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(54) **Title**: A BLAST-RESISTANT STRUCTURE

(57) **Abstract**: A blast-resistant structure comprising a body in which is defined an aperture is disclosed. The aperture is bounded by two edge parts of the body. The blast-resistant structure further comprises a door configured selectively to close-off the aperture; and first and second securing mechanisms configured selectively to secure the door to respective ones of the body edge parts. Each securing mechanism comprises a locking channel that extends generally parallel to the body edge part and a corresponding locking pin having a generally straight part that extends generally parallel to the body edge part and is moveable between an open position in which the locking pin is external to the locking channel and a secured position in which the locking pin is engaged in the locking channel.

A Blast-Resistant Structure

Field

The present invention relates to a blast-resistant structure.

Background

Refuse bins are typically provided in public places in town and city centres. However, security concerns have resulted in the removal of refuse bins from some public areas causing inconvenience to the public and an increase in cost for those charged with litter clearance.

Bomb resistant bins with the ability to contain explosions are known. The design of such bins is challenging because of the usually conflicting requirements of effectiveness of blast-resistance and cost of manufacture, ease of emptying, ease of use by the public, ease of installation and later removal.

Summary

According to the present invention, there is provided a blast-resistant structure comprising: a body in which is defined an aperture, the aperture being bounded by two edge parts of the body; a door configured selectively to close-off the aperture; and first and second securing mechanisms configured selectively to secure the door to respective ones of the body edge parts, wherein each securing mechanism comprises a locking channel that extends generally parallel to the body edge part and a corresponding locking pin having a generally straight part that extends generally parallel to the body edge part and is moveable between an open position in which the locking pin is external to the locking channel and a secured position in which the locking pin is engaged in the locking channel.

Preferably, the locking channels are fixedly attached to the body and the locking pins are fixedly attached to the door. Alternative arrangements provide viable embodiments, although providing the locking pins as part

of the door allows for simpler construction whilst allowing the door to be opened when required.

Conveniently, the locking pins are integrated onto a locking pin mechanism such that the locking pins are in a fixed relationship with respect to one another. This can allow improved resistance to blast forces because other components of the door can be removed from the requirement of preventing the edges of the body moving apart in the event of a blast.

In one embodiment, a single sheet of material constitutes part of both the locking pins. This can provide suitable strength to the key aspects of the locking pin mechanism whilst allow it to have a relatively simple form and be relatively easy to manufacture.

Preferably, the locking pin mechanism comprises two pairs each of first and second locking pins, wherein both of the first locking pins are formed on a common axis and both of the second locking pins are formed on a different common axis. This can provide good structural rigidity over a relatively large door area without requiring multiple operations to engage the securing mechanisms.

Conveniently, the locking pin mechanism is translatable relative to a body of the door in response to locking and unlocking forces. This can allow the use of a relatively simple mechanism for allowing securing and unlocking of the door to the body, and also the use of relatively simple movements for achieving this, whilst providing blast-resistance.

The body may be formed from a sheet of material, and wherein the body edge parts are located at edges of the sheet. This can allow suitable resistance to blast forces within the body with a relatively simple and easy to manufacture structure for the body. With this feature, construction

structural integrity can be provided without requiring features to ensure that the body retains its shape in the event of a blast originating within the body.

Conveniently, the two edge parts of the body are generally parallel to one another. Alternatively, the edge parts may not be straight. Here, a part of an edge part at which the first securing mechanism is located preferable is generally parallel to a part of the other edge part at which the second securing mechanism is located and both of the securing mechanisms are located on a line that is perpendicular to both the edge parts.

Preferably, the two generally parallel edge parts are generally vertical in use. This allows the door to be hinged or otherwise supported so that it moves between open and closed positions without any vertical change in the centre of gravity of the door. This can allow relatively straightforward opening and closing of the door by an operative even if the door is relatively heavy. This feature can also provide particular structural integrity in the horizontal plane, so as to cause the structure to direct blast forces upwards.

The blast-resistant structure may comprise a hinge mechanism configured hingedly to couple the door to one of the body edge parts and to allow the door to open to allow access to an interior of the body through the aperture when the first and second securing mechanisms are in the open position.

Brief Description of the Drawings

Embodiments of the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a perspective view of a blast-resistant container embodying the present invention;

Figure 2 shows a perspective view of an inner side of a door of the container;

Figure 3 shows a perspective view of an inner side of the door of the container without a cover;

Figure 4 shows a front view of an outer side of the door shown in Figures 2 and 3;

Figure 5 shows a perspective view of a paper gate fitted to the door;

Figure 6 shows a perspective view of an upper locking plate with locking hooks;

Figure 7 shows a perspective view of a lower locking plate with locking hooks;

Figure 8 shows a perspective view of a part of either of the locking plates and showing a second layer;

Figure 9 shows a perspective view the same as Figure 8 but with a reinforcing component in place;

Figure 10 shows a perspective view of part of the reinforcing component shown in Figure 9;

Figure 11 shows a perspective view of a cover fitted to an inner side of the door; and

Figure 12 shows a perspective view of the container without the door.

Detailed Description

Referring now to the drawings, there is shown in Figure 1 a blast-resistant container 1 configured to absorb and upwardly direct forces of an explosion originating inside the container 1.

The container 1 comprises a door 2, a rear wall 3, a left and a right side wall 4, 5 and a base 6 defining a space for holding refuse. The rear wall 3, the left and the right side walls 4, 5 are integrally formed, for example, it may be formed of a metal sheet. The door 2 is removably attachable to edges formed at the front of the two side walls 4, 5 so as to provide access to the space provided within the container 1. The door 2 is hinged so that is can be swung open and closed. The hinge axis is vertical, and there is no vertical change in the centre of gravity of the door as it hinges.

The base 6 is formed with a plurality of holes (not shown) for receiving fastening means such as bolts so that the container 1 can be secured to the ground upon which it stands. At an opposite end to the base 6, an aperture 8 is formed for directing or channelling a blast from an explosion in a direction away from the base 6 and generally vertically. The longitudinal axis of the container 1 is generally vertical in use.

Referring now to Figures 2 to 5, the door 2 comprises a front panel 20 preferably made out of a metal sheet. The door 2 of the container is provided with a refuse aperture 9 through which a user disposes of their waste so that the waste is received and contained in the space of the container 1. A refuse aperture panel 21 is fitted on the inner surface of the front panel 20 covering the aperture 9. The refuse aperture panel 21 is removably attachable to the refuse aperture 9 and when it is attached to the front panel 20 a user is prevented from disposing of their waste through the aperture 9. This may be necessary in order to put the container temporarily out of use as a bin, in particular during high security alerts. In an alternative embodiment, the refuse aperture panel 21 may be formed with a variety of holes so that the size of the waste received in the space of the container 1 can be controlled.

The door 2 is removably attached to the container 1 by cooperating means. The cooperating means of the door 2 includes locking hooks 28 attached to locking plates 25, 26 which are movable in a direction parallel to the longitudinal axis of the container 1. The locking hooks 28 may also be termed locking pins. The locking plates 25, 26 may also be termed locking pin mechanisms. The locking hooks 28 engage with corresponding cooperating elements, which can be termed locking channels, which are described in more detail below. The cooperating means enable the door 2 to be secured to the left and right side walls 4, 5 of the container 1 such that it is retained in its position in the event of an explosion within the container. Additionally, the cooperating means allow for the door 2 to be opened such as to allow access to the interior of the container 1, in particular when the container is used for refuse and needs emptying or cleaning.

The locking plates 25, 26 comprise an upper 25 locking plate and a lower locking plate 26 which are shown in Figures 6 and 7, respectively, and in situ in Figure 3. Both plates 25, 26 have a rectangular profile and are formed of a respective metal sheet. Centrally positioned apertures 27 of the plates 25, 26 have been cut out. This reduces the weight of the plates 25, 26 as well as the quantity of material required without significantly reducing strength where high strength is most needed. At approximately each corner of each of the plates 25, 26, the locking hooks 28 are formed. The locking hooks 28 each have a longitudinal axis that extends perpendicular to a line connecting opposite locking hooks. The axes of the locking hooks is vertical in use.

An end of an arm 29 is attached to the lower locking plate 26. At an opposite end of the arm 29, a rack 30 having teeth 31 is formed. The arm 29 and the rack 30 extend parallel to the locking hooks 28, so vertically in use. The upper locking plate 25 is also formed with a rack 30 having teeth 31. When the upper and lower locking plates 25, 26 are in the position shown in Figure 3, the rack 30 on the arm 29 extending from the lower locking plate 26 is parallel to the rack 30 formed on the upper locking plate 25. Furthermore, the teeth 31 of the racks 30 are opposing one another. A pinion 32 is located between the racks 30 and is rotatable about a central axis. The pinion 30 engages with the teeth 31 of the racks 30 such that rotation of the pinion causes the racks 30 to move up and down respectively. This causes the plates 25, 26 to be moved in a direction parallel to the longitudinal axis of the container 1. The plates 25, 26 have generally the same configuration, and approximately the same weight. The rack and pinion arrangement results in the plate 25 moving upwards by the same amount as the other plate 26 is moved downwards. Because the plates 25, 26 have about the same weight, the force required to move the plates 25, 26 to activate locking or unlocking is relatively low. Moreover the force required is approximately the same for both the locking and unlocking movements.

The pinion 30 is further formed with holes (not shown) for receiving a corresponding key (not shown) so that the pinion can be rotated so as to lock and unlock the door 2. As shown in Figure 1, a hole 80 is formed in the door 2 exposing the holes in the pinion such that they can be accessed with a corresponding key 81.

The locking hooks 28 of each locking plate 25, 26 face the same direction and lie in the plane of the locking plates 25, 26. However, the locking hooks 28 of the upper locking plate 25 face the opposite direction to the locking hooks 28 of the lower locking plate 26, as is best seen in Figure 3. When the locking hooks 28 engage with the cooperating elements of the container 1 such that the door 2 is secured to said container 1, movement of the door in a bilateral direction parallel to the longitudinal axis of the container is restricted. This increases the blast resistance of the door 2 in contrast to a container wherein the hooks are configured to face the same direction. If the hooks were to face the same direction, movement of a door due to an explosion might only be restricted in a unilateral direction parallel to the longitudinal axis of the container.

Outer portions of the locking plates 25, 26 and the corresponding locking hooks 28 extending therefrom are provided with a second layer 33, as is best seen in Figure 8. Although it is not shown in Figure 8, it should be understood that a second layer 33 is formed on both locking plates 25, 26. As such, each of the locking hooks 28 includes two layers of sheet metal. However, much of the locking plates 25, 26 is formed of only single thickness sheet steel. The second layers 33 lie in a plane parallel to the locking plates 25, 26 and are formed with holes 24. The second layers 33 are secured to the main sheet of the locking plates 25, 26 by fillet welds where the edges of the holes 24 meet the adjacent surface of the main sheet of the locking plates 25, 26. Additionally or alternatively, the second layers 33 are secure to the main sheet of the locking plates 25, 26 in part by fillet welds at the step formed where the second layers 33 end and the main sheet continues. This is achieved also by the way in which reinforcing members are secured, as is described below.

As can be seen best in Figure 9, each outer portion of the locking plates 25, 26 is also reinforced with a reinforcing member 34. The reinforcing members 34 each lie in a plane perpendicular to the locking plates 25, 26 thereby adding additional strength in yet another direction. The reinforcing members 34 of each plate 25, 26 also extend over the tips of the locking hooks 28. This provides further strength to the hooks 28 and facilitates self-guiding of the locking hooks 28 into the cooperating elements. The corners 35 of the locking hooks 28 are tapered, and the tapering may be rounded. This further eases the guiding of the hooks 28 into the cooperating elements of the container.

The second layers 33 and the reinforcing members 34 are joined to the locking plates 25, 26 by means of welding tabs received through holes. In particular, holes 34b are formed in the second layers 33 at locations corresponding to holes in the locking plates 25, 26 as seen in Figure 8. The reinforcing members 34 are formed with tabs 34a, that are best seen in Figure 10. The tabs 34a have a rectangular cross-section, one dimension of which is equal to the thickness of the metal sheet constituting the reinforcing members 34. The other dimension may be larger, for instance up to 150% of the sheet thickness. In this example, the sheet thickness is 6mm and the other dimension of the cross-section of the tabs is 8mm.

The tabs 34a are inserted into the holes 34b of corresponding dimensions. The holes 34b may be a small amount larger than the exterior dimensions of the tabs 34a, for instance. The tabs 34a protrude by a small distance, in this example approximately 1 millimetre, past the opposite side of the locking plates 25, 26. The 1 millimetre protrusions of the tabs 34a are thereafter welded to the locking plates 25, 26. The weld may be a weld material-free weld. Advantageously, the 1 millimetre protrusions are generally levelled with the surface of the locking plates 25, 26 during the welding. Additional fillet welding is performed for some of the junction between the reinforcing members 34 and the second layer

33, and for some of the junction between the reinforcing members 34 and the locking plates 25, 26.

The locking plates 25, 26 and the second layer are preferably formed of metal sheet. In this way, the downsides of using machined, cast etc metal can be avoided. The metal sheet may be cut into shape by laser cutting. The metal sheet may be a high carbon steel, such as a high carbon hardened steel sold under the name Domex ™.

The cooperating means of the door 2, the locking plates 25, 26, and the associated locking hooks 28, are held in their position against the inner surface of the front panel 20 by the racks engaging with the pinion 32 secured to the front panel 20. A cover 40 is fitted to the inside of the front panel 20, as is best seen in Figure 2. The cover comprises a main panel 41 having side walls 42 depending therefrom. The side walls 42 along the longitudinal sides of the cover 40 are formed with gaps 43 through which the hooks 28 protrude. The side walls 42 are further formed with tabs 44 as can be seen in Figure 11. These tabs are received in corresponding holes 45 or slots on the front panel 20 of the door 2. The holes 45 can be seen in Figure 4. The tabs are welded to the front surface of the front panel 20. This secures the cover 40 to the front panel 20. The tabs may be levelled by the welding and/or may be dressed after welding.

The inner surface of the front panel 20 is further fitted with two u-profile bent sheet metal bars 36. The bars 36 run adjacent the longitudinal edges of said front panel 20. They are secured to the front panel 20 using a 'slot and tab' system like that described above. Briefly, the bars 36 are formed with tabs (not shown) along their free longitudinal edges that are received in corresponding holes 46 in the front panel 20, as shown in Figure 4. The tabs protrude through the holes to the opposite outer surface of the front panel 20, where the tabs are welded to the outer surface of the front panel. The bars 36 provide support to the outer portions of the locking plates 25, 26 as they are moved up and down. Furthermore, the bars 36 also provide additional structural support to the

locking plates 25, 26 in a direction perpendicular to the longitudinal axis of the container in the event of an explosion within the container 1.

The door is also provided with hinges 37 which are received in corresponding holders 38 of the container, thereby enabling a user as they have unlocked the cooperating means to swing open the door 2 to access the space within the container 1.

Referring now to Figure 12, the cooperating means on the container 1 comprises two locking channel structures 50 which are fixedly attached to the inside of the container 1 adjacent to the free edges of the left and right side walls 4, 5. Each locking channel structure 50 is defined in part by one of first and second elongate components 51, 52 and defines respective locking channels for receiving locking pins 28. The locking pins 28 locate in gaps 67 formed between channels 66 when the door is unlocked. When the door is in a locked position the locking pins locate in the channels 66.

Operation of the container 1 will now be described with reference to the Figures. The container 1 is useable as a refuse bin. The container is secured to the ground upon which it stands by fastening means extending through holes in the base 6 and secured to the ground. When the container 1 is used as a bin, the door 2 is closed in that the looking hooks 28 of the locking plates 25, 26 are located in the channels 66 of the locking channel structures 50. The door 2 is thereby secured to the container 1 as the locking hooks 28 engage with the locking channel structures 50 restricting any movement of the door relative to the container 1. In particular, as the locking hooks 28 of each locking plate 25, 26 face opposite directions the door is restricted from moving in a bilateral direction parallel to the longitudinal axis of the container 1.

The door 2 is unlocked by inserting a key 81 into a hole 80 located approximately in the centre of the door 2 and then into corresponding hole(s) (not shown) formed in the pinion 32. By turning the key, the pinion 32 is

rotated by the user and the racks 30 move in opposite directions such that the locking plates 25, 26 are moved in a direction parallel to the longitudinal axis of the container towards one another, in other terms towards the centre of the door 2. As the locking plates 25, 26 move towards the centre of the door, the locking hooks 28 move out of the channels 66 such that they locate in the gaps 67 of the locking channel structures 50. Once the key 81 is turned such that the door 2 is in an opened position, the key 81 is retained in the door and cannot be removed until the key 81 is rotated back to its original position.

To lock the door 2, the key is turned in the opposite direction thereby also rotating the pinion 32 in the opposite direction compared to when unlocking the door. By doing so the racks 30 are moved such that the locking plates 25, 26 travel away from one another and away from the centre of the door. The locking hooks 28 thereby enter the channels 66 of the locking channel structures 50. The hooks 28 are self-guided into the channels 66 as a result of the features of the reinforcing members 34 of each locking plate 25, 26 extending over the tips of the locking hooks 28 and the corners 35 of the locking hooks 28 being tapered. When the door is in its locked position, the key 81 is aligned with the hole 80 in the door such that the key 81 can be removed.

The container 1 absorbs and upwardly directs forces of an explosion originating inside the container 1 by the container being structurally sound and strong due to the two side walls 4, 5 and the rear wall 3 being integrally formed and the door 2 being securely attached to the container 1. In the event of an explosion within the container, forces are exerted outwards on the three walls 3, 4, 5 and the door 2 of the container. The container 1 remains in its position as it is secured to the ground upon which it stands. The three walls 3, 4, 5 can withstand forces of great magnitude as they are formed out of a single sheet of metal. The door 2, being in a locked position, remains secured to the container 1 due to the locking hooks 28 of each locking plate 25, 26 facing opposite directions such that the door is restricted to move in a bilateral direction parallel to the longitudinal axis of the container. Furthermore, the fact that the locking

hooks 28 and the locking plates lie in a plane perpendicular to the left and right side walls 4, 5, means that the locking hooks and the locking plates resist forces exerted in a general perpendicular direction on the inner surfaces of the side walls 4, 5, thereby retaining the side walls 4, 5 in their position.

Although embodiments of the invention have been shown and described, it will be appreciated by those skilled in the art that variations may be made to the above exemplary embodiments that lie within the scope of the invention, as defined by the following claims.

Claims

1. A blast-resistant structure comprising:

a body in which is defined an aperture, the aperture being bounded by two edge parts of the body;

a door configured selectively to close-off the aperture; and

first and second securing mechanisms configured selectively to secure the door to respective ones of the body edge parts,

wherein each securing mechanism comprises a locking channel that extends generally parallel to the body edge part and a corresponding locking pin having a generally straight part that extends generally parallel to the body edge part and is moveable between an open position in which the locking pin is external to the locking channel and a secured position in which the locking pin is engaged in the locking channel.

2. A structure as claimed in claim 1, wherein the locking channels are fixedly attached to the body and the locking pins are fixedly attached to the door.

3. A structure as claimed in claim 2, wherein the locking pins are integrated onto a locking pin mechanism such that the locking pins are in a fixed relationship with respect to one another.

4. A structure as claimed in claim 3, wherein a single sheet of material constitutes part of both the locking pins.

5. A structure as claimed in claim 4, wherein the locking pin mechanism comprises two pairs each of first and second locking pins, wherein both of the first locking pins are formed on a common axis and both of the second locking pins are formed on a different common axis.

6. A structure as claimed in any of claims 3 to 5, wherein the locking pin mechanism is translatable relative to a body of the door in response to locking and unlocking forces.

7. A structure as claimed in any preceding claim, wherein the body is formed from a sheet of material, and wherein the body edge parts are located at edges of the sheet.

8. A structure as claimed in any preceding claim, wherein the two edge parts of the body are generally parallel to one another.

9. A structure as claimed in claim 8, wherein the two generally parallel edge parts are generally vertical in use.

10. A structure as claimed in any preceding claim, comprising a hinge mechanism configured hingedly to couple the door to one of the body edge parts and to allow the door to open to allow access to an interior of the body through the aperture when the first and second securing mechanisms are in the open position.

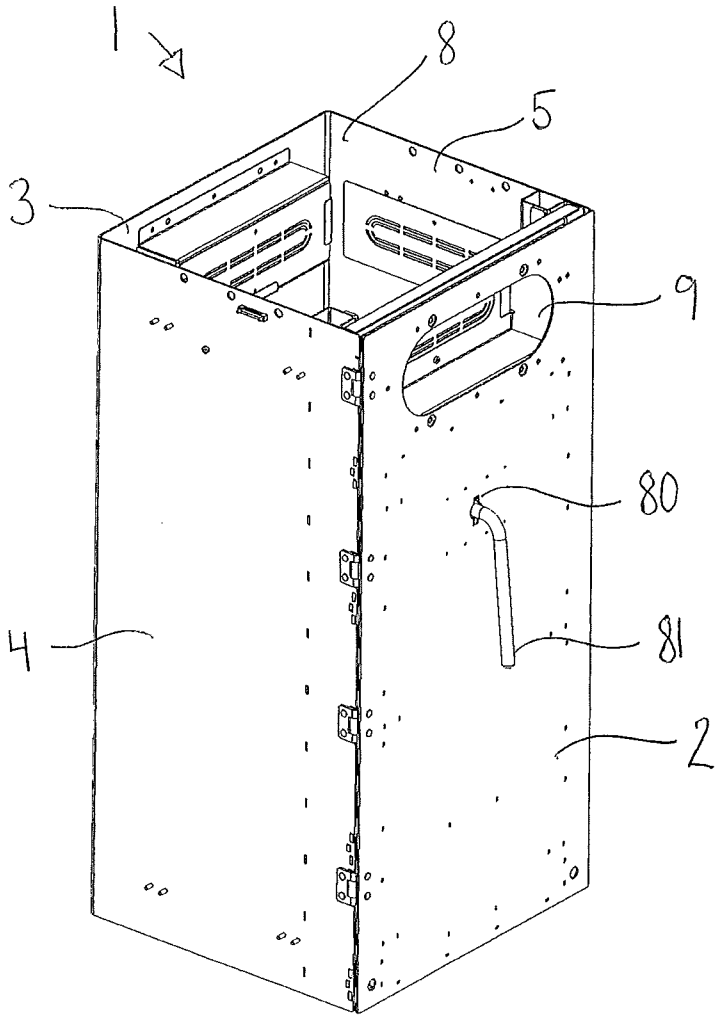

FIGURE 1

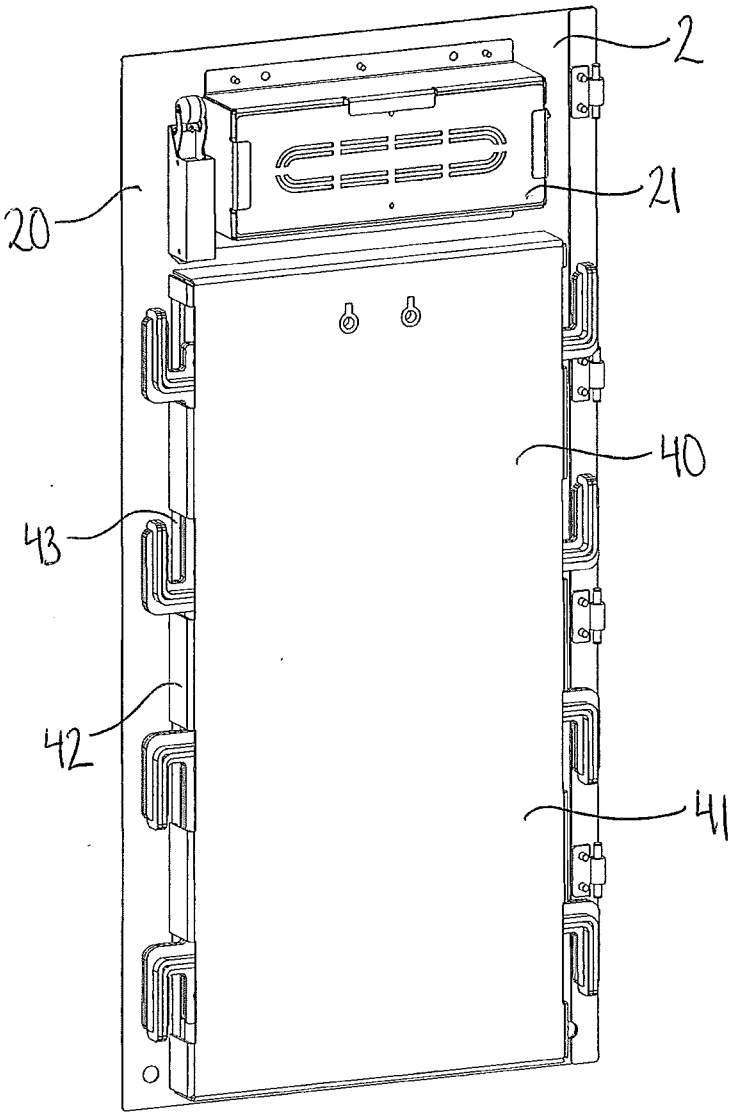

FIGURE 2

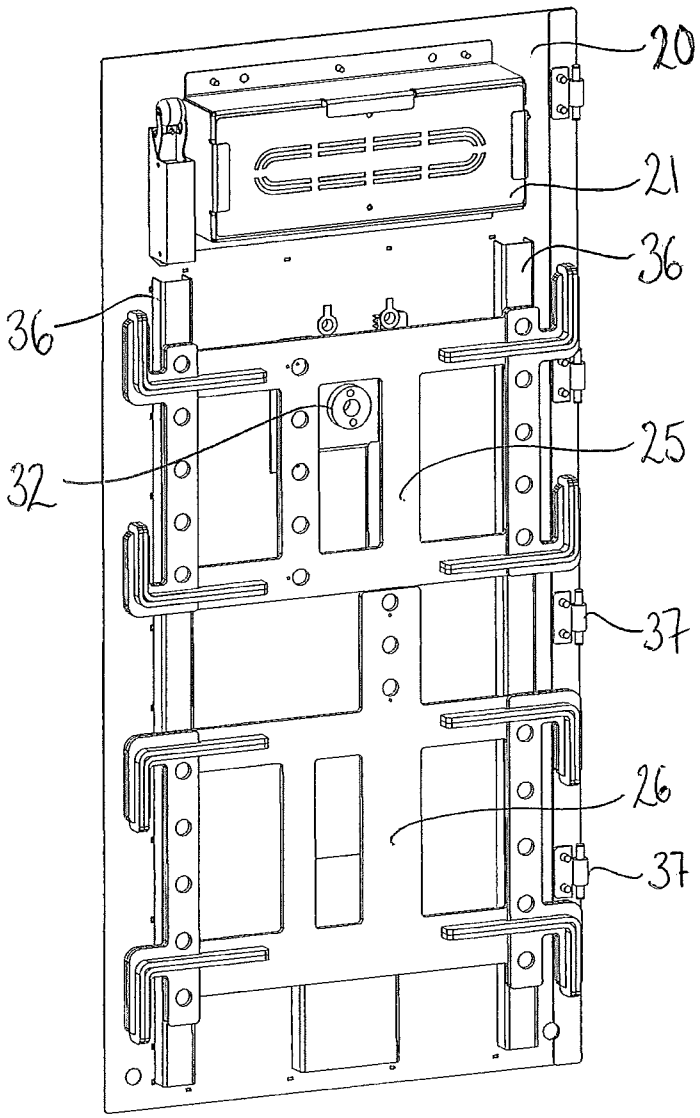

FIGURE 3

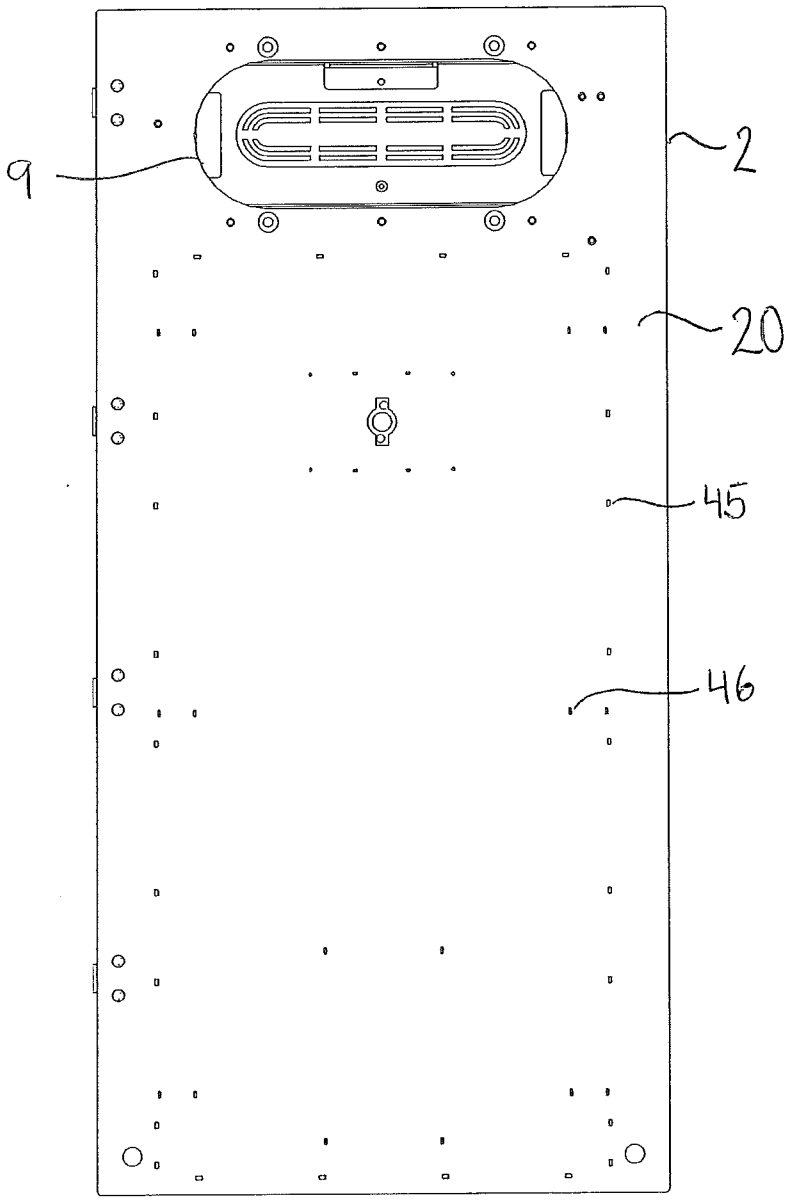

FIGURE 4

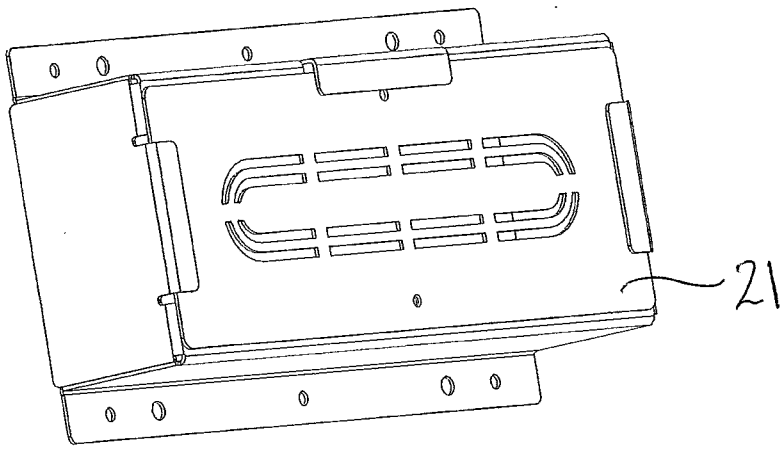

FIGURE 5

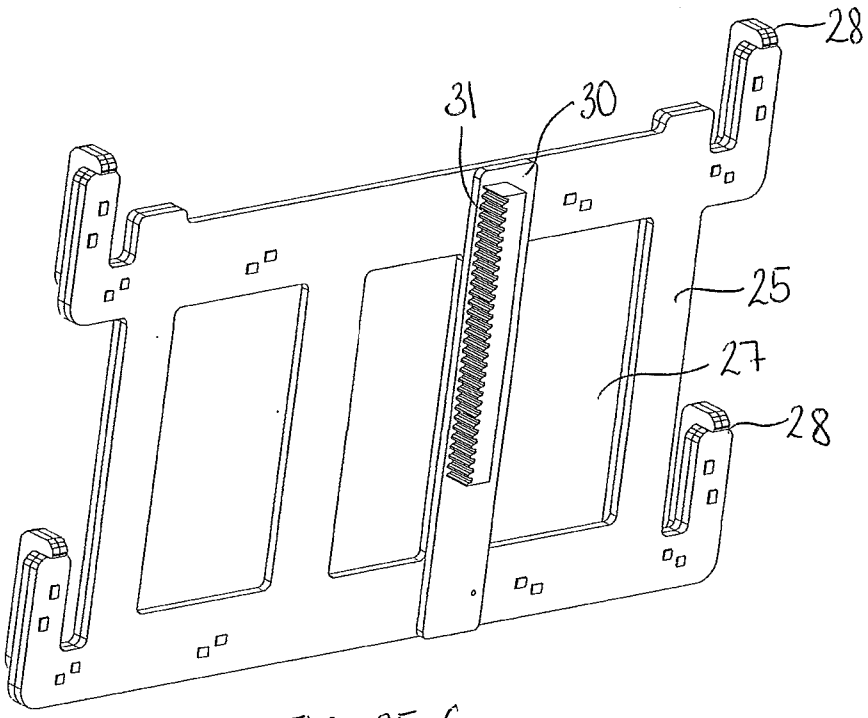

FIGURE 6

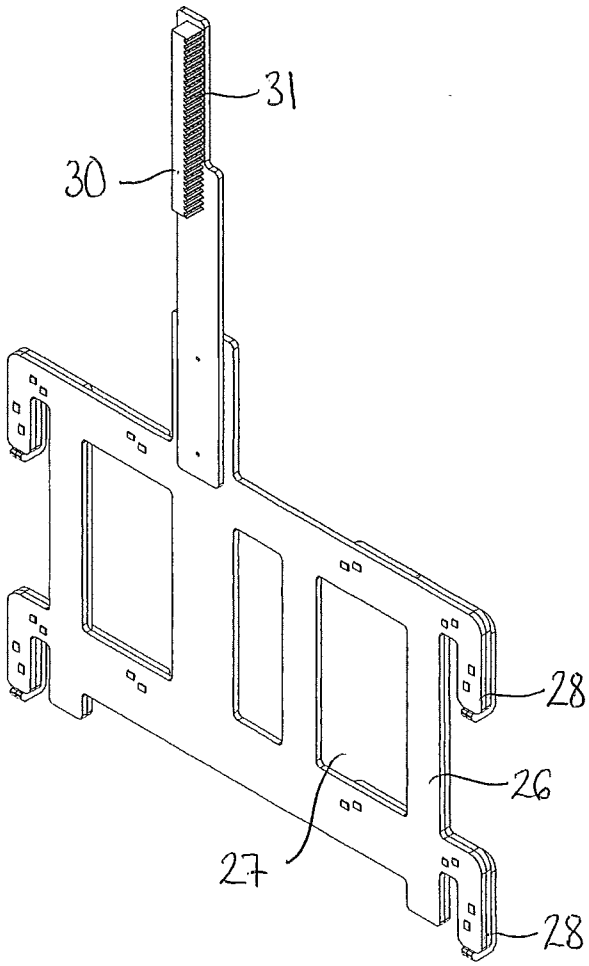

FIGURE 7

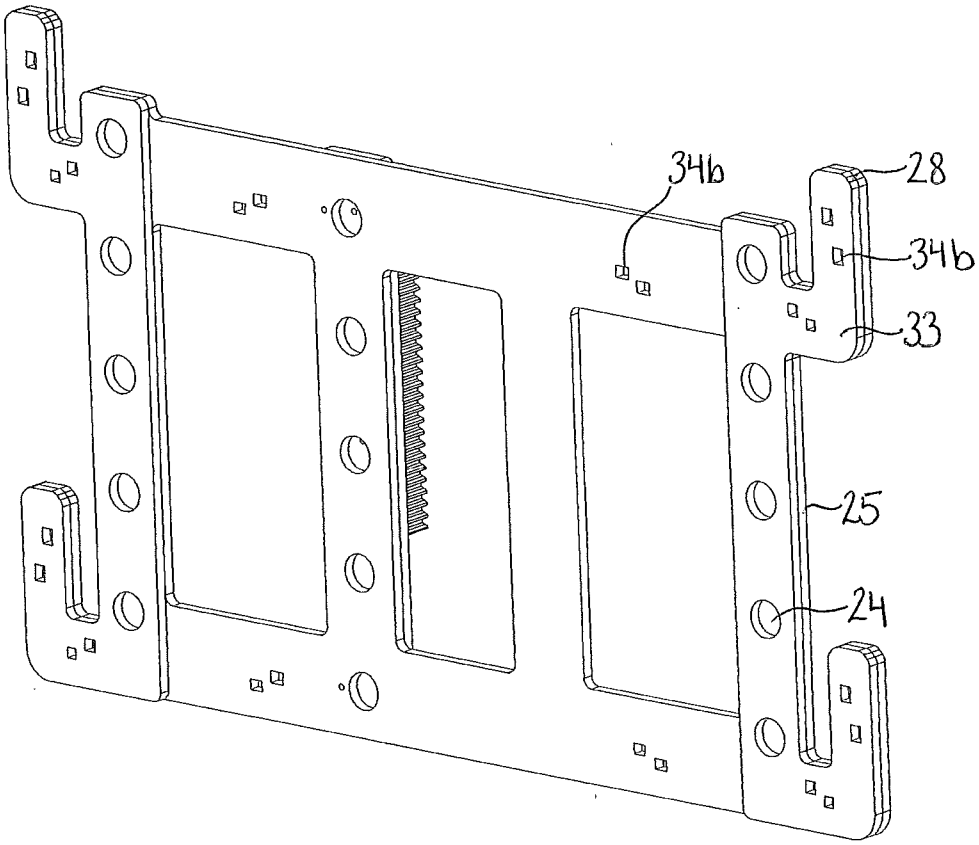

FIGURE 8

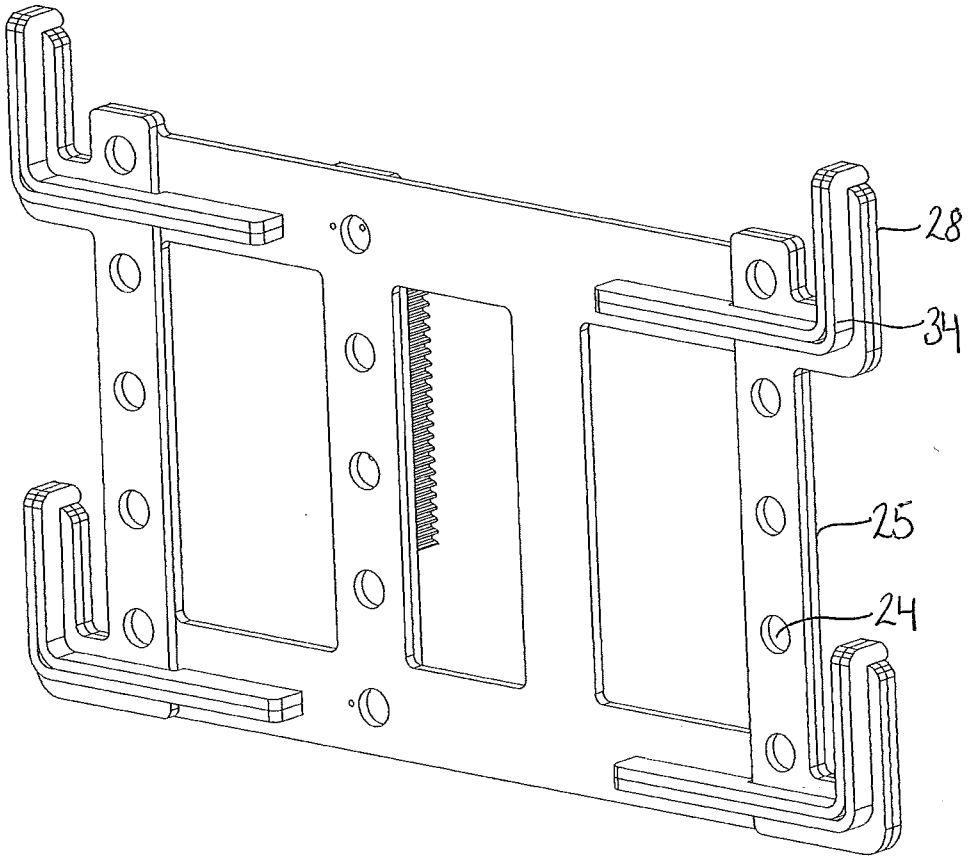

FIGURE 9

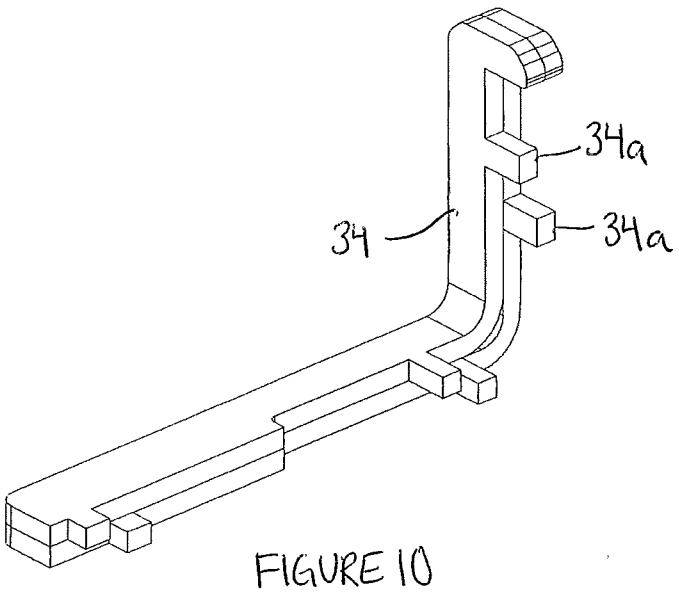

FIGURE 10

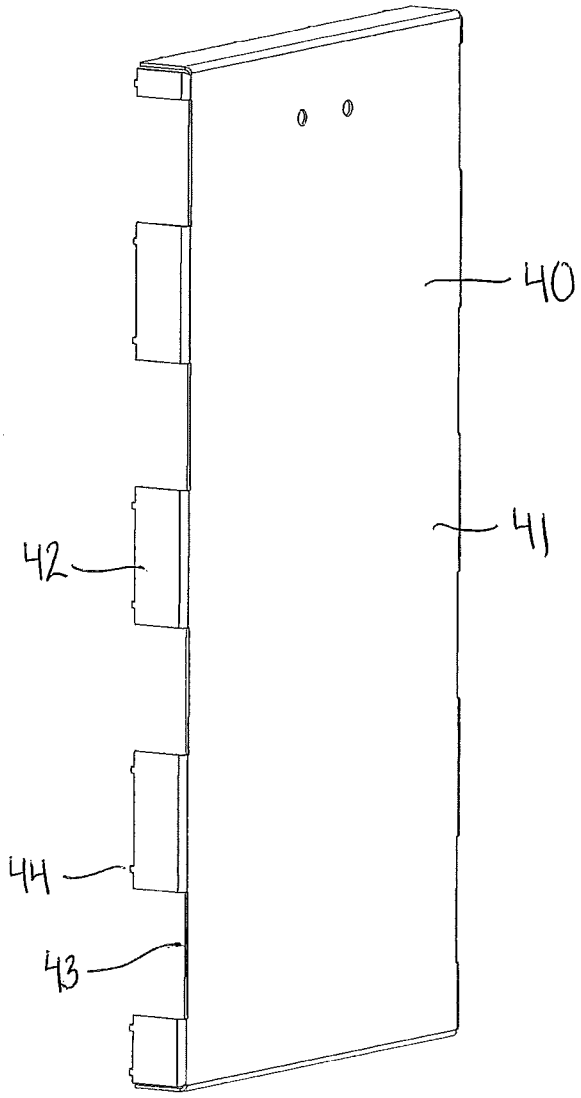

FIGURE 11

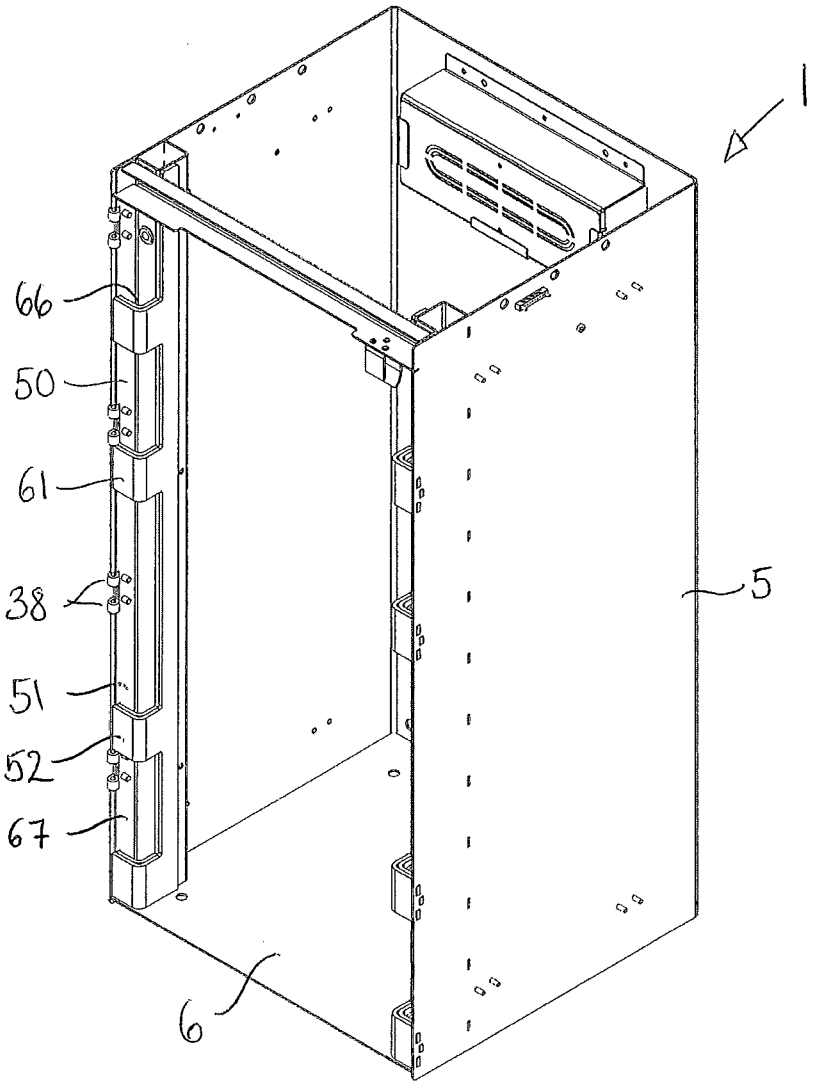

FIGURE 12