceding claims, wherein said means of movement (50) are adapted to translate said lower hinges (61) in a direction in which said first and second portions (2, 3) move towards or away from each other, parallel to the ground and with respect to said fixed structure (90).

5. Plant (100) according to at least one of the preceding claims, wherein said means of movement (50) comprise a first carriage (65), adapted to simultaneously translate said quadrilateral (60) and said lower hinges (61) in a direction in which said two portions (2, 3) move towards or away from each other.

6. Plant (100) according to the preceding claim, wherein said first carriage (65) comprises a supporting plate (65a) which supports said articulated quadrilateral (60) and said second portion (3), and first shoes (65b) attached to said supporting plate (65a) and to said fixed structure (90) and adapted to allow for said translation of said supporting plate (65).

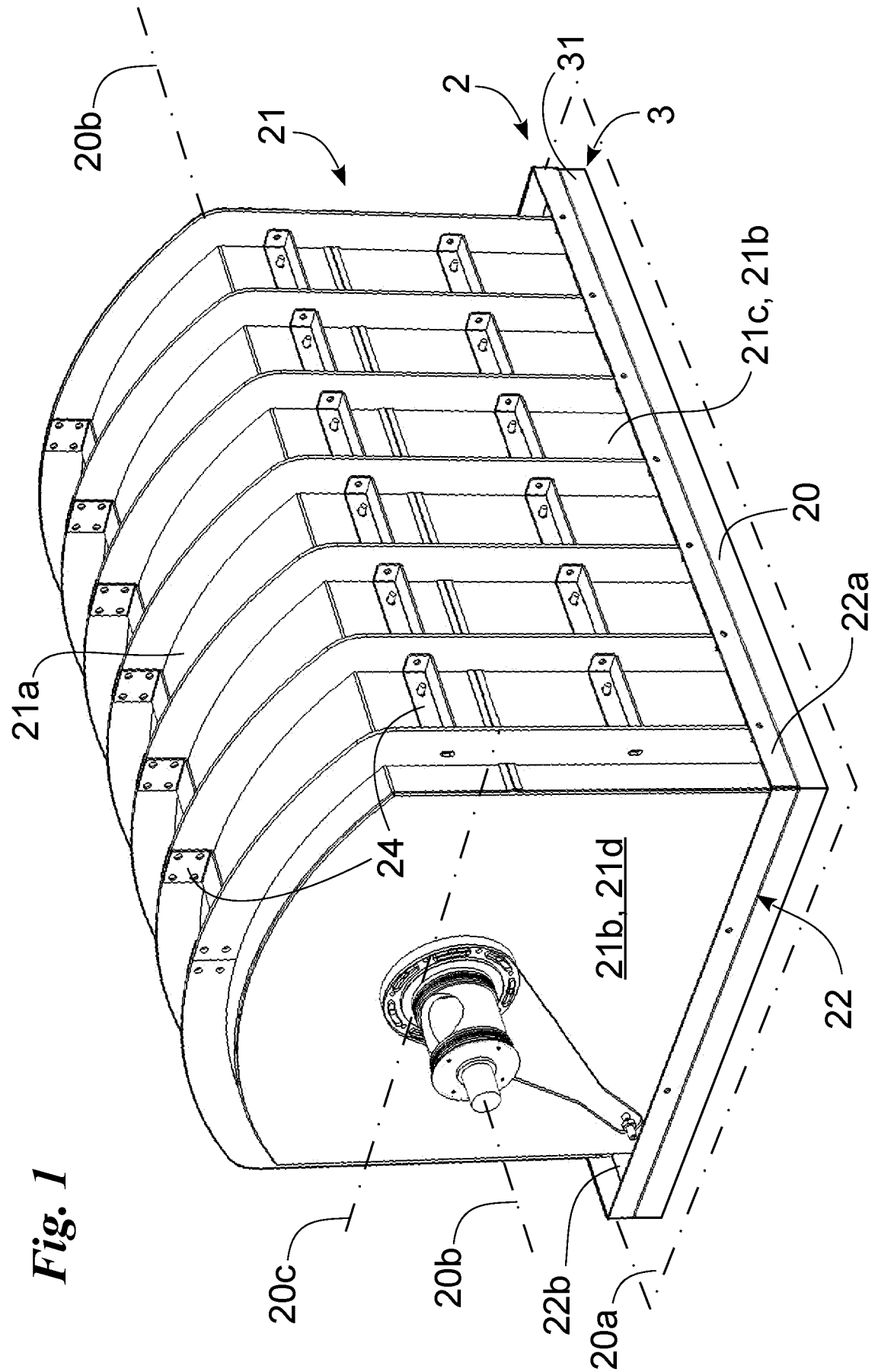
7. Plant (100) according to at least one of the preceding claims, wherein said means of movement (50) comprise a second carriage (66) adapted to translate only one of said lower hinges (61) towards or away from the other said lower hinge (61).

8. Plant (100) according to claims 5-7, wherein said second carriage (66) is arranged inside said supporting plate (65a) and comprises tracks (66a) arranged integral to said supporting plate (65a) and wheels or shoes (61a) arranged at said movable lower hinge (61).

9. Plant (100) according to at least one of the preceding claims, wherein said means of movement (50) are adapted to rotate said first portion (2) around its longitudinal axis (20b) with respect to said fixed structure (90).

10. Plant (100) according to at least one of the preceding claims, wherein

said second portion (3) is a substantially flat plate defining said loading plane (30), and wherein said first portion (2) comprises a concave portion (21), defining said bottom opening (20) and said internal volume (1a).



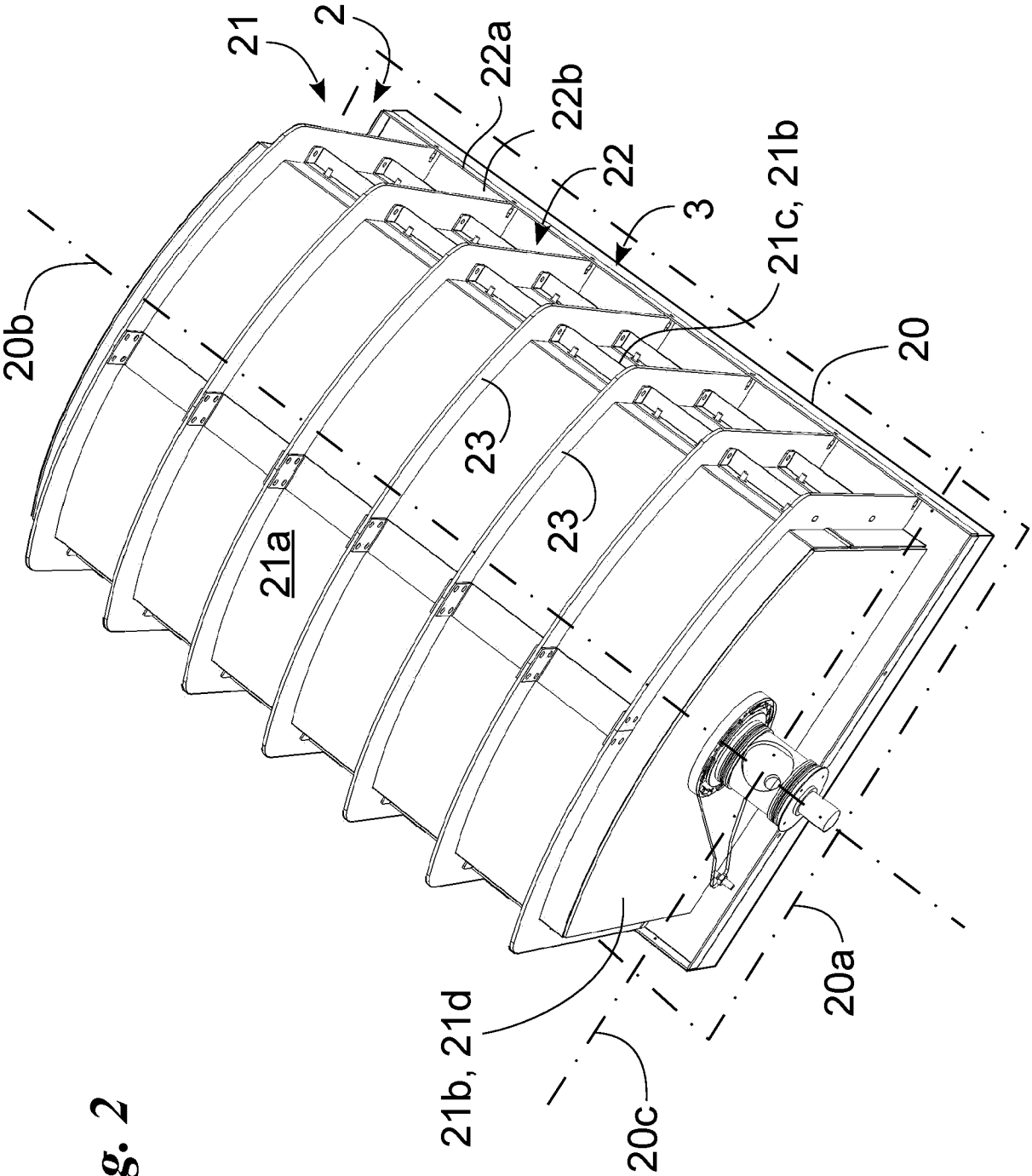
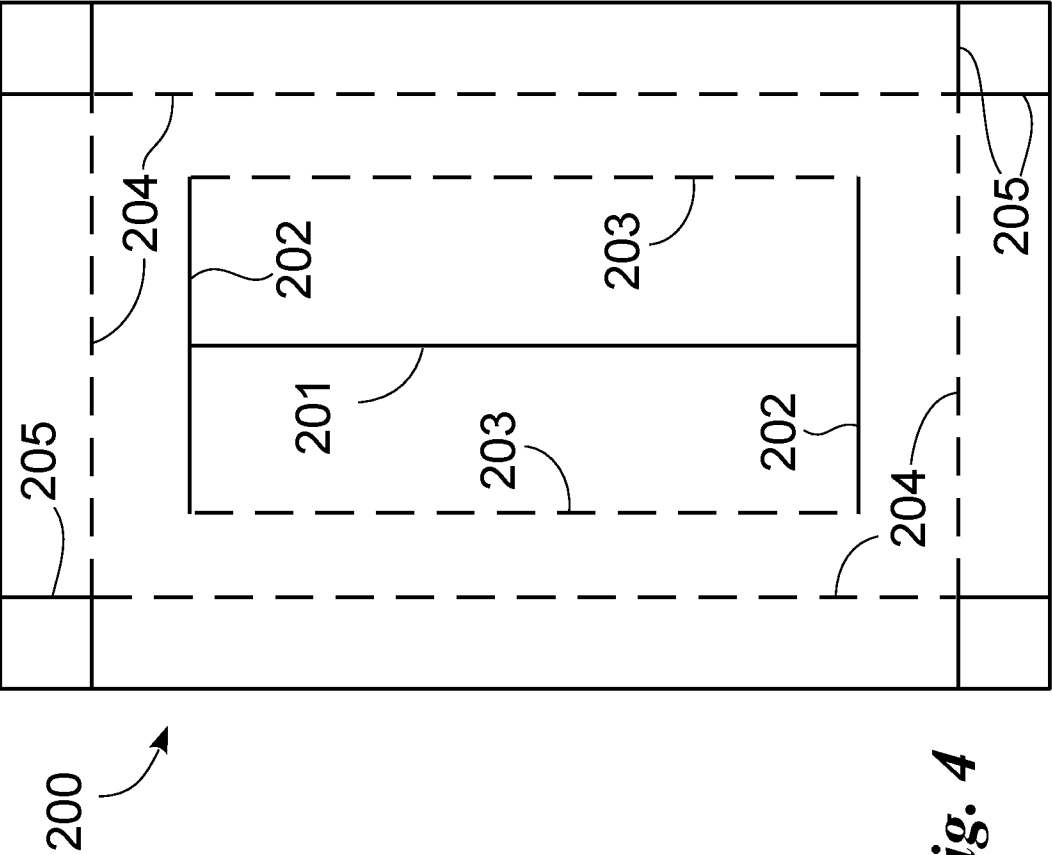
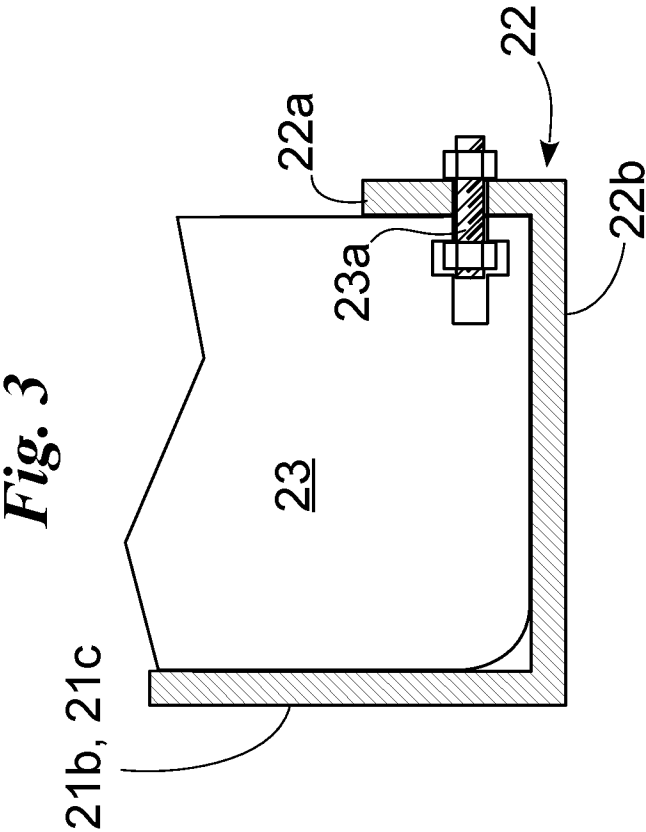


Fig. 2



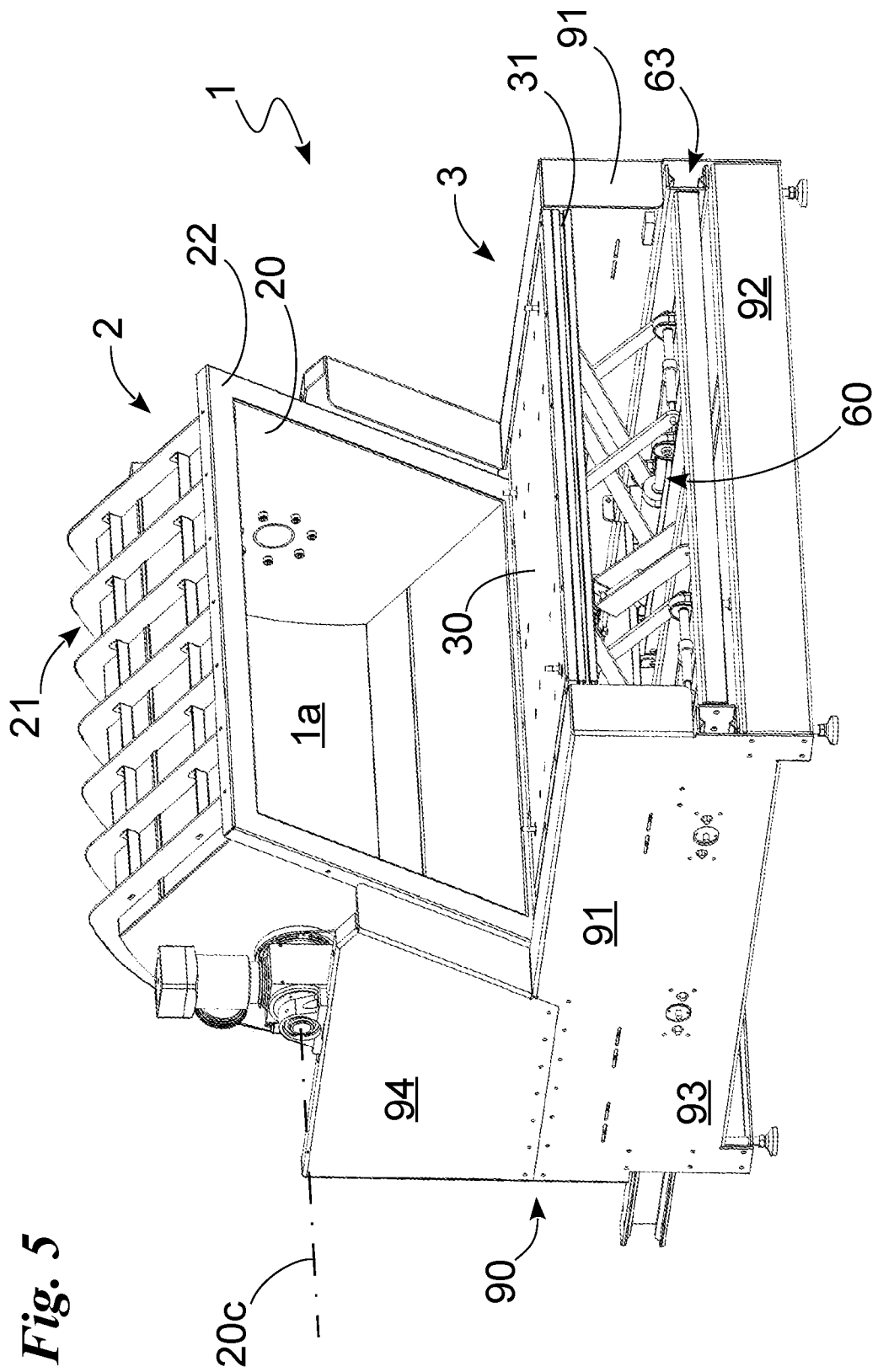


Fig. 5

Fig. 6

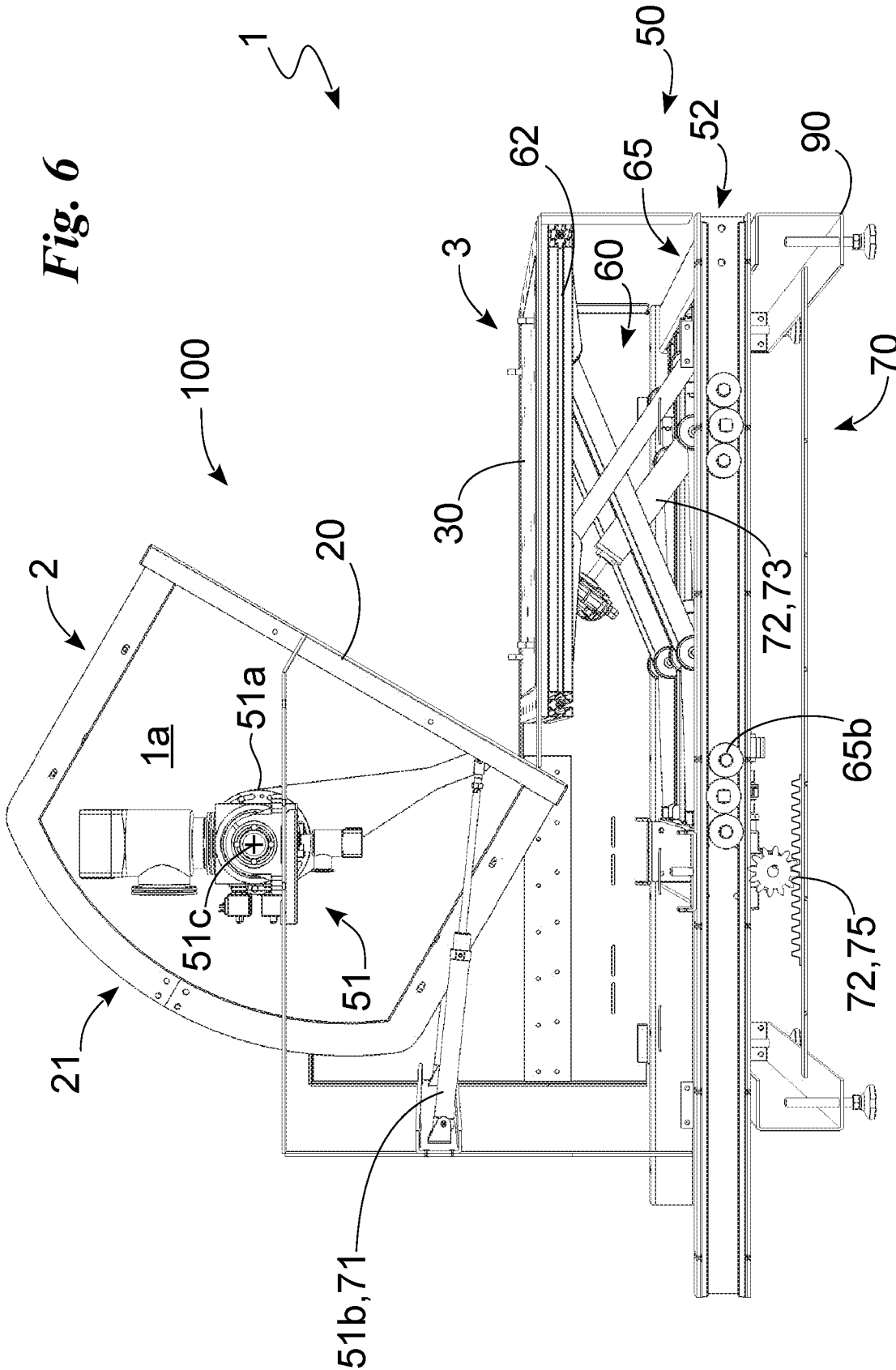


Fig. 7

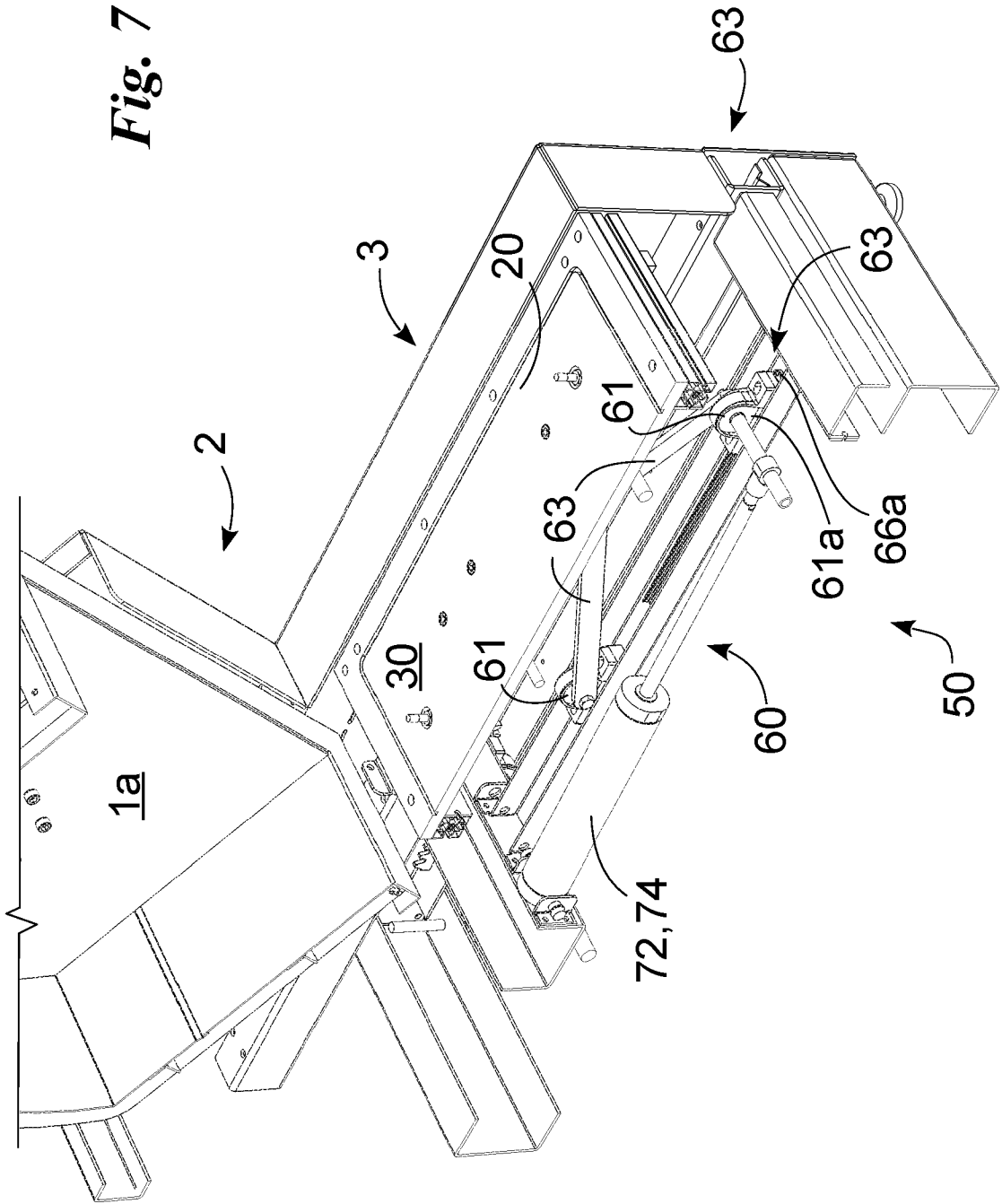


Fig. 8c

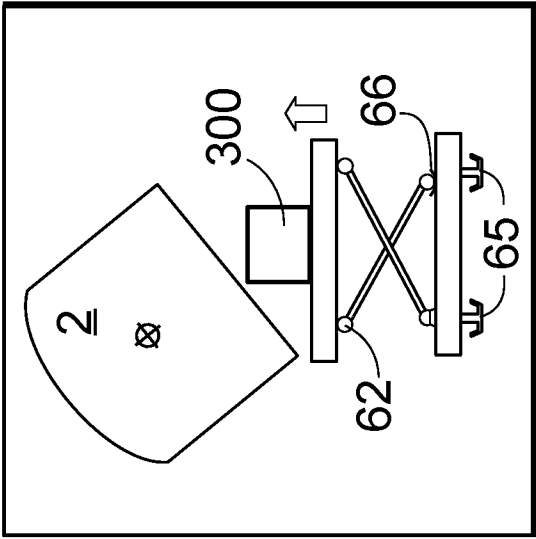


Fig. 8d

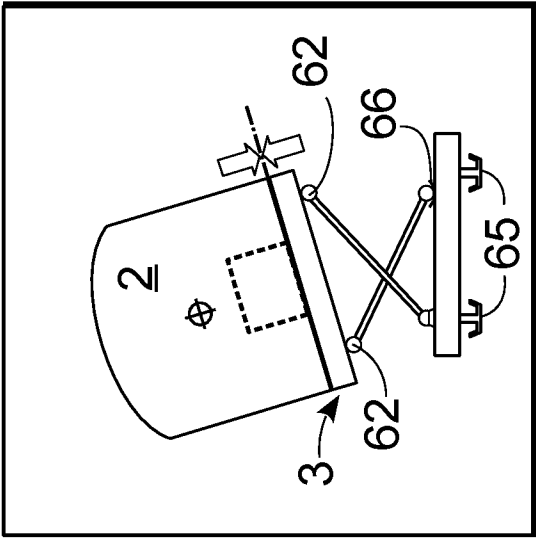


Fig. 8a

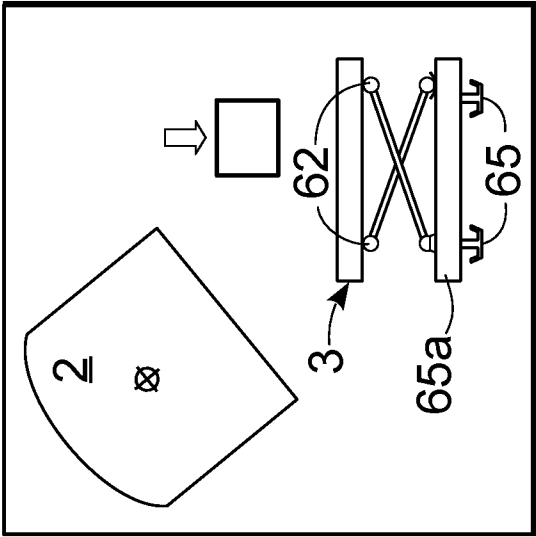
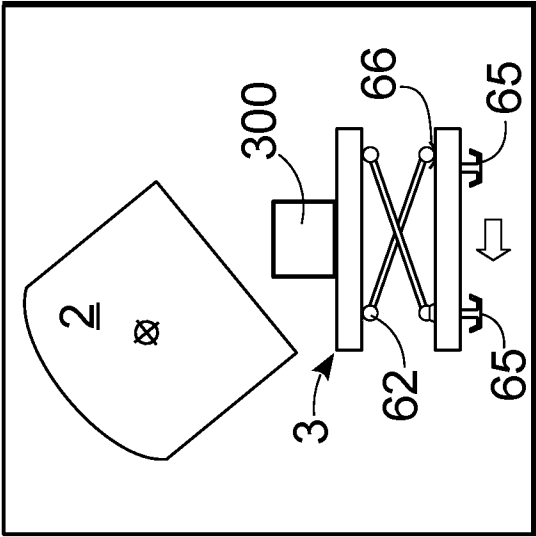


Fig. 8b



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/051661

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01M3/36 B66C1/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01M B66C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 586 894 A2 (JAGENBERG AG [DE]) 16 March 1994 (1994-03-16) figure 8	1-10
Y	----- EP 2 993 658 A1 (ELETTRONICA S R L ETS [IT]; AUSENDA GIOVANNI [IT]) 9 March 2016 (2016-03-09) abstract paragraphs [0025], [0037] figure 4	1-10
Y	----- EP 1 905 933 A2 (BESENZONI S P A [IT]) 2 April 2008 (2008-04-02) figures 2,3 -----	1-10

☐

Further documents are listed in the continuation of Box C.

☒

See patent family annex.

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Date of the actual completion of the international search

5 July 2017

Date of mailing of the international search report

12/07/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Kister, Clemens

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/051661

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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			EP 0586894 A2 16-03-1994
			US 5365774 A 22-11-1994

EP 2993658	A1	09-03-2016	EP 2993658 A1 09-03-2016
			US 2016063884 A1 03-03-2016

EP 1905933	A2	02-04-2008	NONE
