(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 May 2013 (02.05.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/061354 A2

(51) International Patent Classification:
H01L 31/045 (2006.01)

(21) International Application Number:
PCT/IT2012/000333

(22) International Filing Date:
25 October 2012 (25.10.2012)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
RM2011000561 25 October 2011 (25.10.2011) IT

(71) Applicant: **PRO D3 S.R.L.** [IT/IT]; Via Ettore Bugatti, 3-5-7-9, I-10040 Leini (TO) (IT).

(72) Inventor: **SENTINELLI, Sergio**; Via Dei Gerani 38, I-00036 Palestrina (RM) (IT).

(74) Agent: **CICCARELLO, Basilio**; Ingeniis S.A.S., Di Basilio Ciccarello e C., Via Antonio De Berti, 24, I-00143 Roma (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: MOBILE SOLAR POWER-GENERATING SYSTEM WITH DEPLOYING PANELS

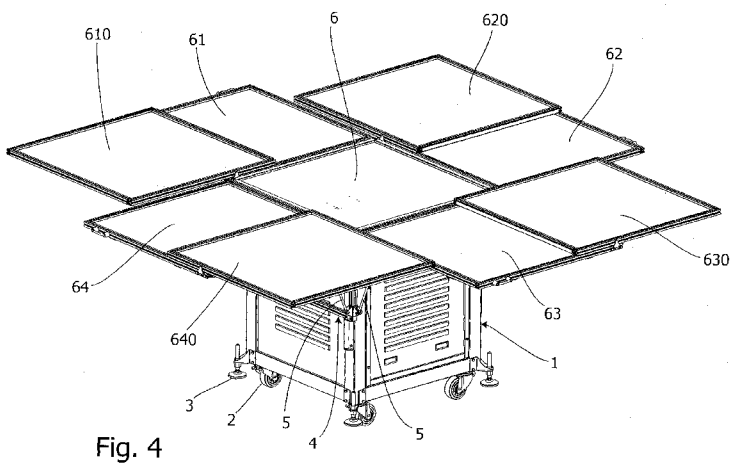

Fig. 4

(57) Abstract: A mobile solar power-generating system with deploying panels has a prismatic container (1), a central photovoltaic panel (6), transversal photovoltaic panels (61, 62, 63, 64) hinged by means of cylindrical hinges (7) on the central panel (6), and side photovoltaic panels (610, 620, 630, 640) that are placed over the transversal photovoltaic panels (61, 62, 63, 64) in a rest position and coplanar with each other in an operating position by sliding the side photovoltaic panels (610, 620, 630, 640) over transversal photovoltaic panels (61, 62, 63, 64).

WO 2013/061354 A2

MOBILE SOLAR POWER-GENERATING SYSTEM WITH DEPLOYING PANELS

TECHNICAL FIELD

The present invention relates to a mobile solar power-generating system with deploying panels.

BACKGROUND ART

Power-generating systems of this kind are already known. See, for example, the patent application RM2010U000015 in the name of the same Applicant relating to a mobile solar power-generating system comprising a square-base parallelepiped container comprising a central photovoltaic panel being supported in a tiltable manner on a top wall of the container by suitable supporting means. A correspondent transversal photovoltaic panel is hinged on each of the sides of the central photovoltaic panel. Another side photovoltaic panel is hinged to each of said transversal photovoltaic panel and positioned over the same. The transversal photovoltaic panels and the side photovoltaic panels are designed in an operating position to become coplanar with the central photovoltaic panel. Mutual engagement means such as bars and bolts are provided for keeping coplanar the transversal photovoltaic panels and the side photovoltaic panels with the central photovoltaic panel when the power-generating system is in an operating position.

For simplicity of exposition the photovoltaic panels are called only panels in the following.

It is evident that in operation the set of central panel, transverse panels, and side panels is subject to the force of gravity acting on all extension of the set, but the set is supported only in its central part by said supporting means located on the top wall of the parallelepiped container.

Furthermore, the set of central panel, transverse panels, and side panels is exposed to the action of atmospheric agents over its entire extension. It is

evident that the means of mutual engagement that has been used so far to maintain each panel joint and coplanar with the adjacent one, is not generally sufficient to counteract the action of the force of gravity and the effects of the atmospheric agents. The same Applicant overcame this drawback as retrieved from the Internet (Pro D3: "ikube Technical Report").

Another drawback present in the power-generating system of the above cited patent application consists of the difficulty of transmission of the electrical current that is generated by each individual panel and collected from the batteries of the mobile solar power-generating system. In fact, the electrical coupling between panels is made by means of connectors, for example of the male-female type, that are placed on the side walls of the panels in correspondence of the hinges. The connectors of this type generally must be joint with a linear and coplanar movement, while in the previous embodiment, the connection should take place at the end of a rotary movement of 90 degrees or 180 degrees having an axis corresponding to that of the hinge.

In the mentioned power-generating system such a deployment of the panels by means of their rotation makes difficult the possible use of electric motors for their automation, in order to prevent the putting into operation with a manual action on the part of an operator.

SUMMARY OF THE INVENTION

In this context, the technical task underlying the present invention is to propose a mobile solar power-generating system that overcomes the drawbacks of the prior art mentioned above.

In particular, it is an object of the present invention to provide a mobile solar power-generating system able to allow the panels, after being deployed in their operating position, to rigidly be maintained coplanar as necessary.

Another object of the present invention is to propose a mobile solar power-generating system that allows the set of panels, after being deployed in their operating position, to maintain a stable connection with the container of the power-generating system.

Another object of the present invention is to ensure a good electrical coupling between the panels.

A further object of the present invention is to propose a mobile solar power-generating system which makes easy the deployment of the panels by an operator for putting the mobile solar power-generating system into operation.

The stated technical task and the specified objects are generally achieved by a mobile solar power-generating system comprising the technical features set forth in claim one and in the secondary claims herein enclosed.

BRIEF DESCRIPTION OF DRAWINGS

Further features and advantages of the present invention will be mostly clear by an indicative and therefore not limiting description of a preferred example of a mobile solar power-generating system as illustrated in the accompanying drawings in which:

- Figures 1 to 5 are isometric views from above that represent subsequent arrangements in deployment of the panels of the power-generating system according to the invention;
- Figure 6 is an isometric view taken from the rear of the panels in operating position of the power-generating system according to the invention;
- Figure 7 is a side view of the power-generating system in Figure 6 according to the invention;
- Figure 8 is a rear view of the power-generating system corresponding to Figure 6 according to the invention;
- Figure 9 is a top plan view of a pair of overlapping panels of the power-

generating system according to the invention;

- Figure 10 is a front view of the panels in Figure 9;
- Figure 11 is a side view of the panels in Figure 9;
- Figure 12 is an enlarged view of a detail of the panels in Figure 10;
- Figure 13 is an enlarged view of a detail of the panels in Figure 11;
- Figure 14 is an enlarged cross-section along the line A-A in Figure 13;
- Figure 15 is an isometric view of two adjacent panels of the power-generating system according to the invention;
- Figure 16 is a top view of the panels in Figure 15, and
- Figure 17 is an enlarged side view of a detail of the panels in Figure 15.

DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

First, reference is made to figures 1 to 5, which are isometric views showing subsequent arrangements in deployment of the panels of the power-generating system according to the invention. In Figure 1 a mobile solar power-generating system is shown in its rest position with retracted panels for its transportation. In particular, a square-base parallelepiped container is indicated as 1, being provided with wheels generally indicated as 3. Parts inside the prismatic container 1 are not described here because a reference regarding them is made to the patent application RM2010U000015.

In the same Figure 1 a central panel 6 is shown. Hinged on each of the sides of the central panel 6 by cylindrical hinges 7 is a correspondent transversal panel 61, 62, 63, 64, being oriented downward in its rest position.

Each transversal panel 61, 62, 63, 64, is able to rotate 90 degrees upward so that it is arranged coplanar with the central panel 6. Correspondent to each transversal panel 61, 62, 63, 64 is a side panel 610, 620, 630, 640 being maintained in its rest position by retaining means not described. According to the present invention, as will be described below, the side panels 610, 620, 630, 640 are intended to slide on the correspondent transversal panels 61, 62, 63, 64 to reach their operating position.

In Figure 2, which represents one of the following arrangements in the deployment of the panels, the transversal panels 61, 62, 63, 64 are shown in a position slightly rotated upwards as they are supported on a frame 4 by means of so-called gas springs indicated generally as 5 . The gas springs 5 have supporting hinges at their superior and inferior ends, indicated generally as 51 and 52. The hinges 51 and 52 are fixed on the lateral edges of each transversal panel and, respectively, on the frame 4 that is rigidly connected to the central panel 6. Said lateral edges are called hereinafter also lateral section bars. The frame 4 is partially shown here, but is clearly visible in the following figures. The side panels 610, 620, 630, 640 are placed over the transversal panels.

In Figure 3 there is shown a further arrangement in which the transversal panels 61, 62, 63, 64 are maintained by the gas springs 5 in a position coplanar with the central panel 6, and the side panels 610, 620, 630, 640 are placed over the transversal panels.

In Figure 4 there is shown how the side panels 610, 620, 630, 640 slide partially in order to become coplanar with the central panel 6 and the transversal panels 61, 62, 63, 64 at the end of the sliding operation, as shown in Figure 5.

In Figure 5 one can observe the final arrangement in the deployment in which the central panel 6, the transversal panels 61, 62, 63, 64 and the side panels 610, 620, 630, 640 are coplanar with each other.

With reference to Figure 6, there is shown an isometric view from the rear side of the panels of the power-generating system according to the invention in an operating position. The central panel 6 is fastened to the prismatic container 1 by means of two hinge elements 8 and is able to rotate around them by means of two counteracting shock absorbers generally indicated with 9, in their quality of tilt control means. Both hinge elements 8 and the shock absorbers 9 are fixed on the one hand to the

central panel 6 and the other to the top wall 10 of the prismatic container 1. In the same figure 6 one can see that the central panel 6 is sized slightly greater than the top wall 10 of the prismatic container 1. The frame 4 is connected to the central panel 6. The frame 4 is formed by orthogonal rods 41, 42, 43, 44 being secured at an upper end thereof at right angles to the vertices of the central panel 6 in a manner that the frame 4 does not encounter the top wall 10 of the prismatic container 1 in its rotation. The lower ends of the rods 41 and 42 (the latter can be seen in Figure 7) are mutually connected by means a parallel rod 412, the lower ends of the rods 41 and 44 are mutually connected by means of a parallel rod 414, and the lower ends of the rods 43 and 44 are mutually connected by a parallel rod 434. The lower ends of the rods 42 and 43 are not connected to each other: this allows the frame 4 to rotate integrally with the central panel 6 about the horizontal axis identified by the hinge elements 8.

Fixed at the lower ends of the orthogonal rods 41, 42, 43, 44, are supporting hinges 52 for the gas springs 5 supporting the transversal panels 61, 62, 63, 64. Attached to the same lower ends of the orthogonal rods 41, 42, 43, 44, are the lower ends of windbracing removable rods 11 which retain the side panels 610, 620, 630, 640, in their operating position by attachment means to the frame, on the one hand, and to the panels, on the other hand. The attachment means to the panels are not described in detail. Figure 7 and Figure 8 are a side view and a rear view respectively, of the panels of the power-generating system in their operating position showing the elements already described in Figure 6.

Reference is made now to Figures 9, 10 and 11, which are a top plan view, a front view and a side view respectively, of one of the side panels, such as the panel 610, that is placed over the respective transversal panel 61 in its rest position. In said Figures there is shown how each side panel slides on the corresponding transversal panel until it reaches the operating position

and how the side panel is retained in this position.

The panels have edges made with section bars traditionally used in the manufacturing field of the photovoltaic components. With reference to Figure 13, which shows a detail of Figure 11 in an enlarged scale, one can observe that the section bars have a substantially square-shaped cross-section, with the diagonals of the square that meet at a central core so that at least two open lateral seats are formed.

In particular, referring to the arrangement of the power-generating system shown in Figure 1, the superior and inferior section bars of the transversal panels 61, 62, 63, 64, are generally indicated as 12, the superior and inferior section bars of the side panels 610, 620, 630, 640, are indicated generally as 13, while the lateral section bars of the transversal panels 61, 62, 63, 64, are generally indicated as 14 and the lateral section bars of the side panels 610, 620, 630, 640, are indicated generally as 15.

Returning to Figures 10 to 13, the cross-section of the section bars forms at least one groove open towards the outside with respect to the panel, the groove being indicated as 120 for the section bar 12 and as 130 for the section bar 13, as shown in the following Figures 12 and 13, which are enlarged views of the details of the panels in Figures 10 and 11.

Again according to the view of Figure 1, fixed on the section bar 14, on the left of each panel 61, 62, 63, 64, are two hooking members 22, for example simple brackets, that can be seen better in the next figure 15. On the section bar 14, to the right of each panel 61, 62, 63, 64 according to the view of Figure 1, is fixed a U-shaped hooking member 18 facing upwards.

Fixed on the section bar 13, which is superior in the position of rest of the invention shown in Figure 1, is a U-shaped hooking member 23 facing downwards, as indicated in Figure 11.

With reference to Figure 12, the section bar 12 at one of its ends is provided with a support member 16 conformed like a upside down Y in the present

embodiment. The support member 16 is fixed to the section bar 12 by a pair of fasteners 160, for example rivets, in the arms of the Y, and bears a fixed wheel 17 in the Y core, as shown in Figure 13. In the same Figure 12, there is shown the cross-section of an U-shaped hooking member 18 facing upwards place over the entire length of the section bar 14.

Referring to Figure 13, a fixed wheel 17 is received in the groove 130 of the section bar 13, and this arrangement enables the section bar 13 of the side panel 610 to slide with respect to the section bar 12 of the transversal panel 61.

As further shown in Figure 13, the section bar 13, in its side facing the section bar 12, is provided with a bearing element 19 holding a movable wheel 20 designed to be received by an upper groove 120 of the corresponding section bar 12.

Referring to Figure 14, which is a cross-section view along the line A-A in Figure 13, there is shown the bearing element 19 with its movable wheel 20. In the same figure 14 there is shown a cross-section of an U-shaped hooking member 21 facing downwards that is placed preferably over the entire length of the section bar 13.

In putting in operation, starting from the rest position in Figure 1, an operator lifts progressively and sequentially the transversal panels 61, 62, 63, and 64, by rotating them about the cylindrical hinges 7. After achieving a position of the transversal panel coplanar with the central panel 6, this position is kept thanks to the action of the gas springs 5. Then the operator moves each side panel 610, 620, 630, and 640 for its entire length on the corresponding transversal panel 61, 62, 63, and 64 thanks to the action of fixed wheels 17 and the movable wheels 20, which facilitate the sliding of the panels. The condition shown in Figure 15 is obtained, in which there are shown side by side, by way of example, the transversal panel 61 and the side panel 610. In the transversal panel 61 there is shown a handle 24

suitable for the rotation of the panel 61.

Reference is made now to Figures 16 and 17 that are a top view of the panels in Figure 15 and an enlarged side view of a detail of the same panels respectively. At the end of the sliding operation, the U-shaped hooking member 21 facing downward of each side panel 610, 620, 630, and 640 is made to mate with the U-shaped hooking member 18 facing upwards of the corresponding transversal panel 61, 62, 63, and 64. At the same time, the hooking member 23 on the superior section bar 13 of each side panel 610, 620, 630, and 640 is made to mate with the hooking members 22 of the adjacent transversal panel 64, 61, 62, and 63.

Then, each side panel 610, 620, 630, and 640 simply rests on two transversal panels adjacent thereto and is therefore retained in the operating position through the application of windbracing removable rods 11 by the operator.

It is evident how the described structure comprised of frame 4 being rigidly connected to the central panel 6, cylindrical hinges 7, gas springs 5, hooking members 18, 21 and 23, brackets 22 and windbracing removable rods 11, provides the set of deployed panels the ability to resist the force of gravity and the effects of atmospheric agents possibly present.

Moreover, the panels, when they are deployed in their operating position, are maintained rigidly coplanar with one another thanks to the gas springs 5 and to the windbracing removable rods 11 and in stable connection with the container of the power-generating system by means of the hinges 8 and the shock absorbers 9.

Even if the electric system of the power-generating system according to the invention is not shown, it is evident that the sliding of the side panels with respect to the transversal panels allows their optimal electrical connection with the use of conventional plugs and sockets.

Thanks to the arrangement described above the deployment of the panels by an operator for putting power-generating system into operation is facilitated, possibly also with the use of electric motors that automate the rotation of the transversal panels and the sliding of the side panels. This can also be achieved by means of remote controls.

CLAIMS

1. A mobile solar power-generating system with deploying panels comprising:

- a prismatic container (1) having a top wall (10),
- a central photovoltaic panel (6) provided with hinge elements (8) and tilt control means (9) on said top wall (10),
- transversal photovoltaic panels (61, 62, 63, 64) hinged by cylindrical hinges (7) on the central photovoltaic panel (6) and provided with superior/inferior section bars (12, 12) and lateral section bars (14, 14), the profile shape of the superior/inferior section bars (12, 12) having at least a groove (120), said transversal photovoltaic panels (61, 62, 63, 64) being oriented downward in a rest position and being able to rotate 90 degrees upward,

characterised in that a correspondent side photovoltaic panel (610, 620, 630, 640) slidably engages each transversal photovoltaic panel (61, 62, 63, 64), so that the side photovoltaic panels (610, 620, 630, 640) are placed over the transversal photovoltaic panels (61, 62, 63, 64) in a rest position and are coplanar with each other in an operating position.

2. The power-generating system according to claim 1, wherein

- the side photovoltaic panels (610, 620, 630, 640) are provided with superior/inferior section bars (13, 13) and lateral section bars (15, 15), the superior/inferior section bars (13, 13) having its cross-section provided with at least a groove (130),
- the superior/inferior section bars (12, 12) of the transversal photovoltaic panels (61, 62, 63, 64) are provided, at one of their ends, with support members (16, 16) holding fixed wheels (17, 17), which are received in the grooves (130) of the superior/inferior section bars (13, 13) of the side photovoltaic panels (610, 620, 630, 640),
- the superior/inferior section bars (13, 13) of the side photovoltaic panels

(610, 620, 630, 640) are provided with bearing elements (19, 19) holding movable wheels (20, 20), which are received in the grooves (120) of the superior/inferior section bars (12, 12) of the transversal photovoltaic panels (61, 62, 63, 64),

so that the side photovoltaic panels (610, 620, 630, 640) are slidable on the transversal photovoltaic panels (61, 62, 63, 64).

3. The power-generating system according to claim 2, wherein the lateral section bars (14, 14) of the transversal photovoltaic panels (61, 62, 63, 64) are provided with first hooking members (18), and the lateral section bars (15, 15) of the side photovoltaic panels (610, 620, 630, 640) are provided with second hooking members (21), the first hooking members (18) of the lateral section bars (14, 14) and the second hooking members (21) of the lateral section bars (15, 15) engaging each other when the side photovoltaic panels (610, 620, 630, 640) are coplanar with the transversal photovoltaic panels (61, 62, 63, 64) in an operating position.

4. The power-generating system according to claim 2, wherein the superior section bars (13) of the side photovoltaic panels (610, 620, 630, 640) are further provided with third hooking members (23) and the lateral section bars (14, 14) of the transversal photovoltaic panels (61, 62, 63, 64) are provided with fourth hooking members (22), the third hooking members (23) of the superior section bars (13) of the side photovoltaic panels (610, 620, 630, 640) and the fourth hooking members (22) of the lateral section bars (14, 14) engaging each other when the side photovoltaic panels (610, 620, 630, 640) are coplanar to the transversal photovoltaic panels (61, 62, 63, 64) in an operating position.

5. The power-generating system according to claim 1, wherein a frame (4), which is comprised of orthogonal rods (41, 42, 43, 44) being fixed at their superior ends orthogonally to the vertices of the central photovoltaic panel (6) and joined consecutively at their lower ends by parallel rods (412,

414, 434), is connected to the transversal photovoltaic panels (61, 62, 63, 64) by gas springs (5).

6. The power-generating system according to claim 5, wherein the lower ends of two orthogonal rods (42, 43) are separated in order to allow the frame (4) to rotate integral with the central photovoltaic panel (6) about the horizontal axis identified by the hinge elements (8).

7. The power-generating system according to claim 5, wherein hooked between the frame (4) and the side photovoltaic panels (610, 620, 630, 640) are respective removable windbracing rods (11) retaining the side photovoltaic panels (610, 620, 630, 640) in operating position.

8. The power-generating system according to claim 1, wherein the tilt control means (9) is hydraulic shock-absorbing means.

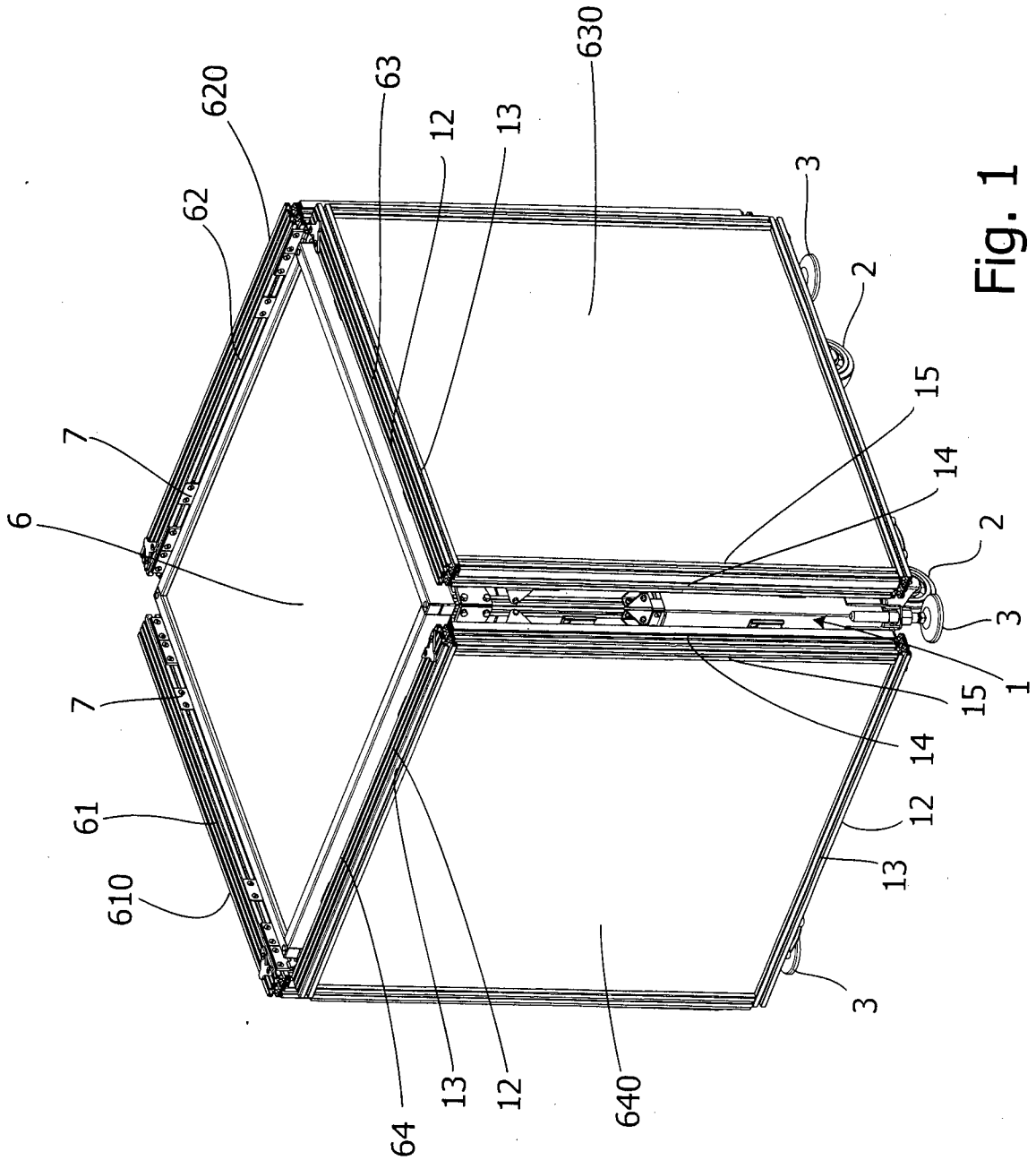

Fig. 1

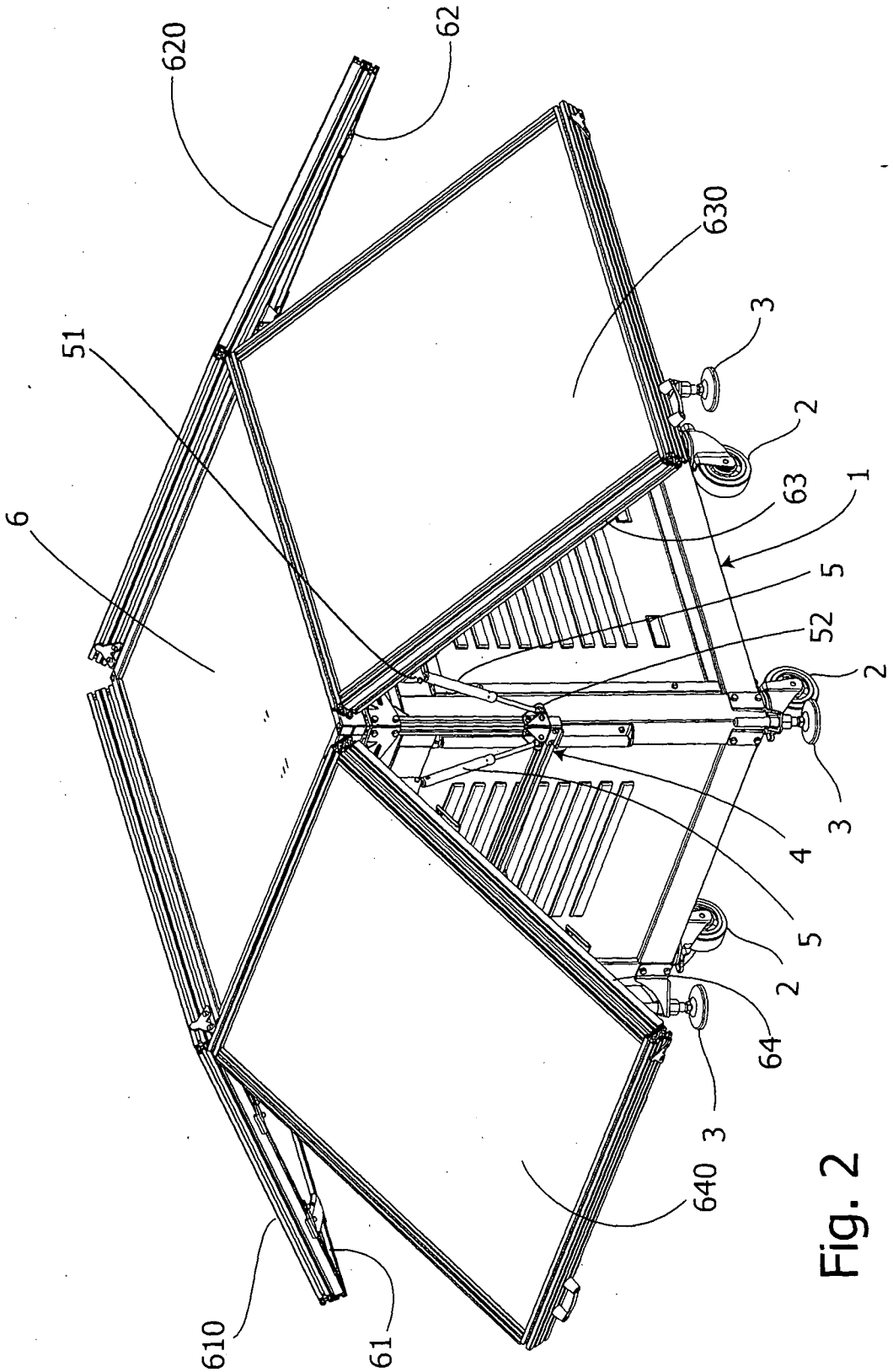

Fig. 2

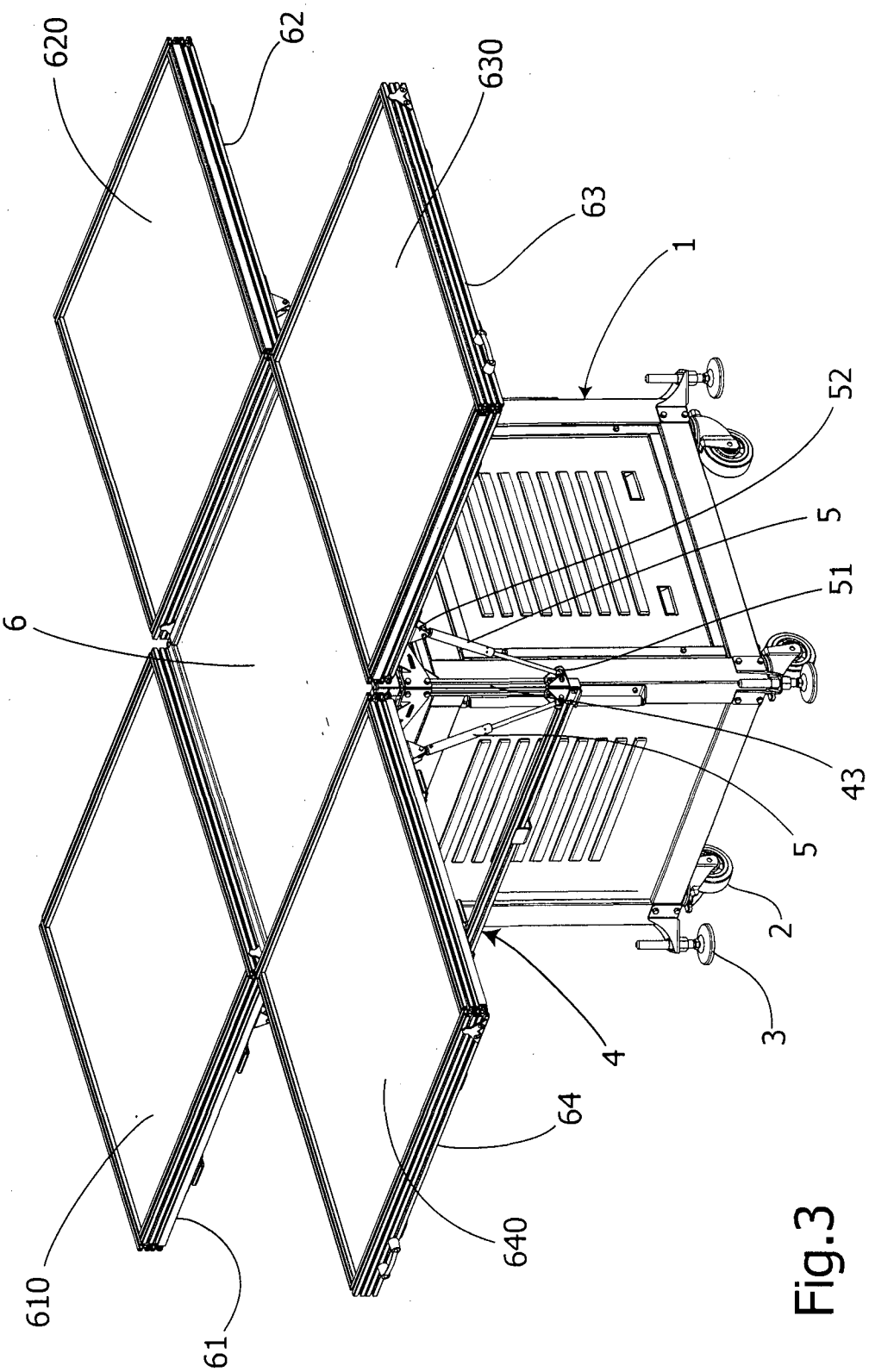

Fig.3

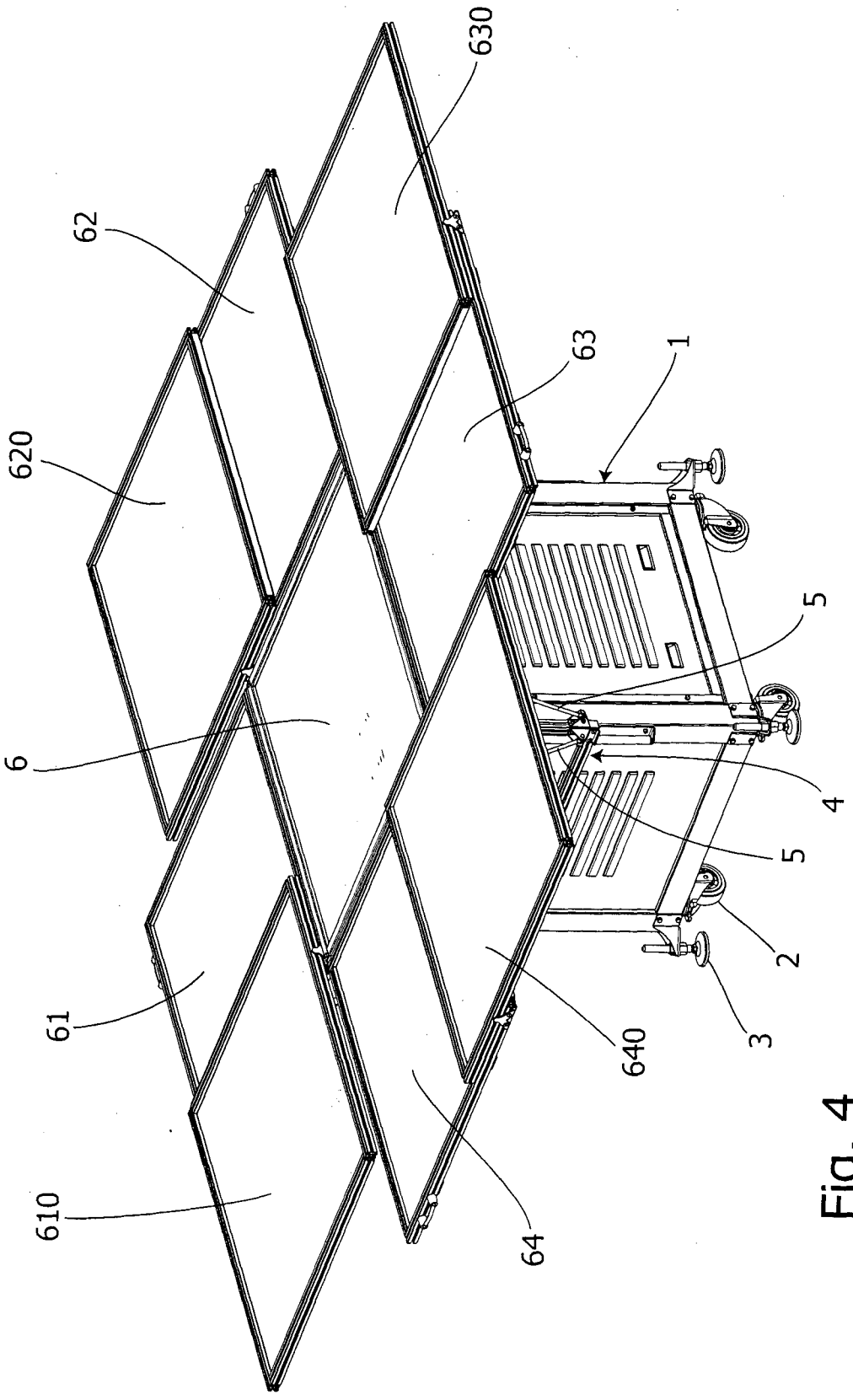

Fig. 4

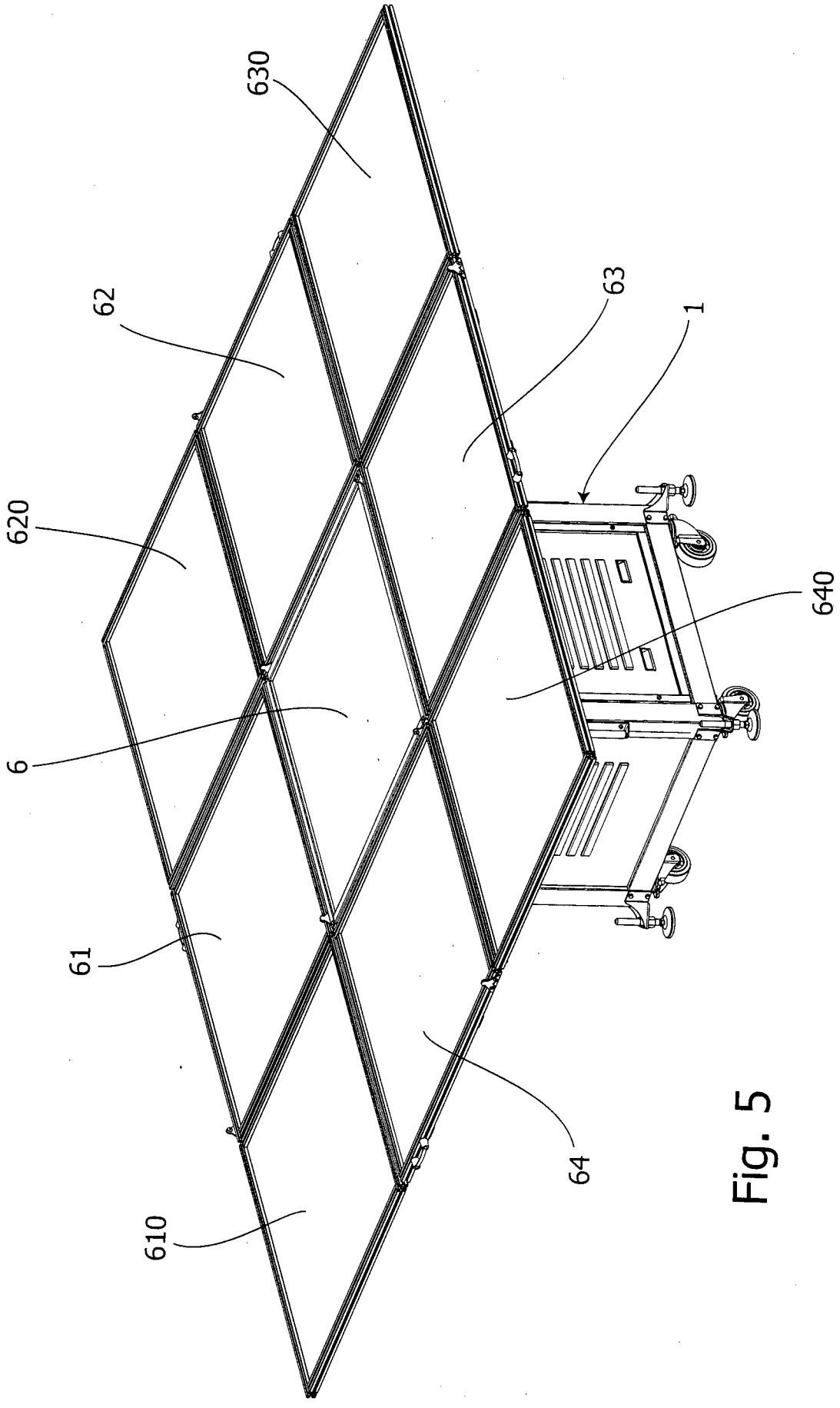

Fig. 5

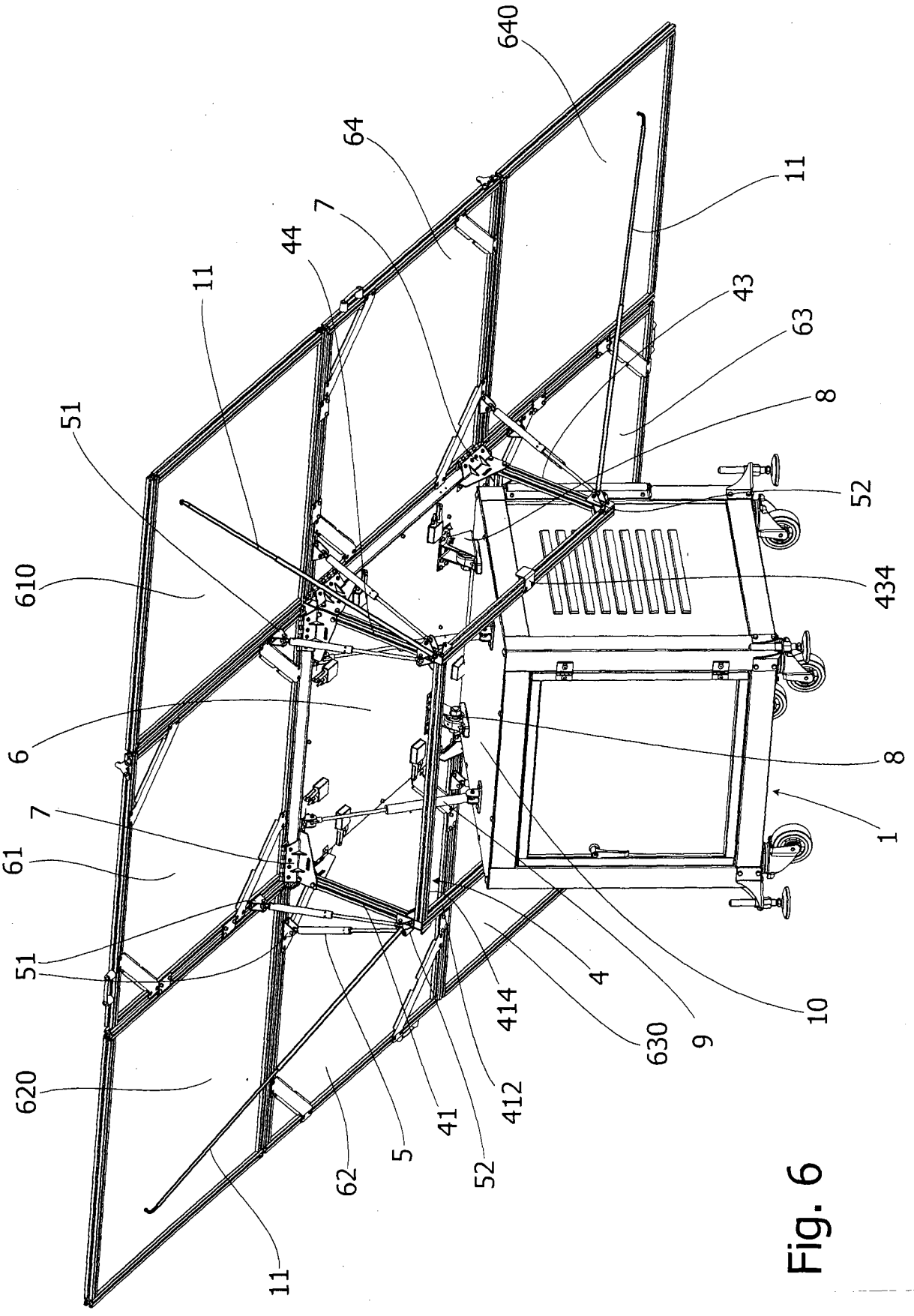
640
64
11
7
44
43
11
63
51
8
52
610
434
6
8
1
7
61
51
4
414
630
9
10
620
62
5
41
412
52
11

Fig. 6

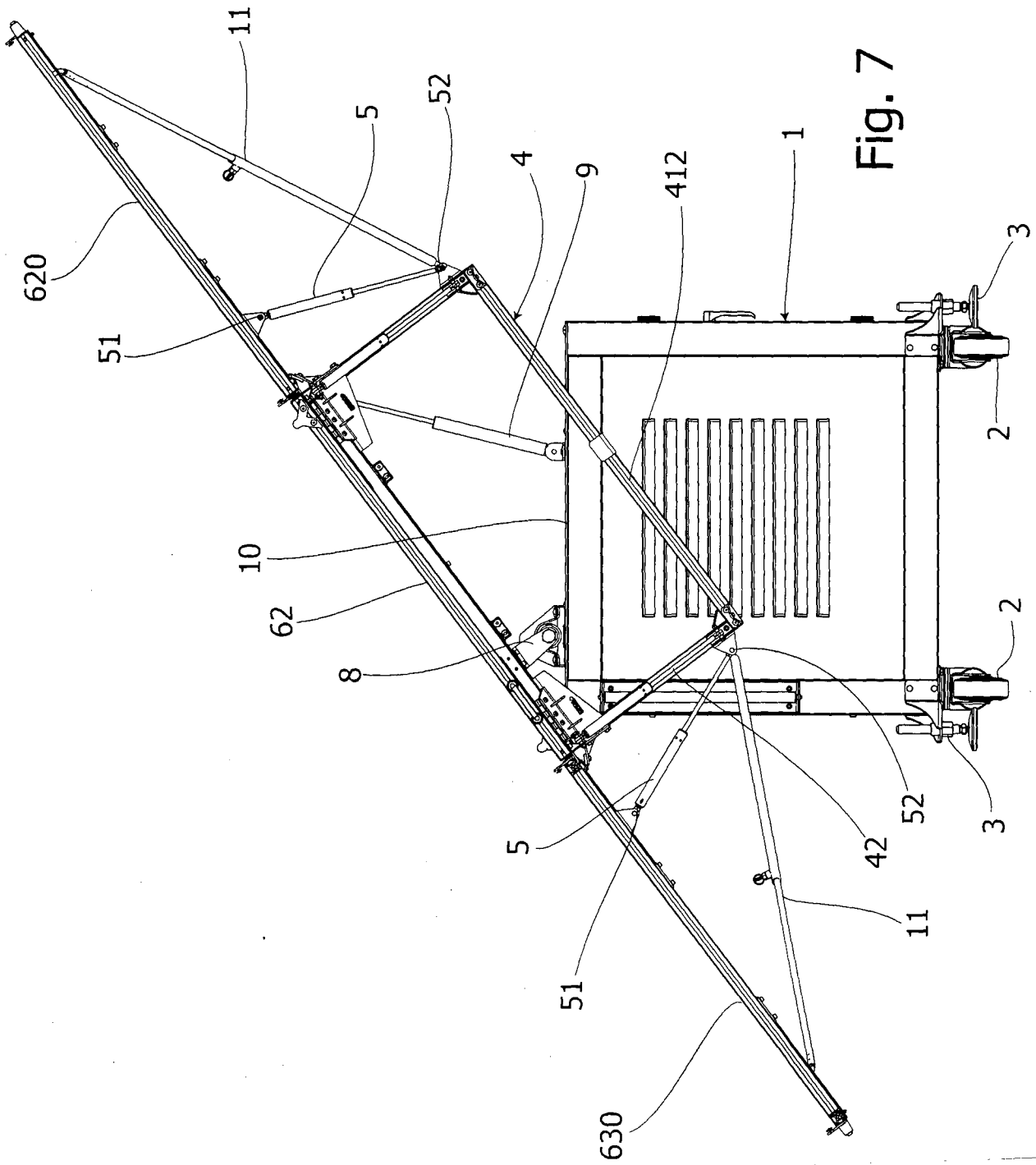

Fig. 7

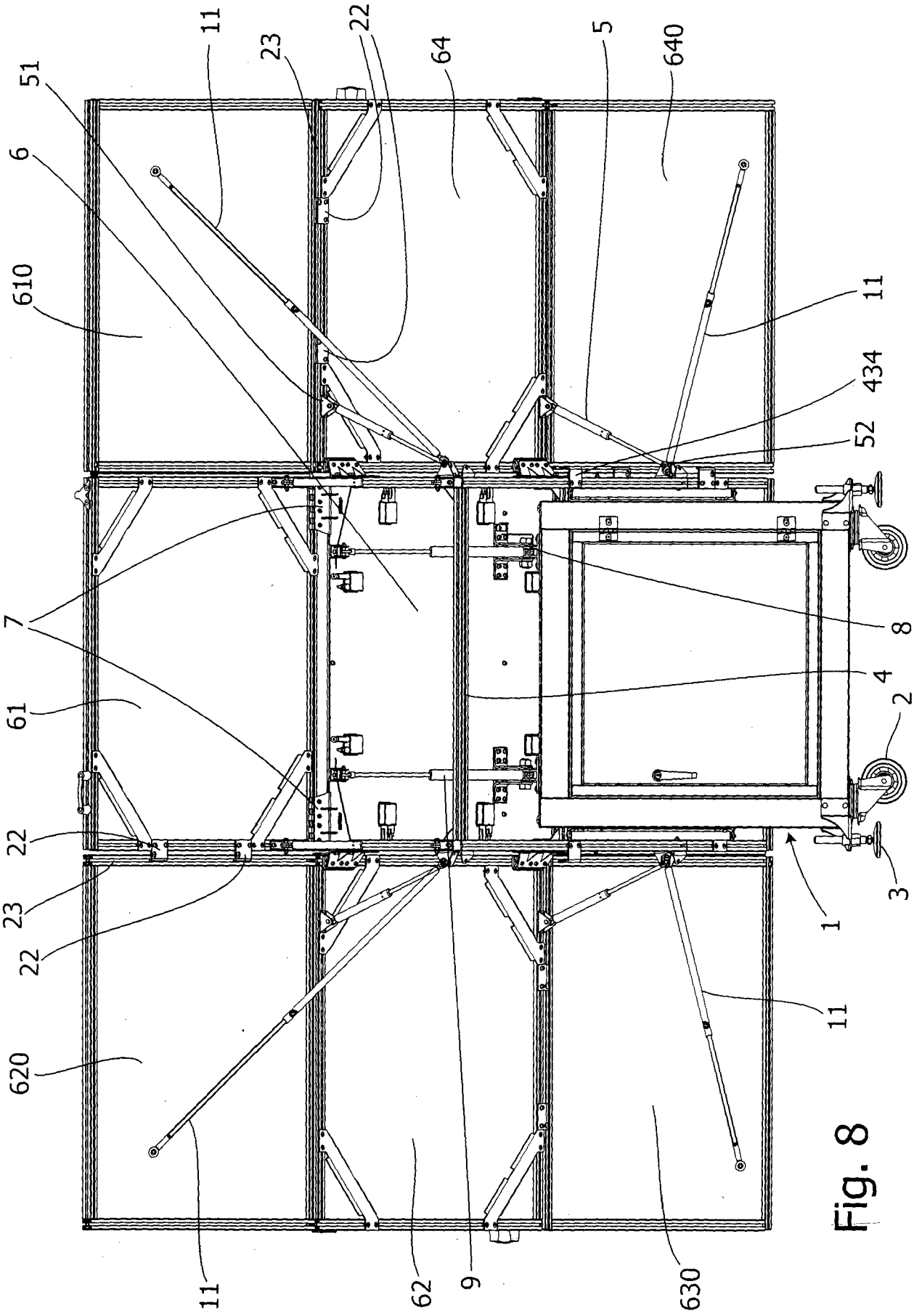
11
23
22
64
5
640
51
6
610
11
434
52
7
8
4
61
2
22
23
22
3
1
11
620
11
62
9
630

Fig. 8

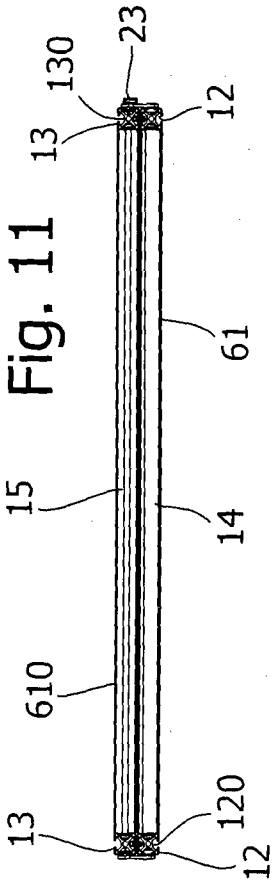

Fig. 11

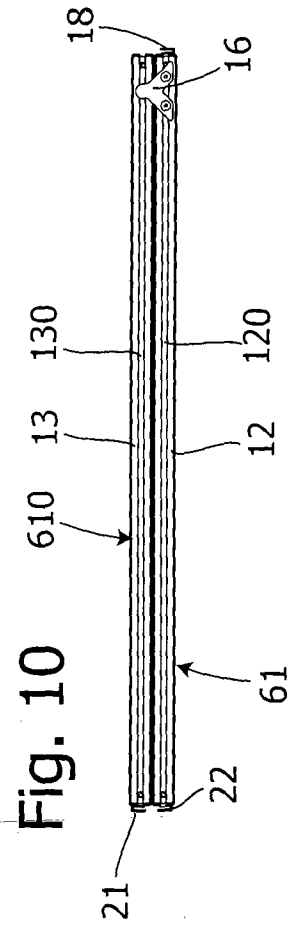

Fig. 10

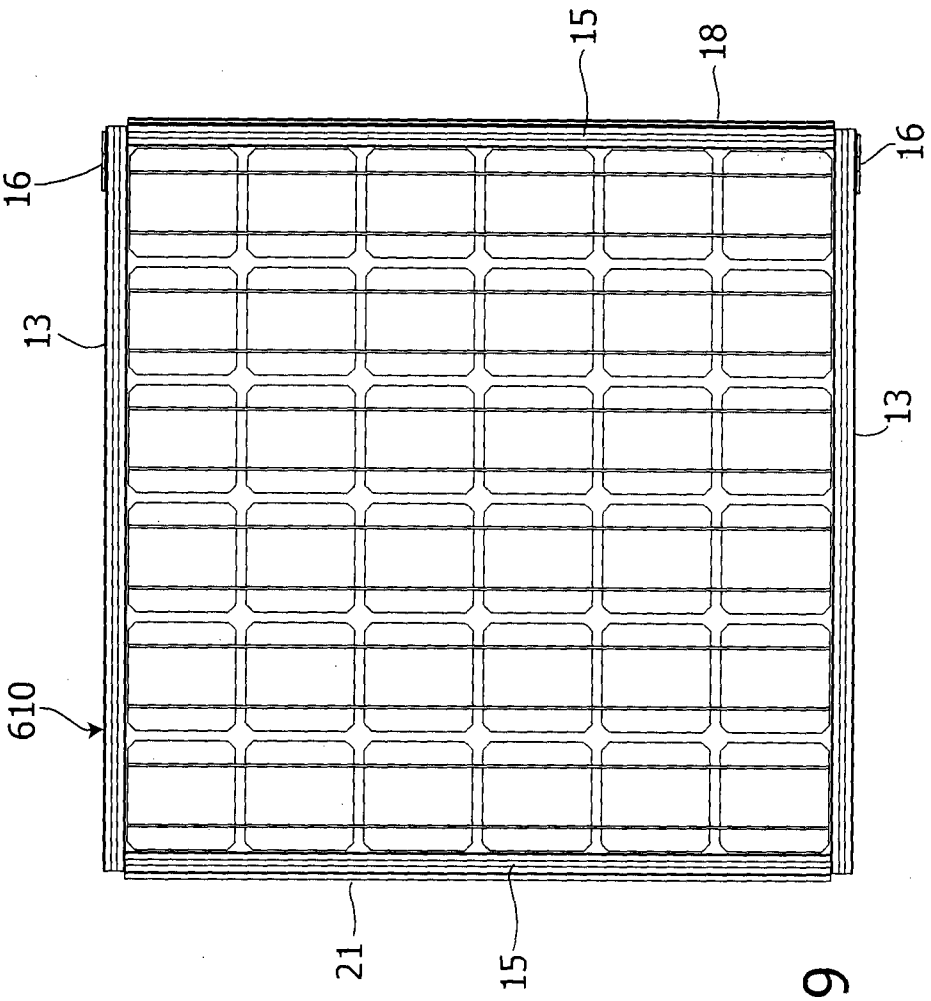

Fig. 9

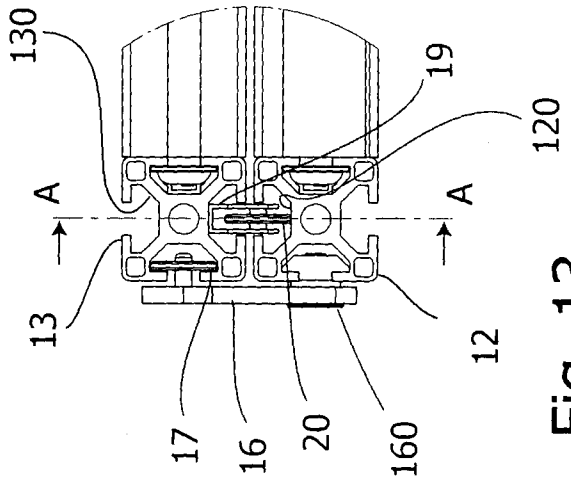

Fig. 13

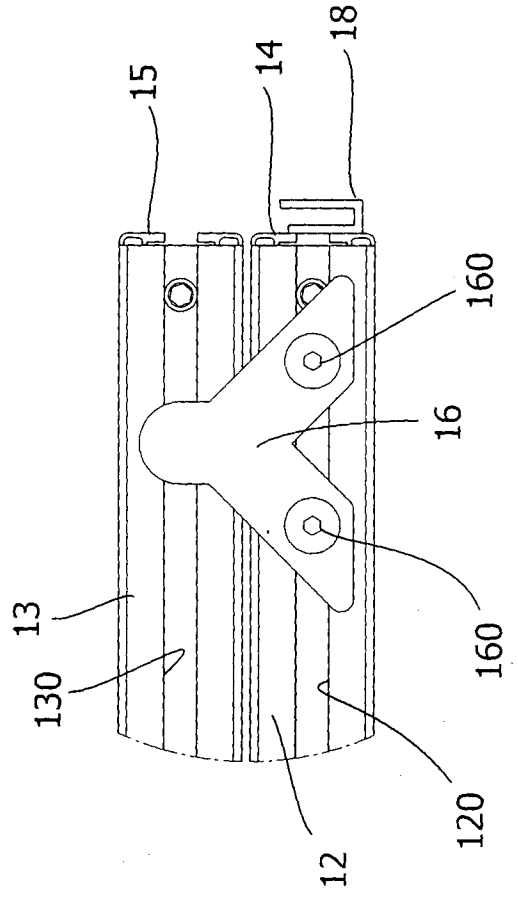

Fig. 12

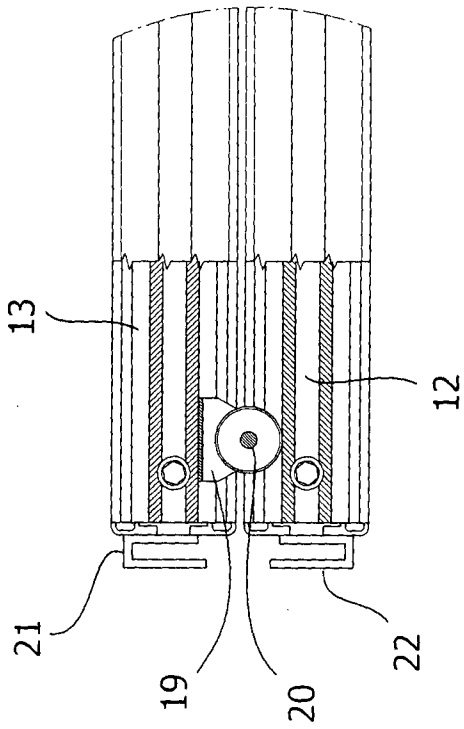

Fig. 14

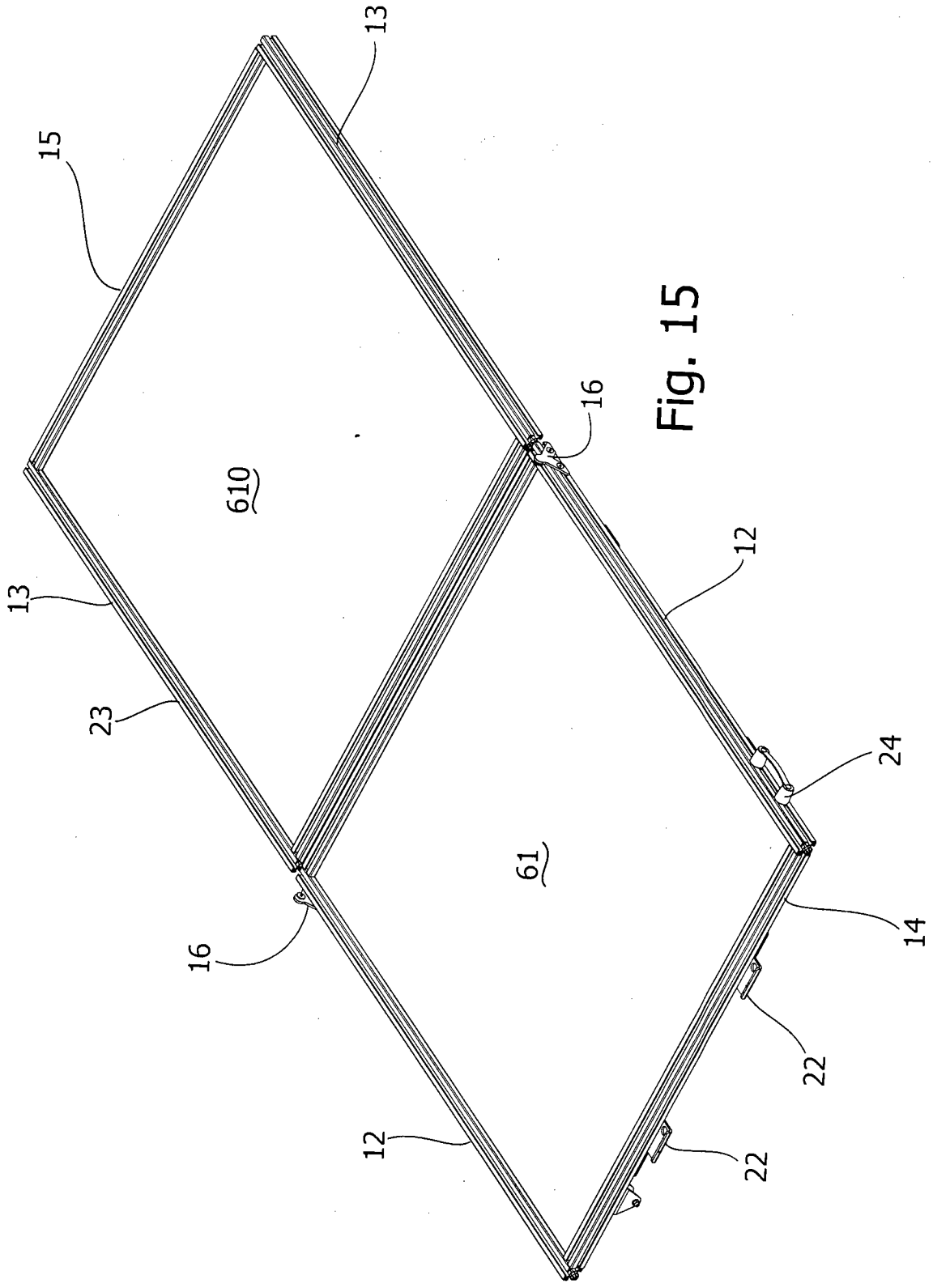

Fig. 15

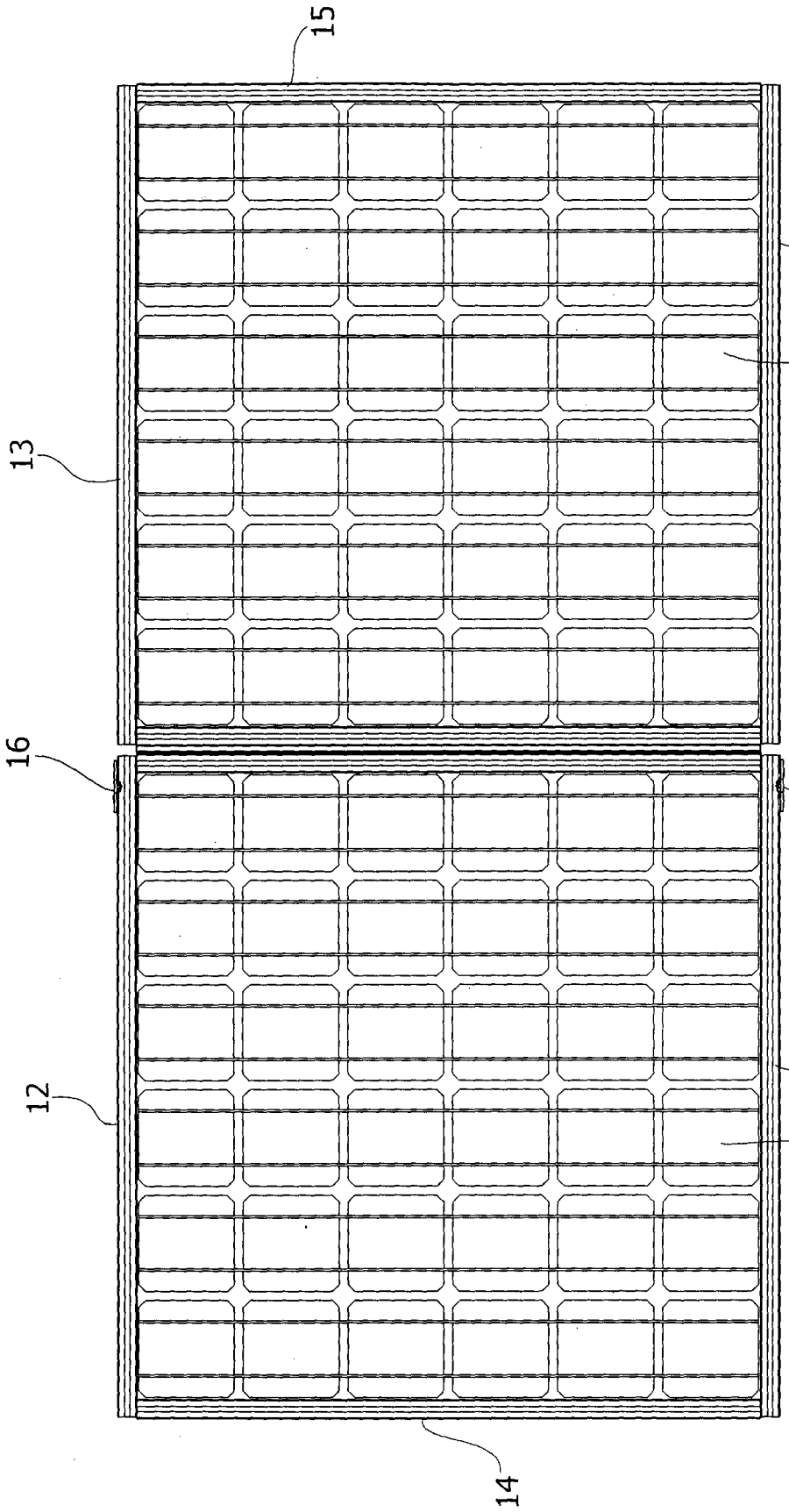

Fig. 16

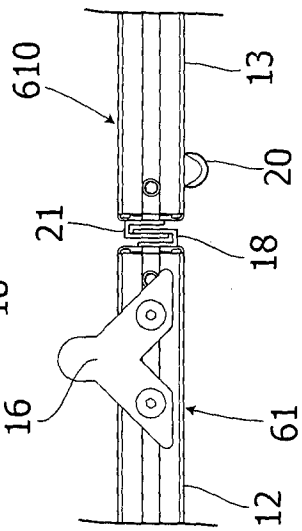

Fig. 17