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(54) **RAIL MOUNTING APPARATUS AND METHOD**

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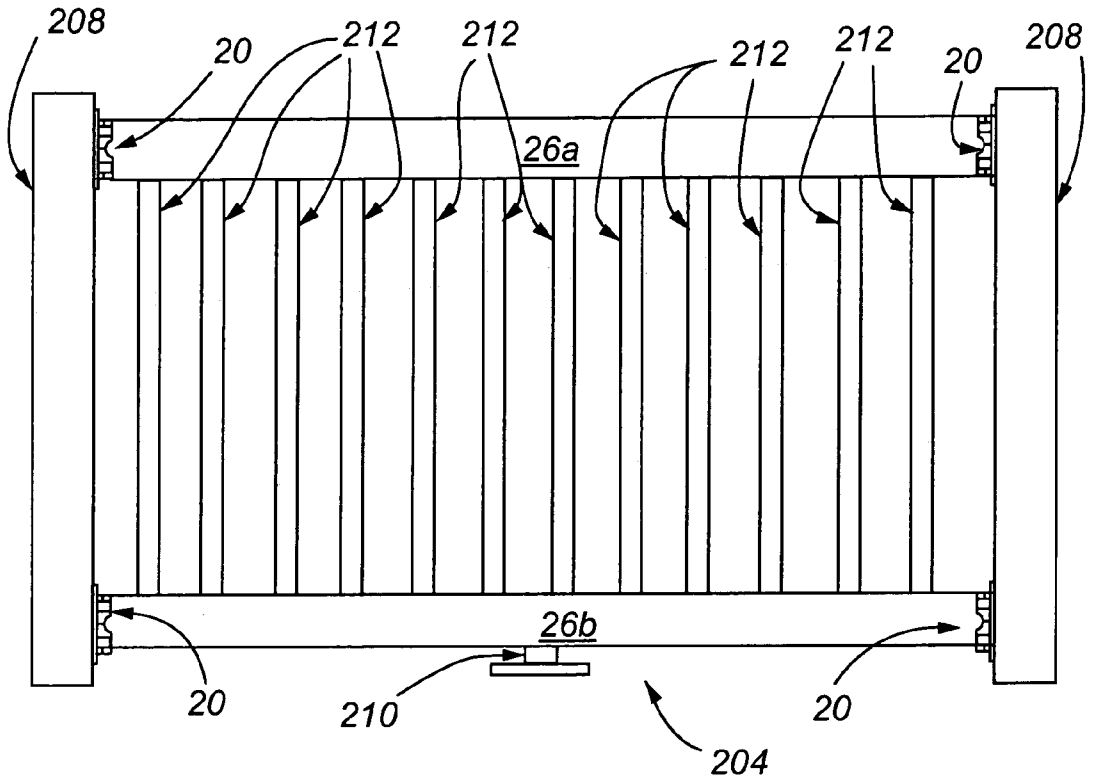
(57) **ABSTRACT**

A method and apparatus is disclosed for mounting a rail (e.g., fence, stair or banister) to a support structure (e.g., a post, wall, etc.), wherein a rail mounting bracket is provided that allows the rail to be supported within an interior of the bracket in a desired position until the rail can be fixedly secured to the bracket in the desired position. The bracket provides various projections from its face that allows a rail to be supported and fixed to the bracket at an upwardly and/or downwardly inclined angle relative to the bracket face. The bracket is designed to withstand various loads specified by building standards for composition fences and banisters.



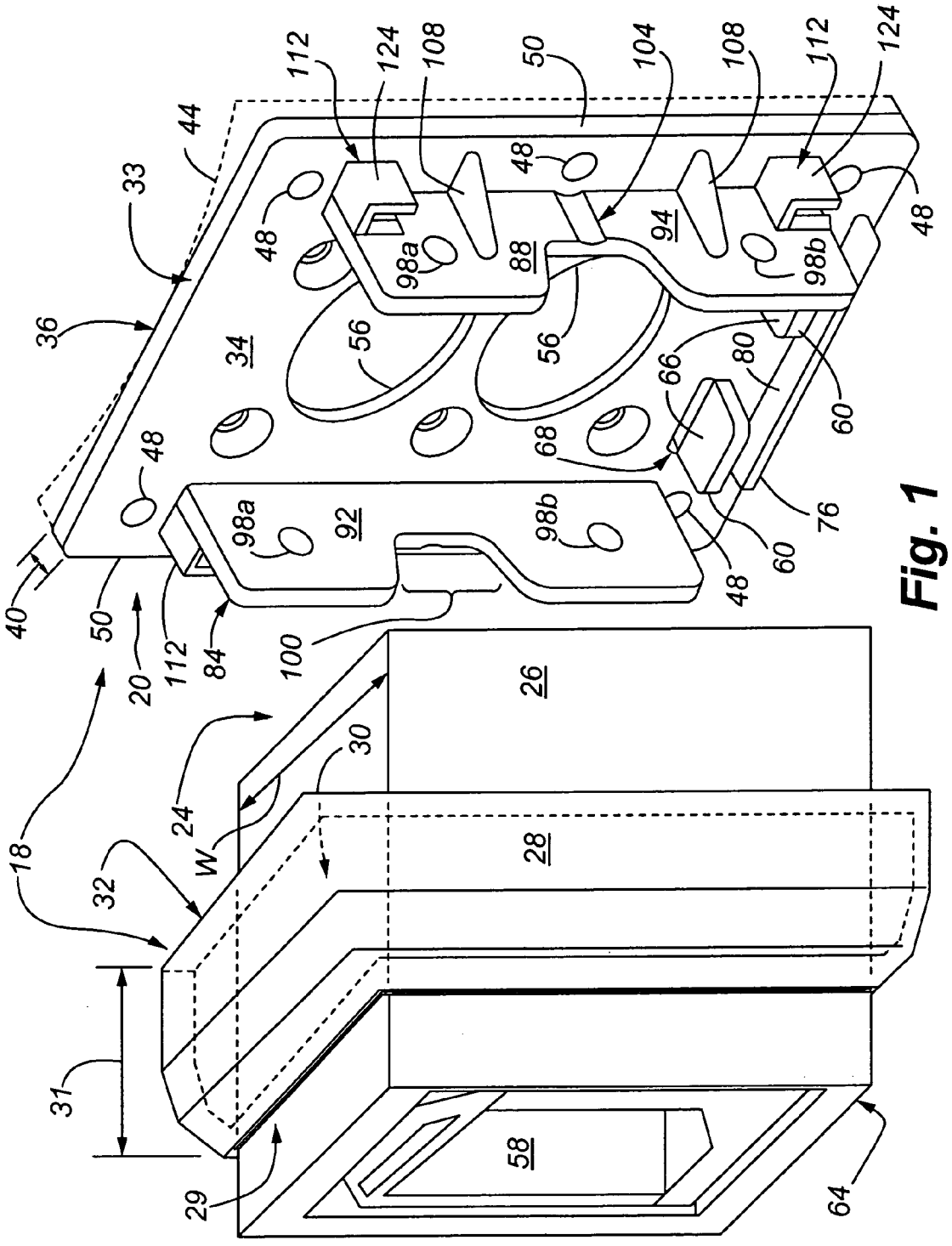

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Fig. 1

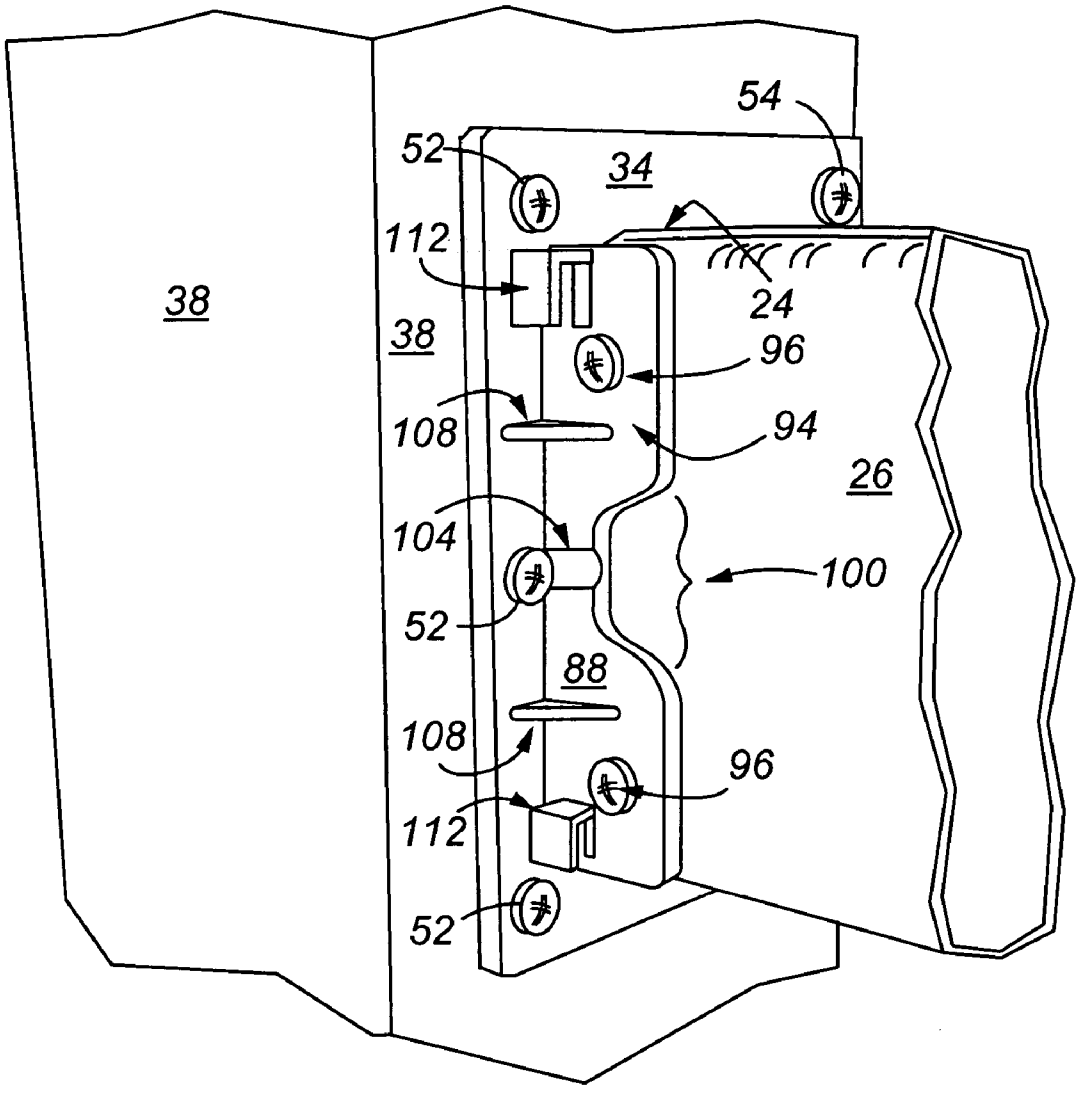

Fig. 2

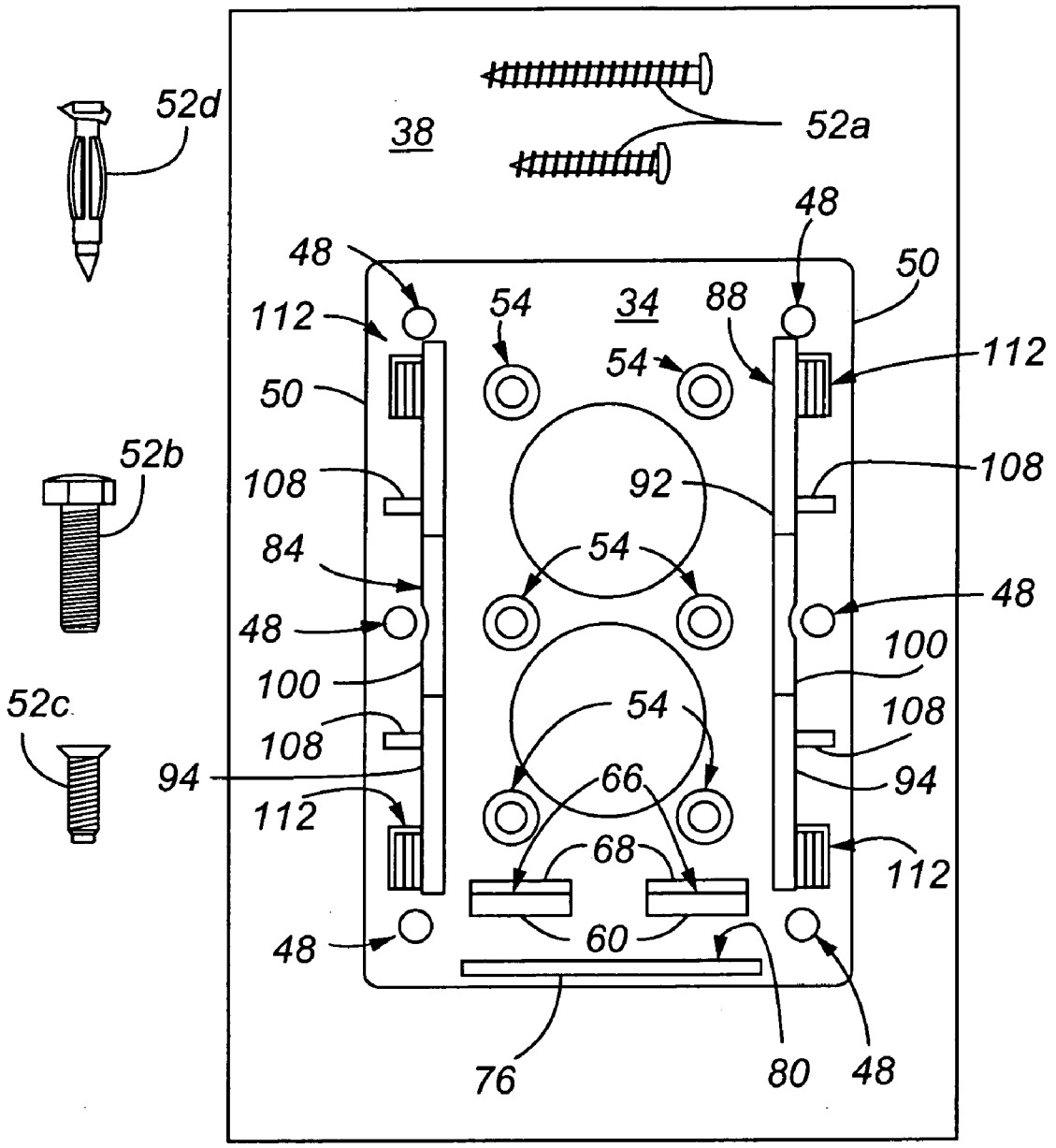
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Fig. 3

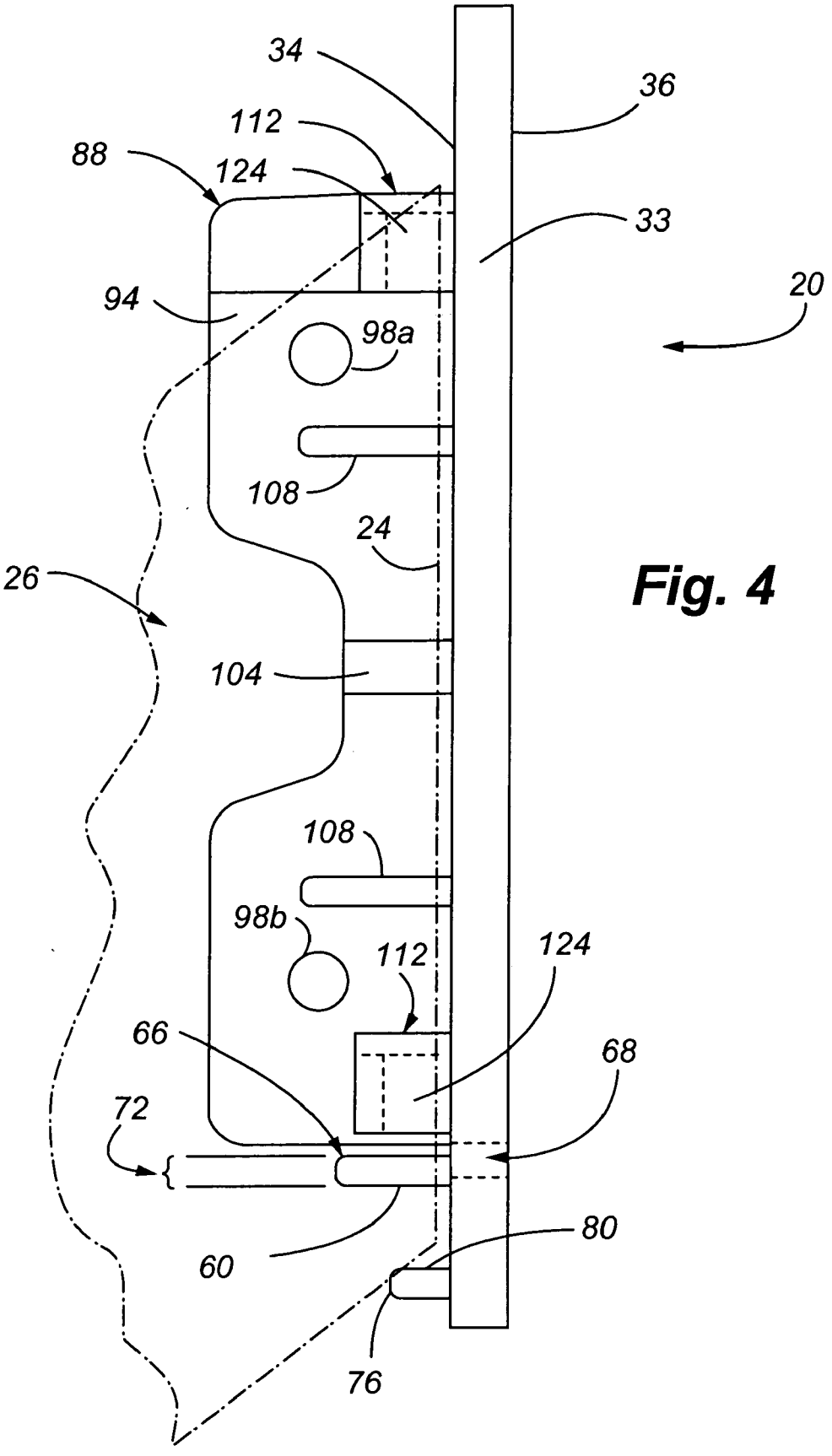
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Fig. 4

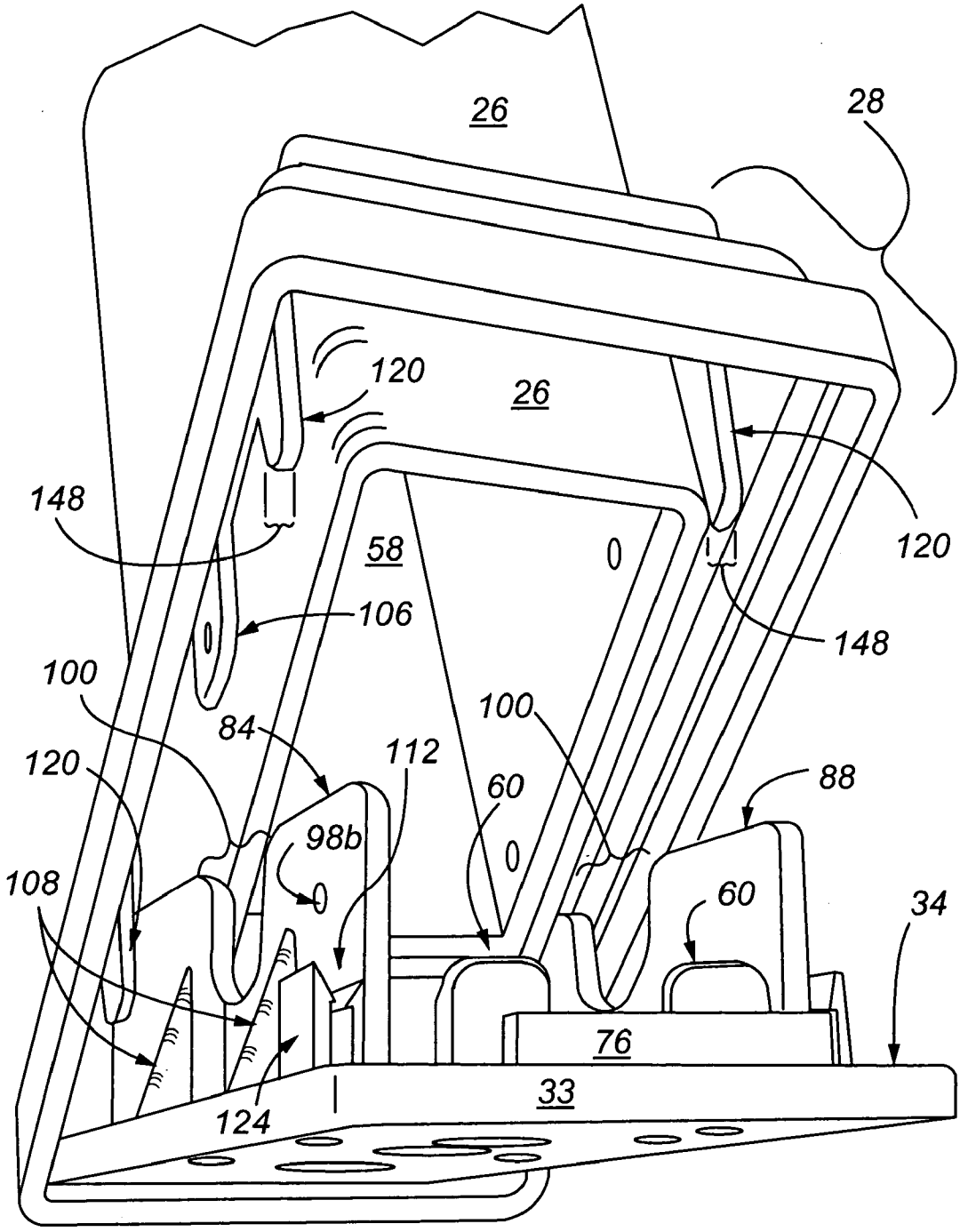
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Fig. 5

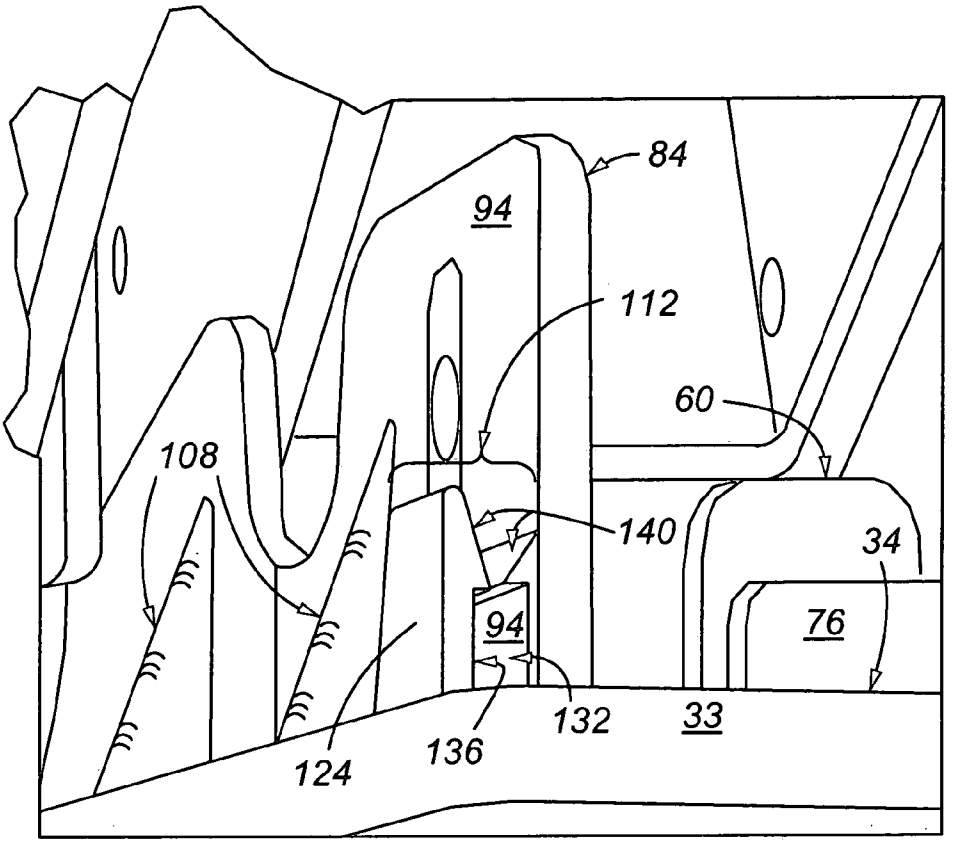
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Fig. 6

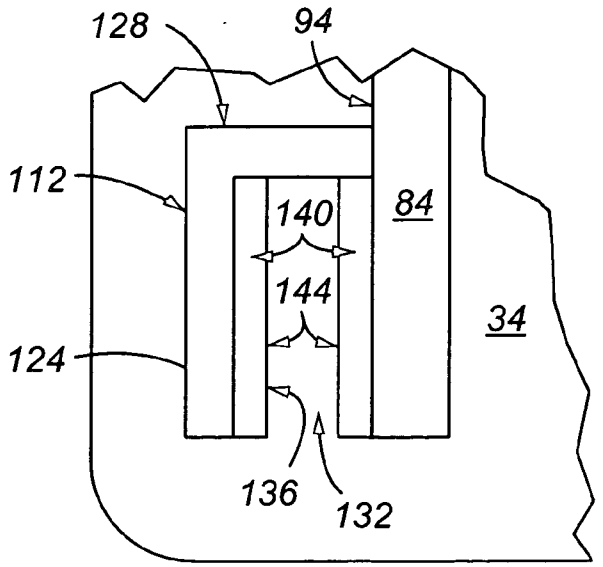
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Fig. 7

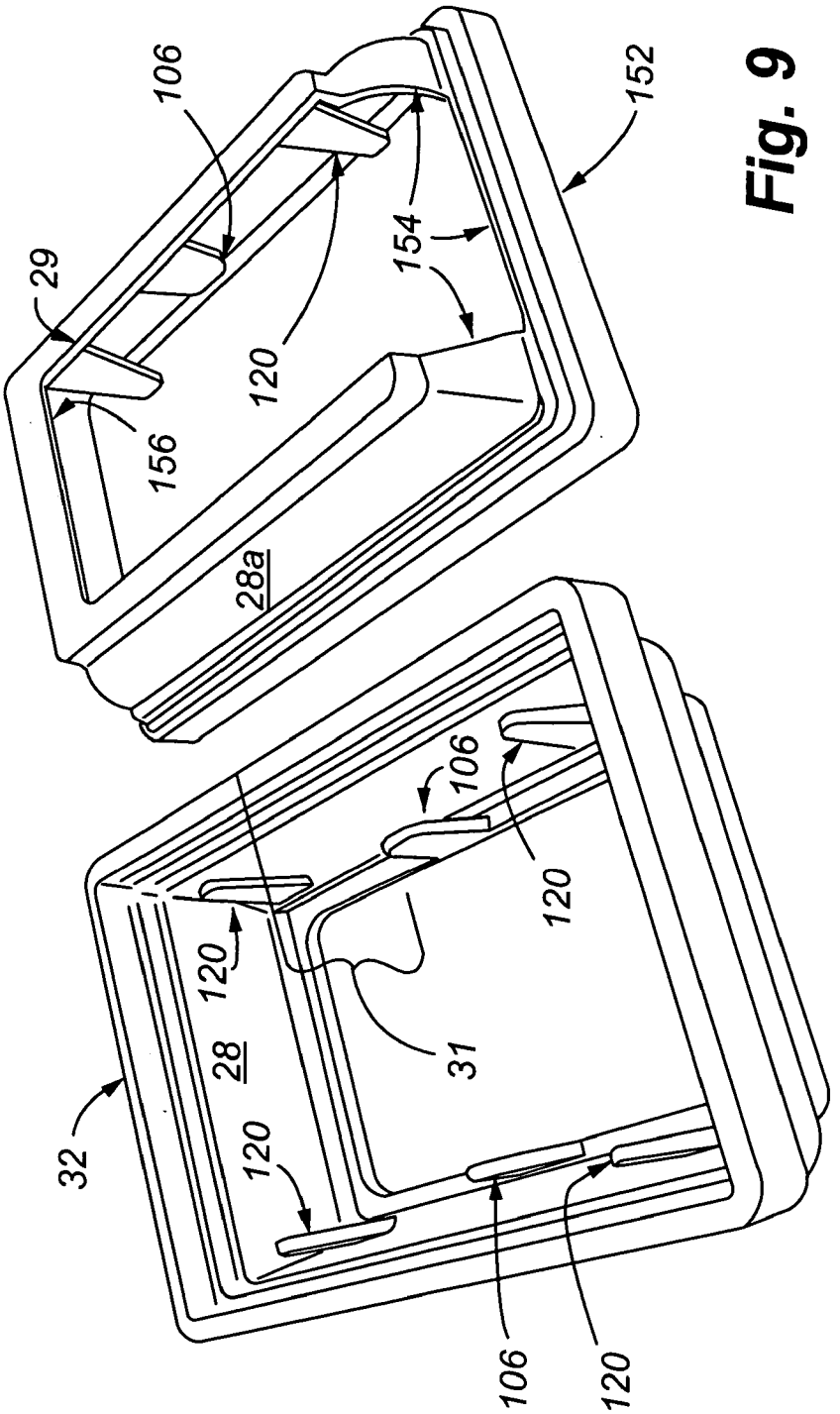


Fig. 9

Fig. 8

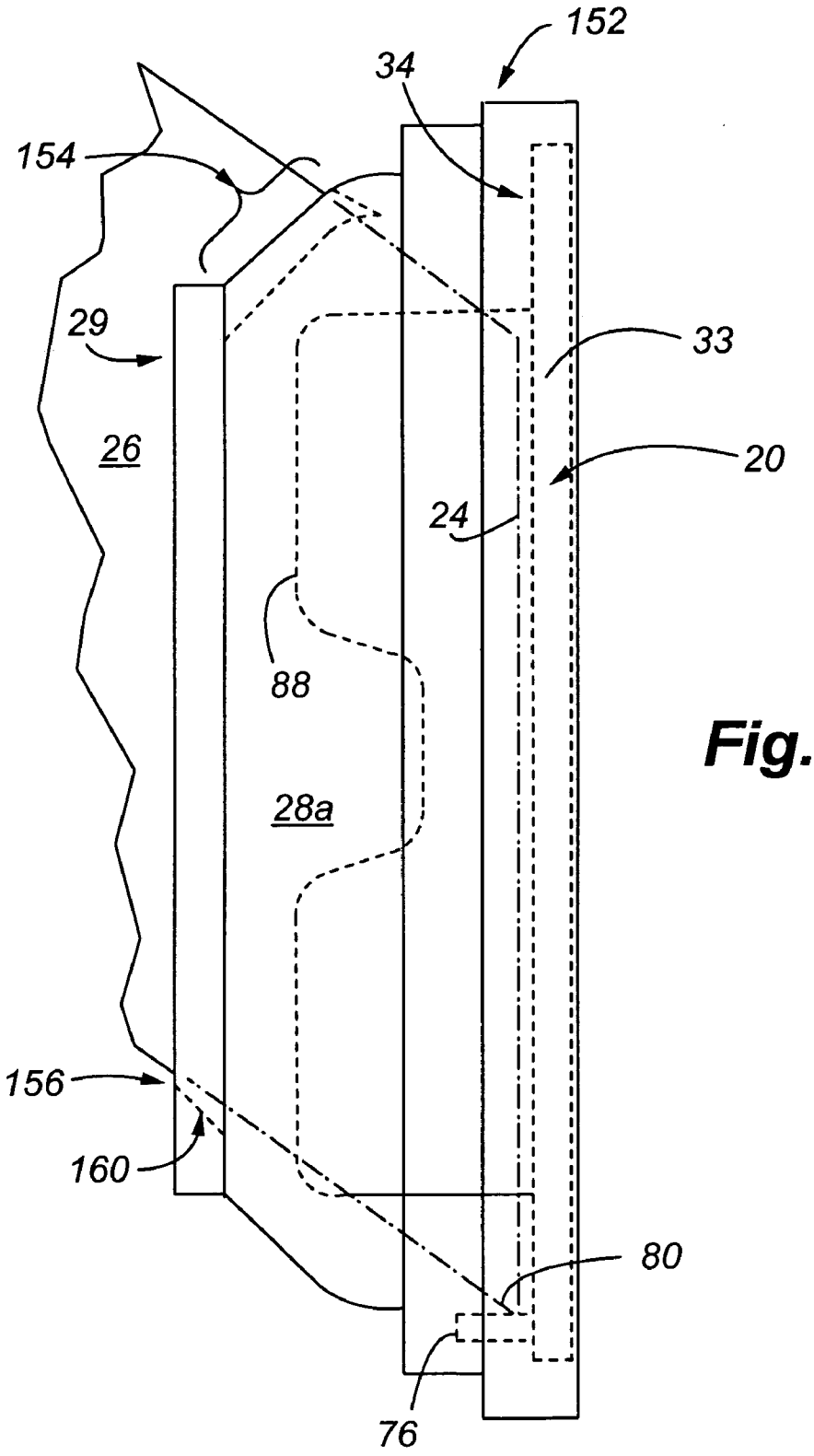


Fig. 10

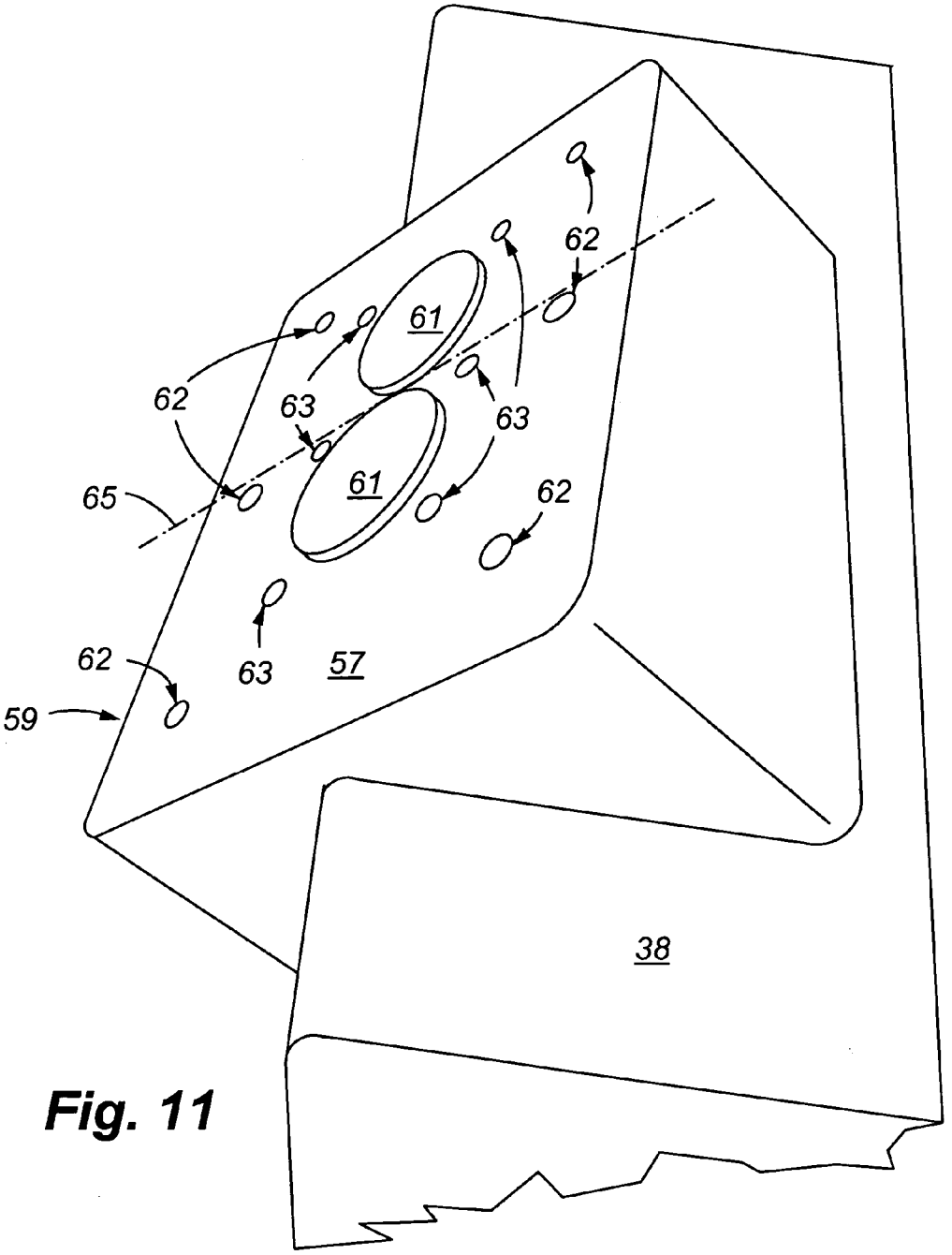


Fig. 11

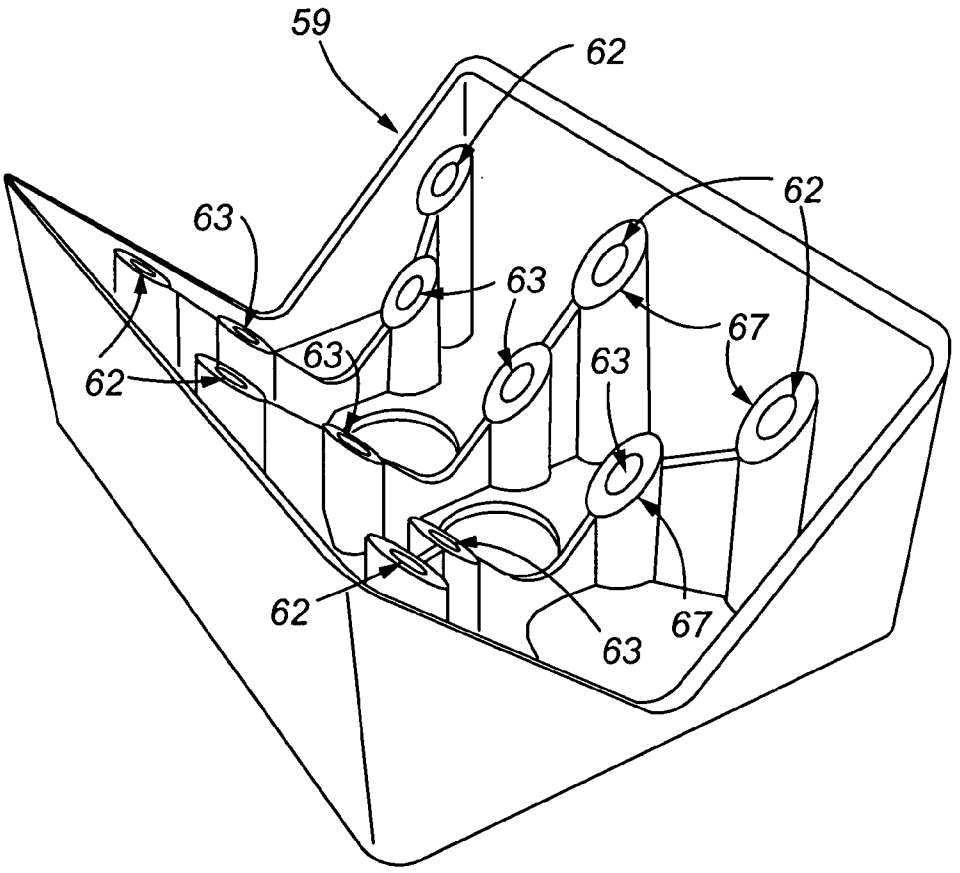
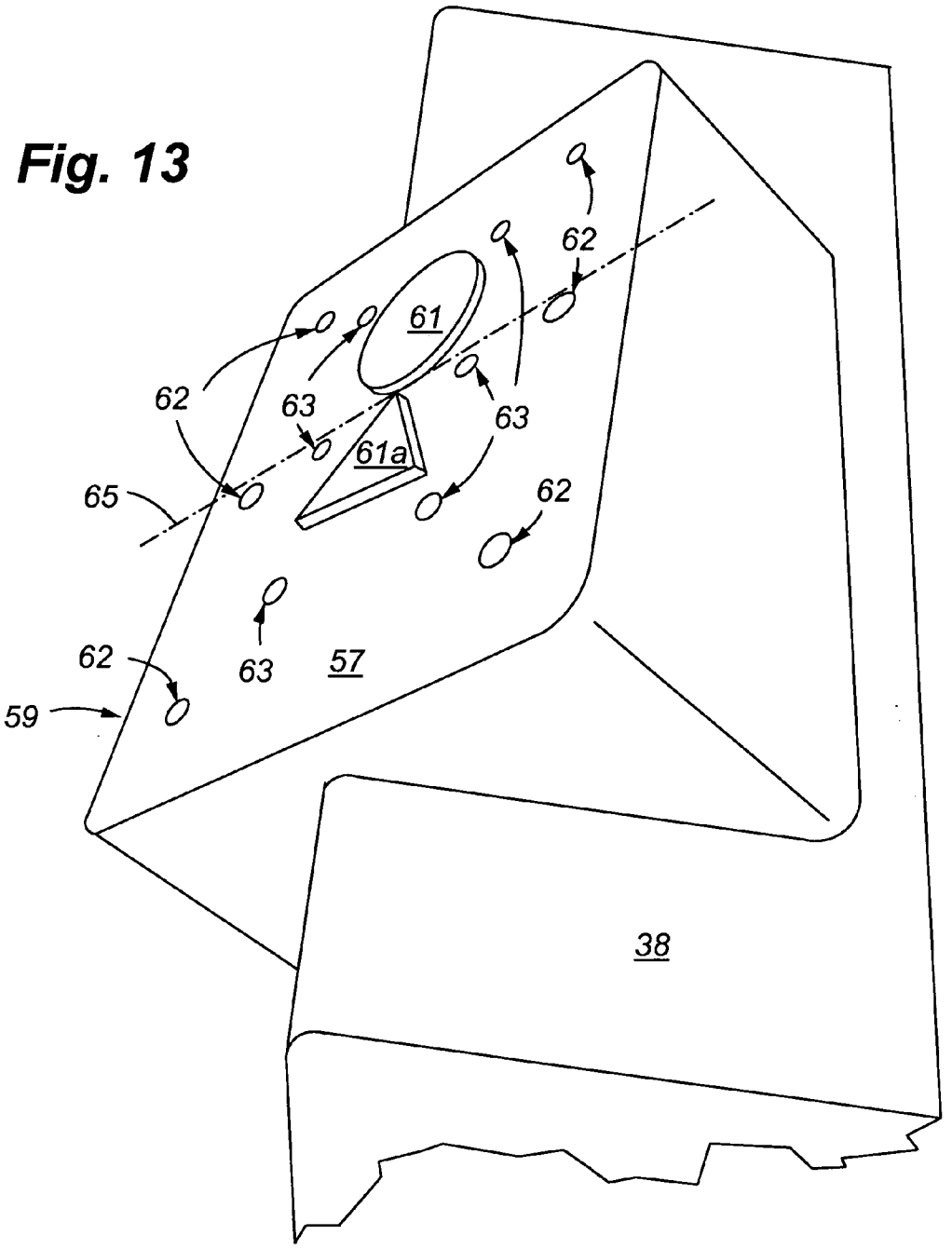


Fig. 12

Fig. 13



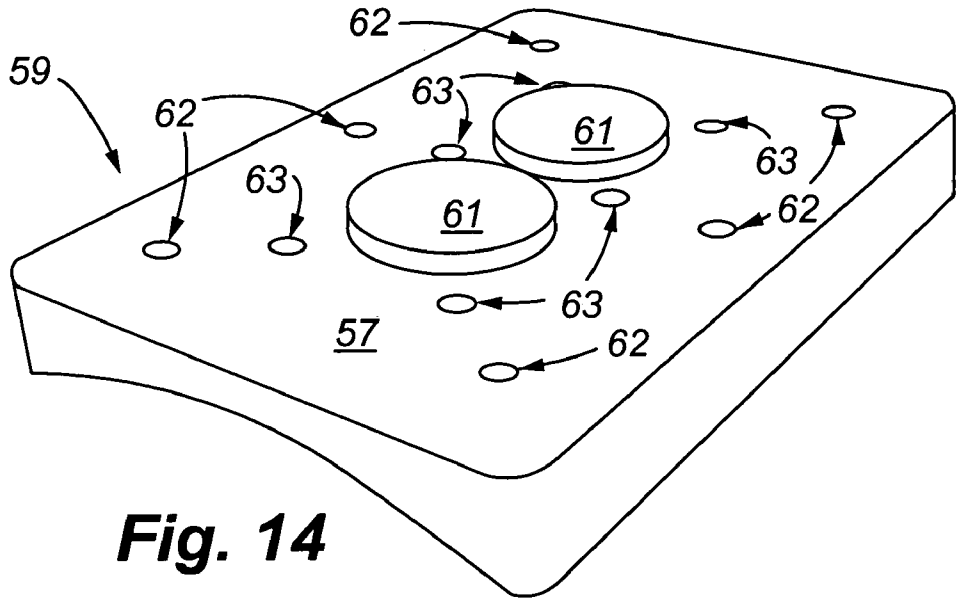


Fig. 14

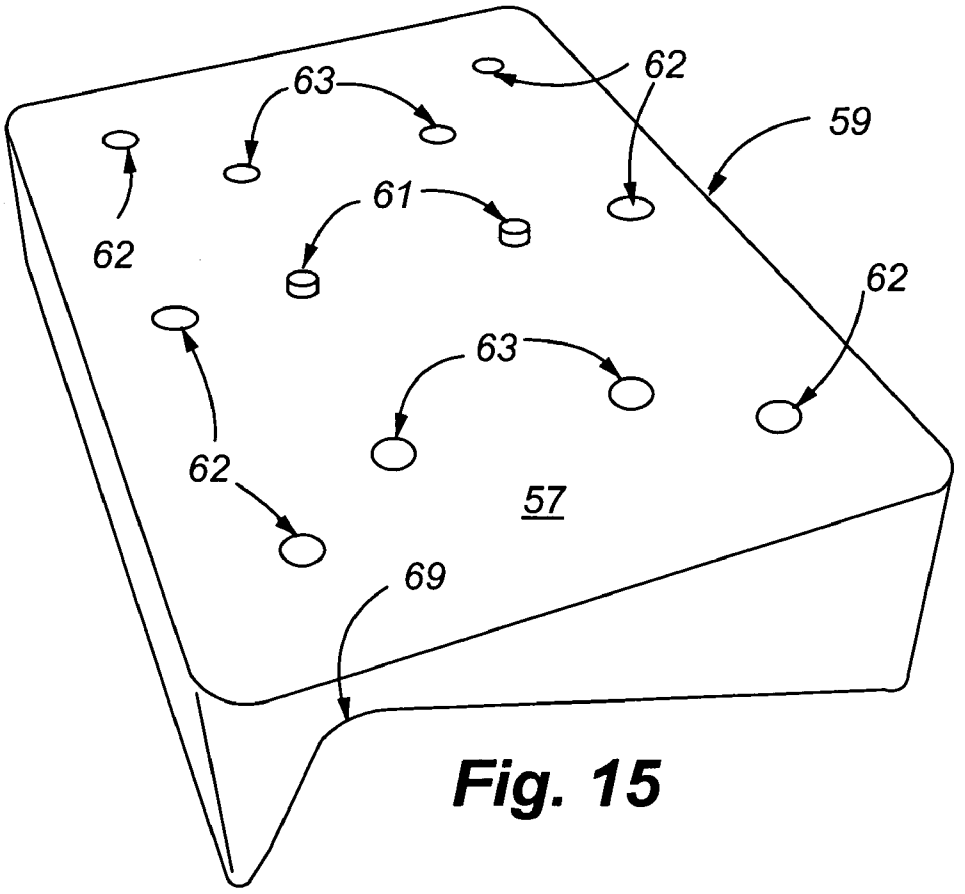


Fig. 15

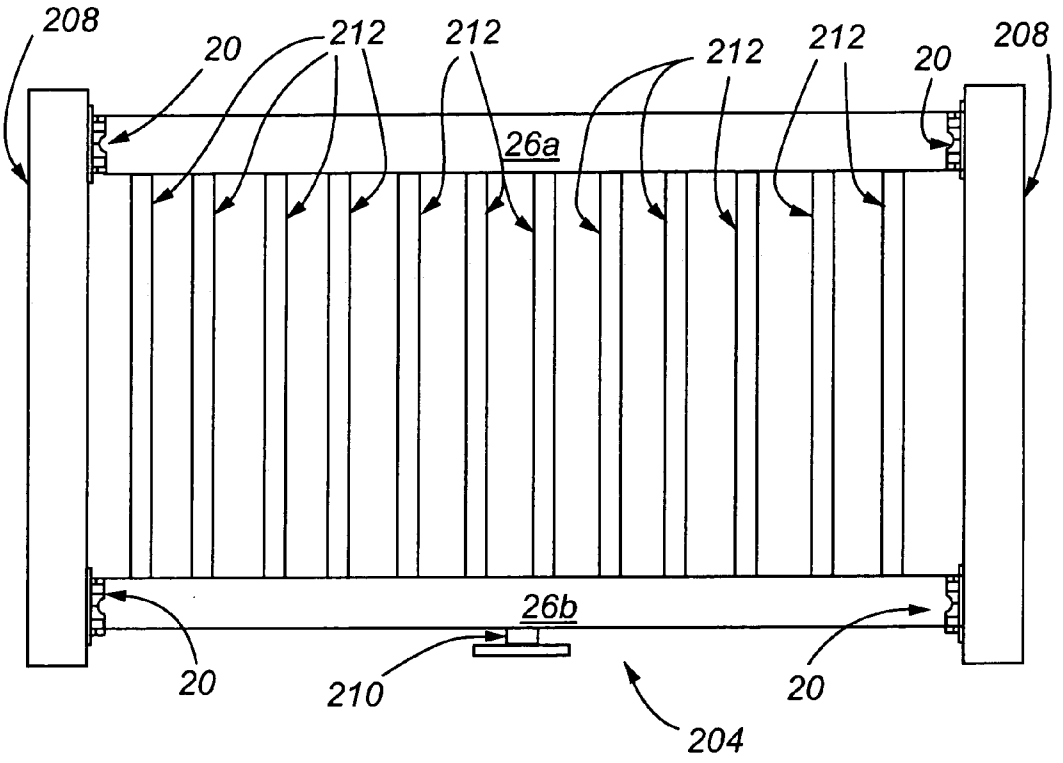
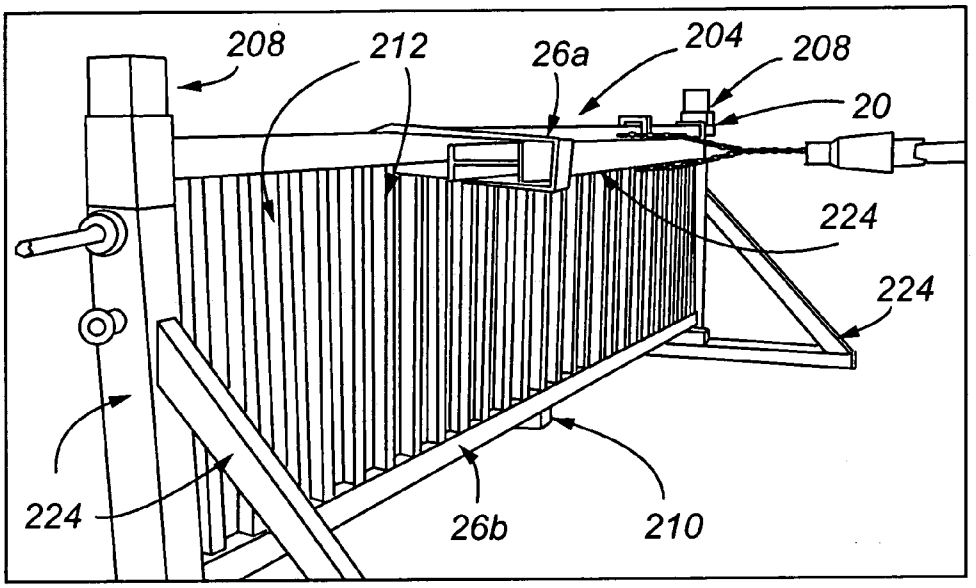


Fig. 16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212
26a
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Fig. 17

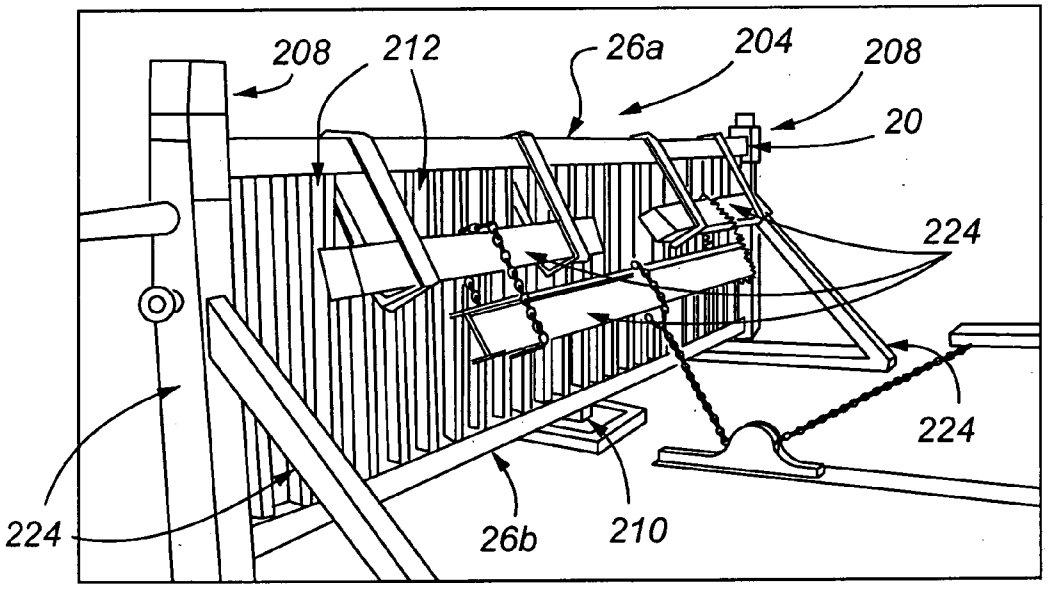
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Fig. 18

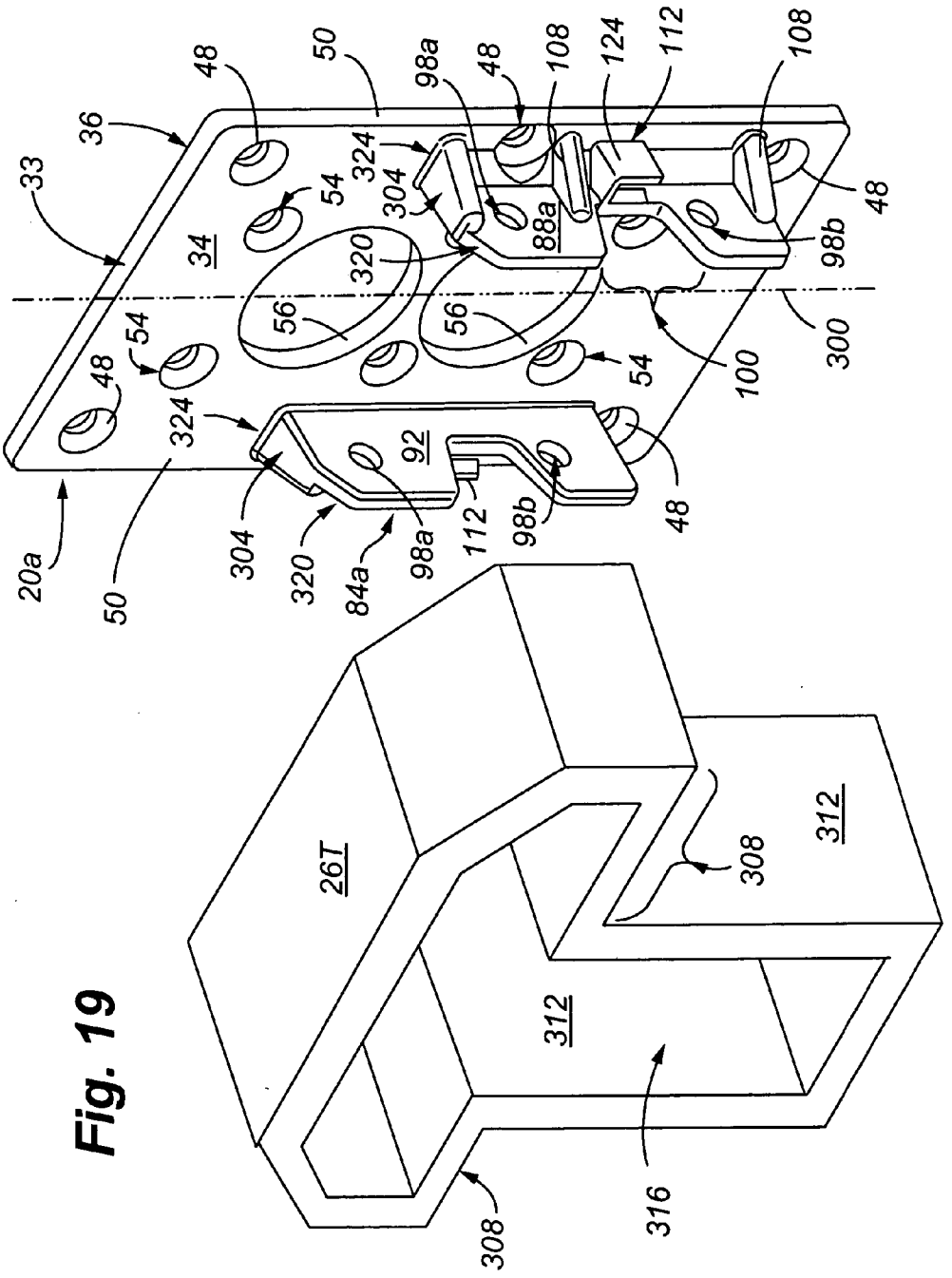
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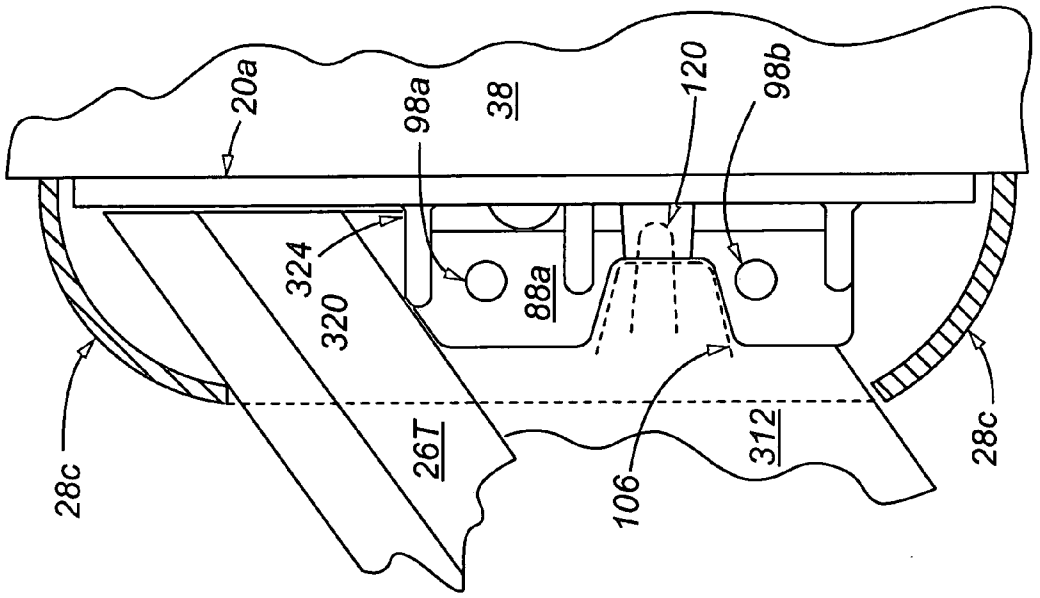
Fig. 19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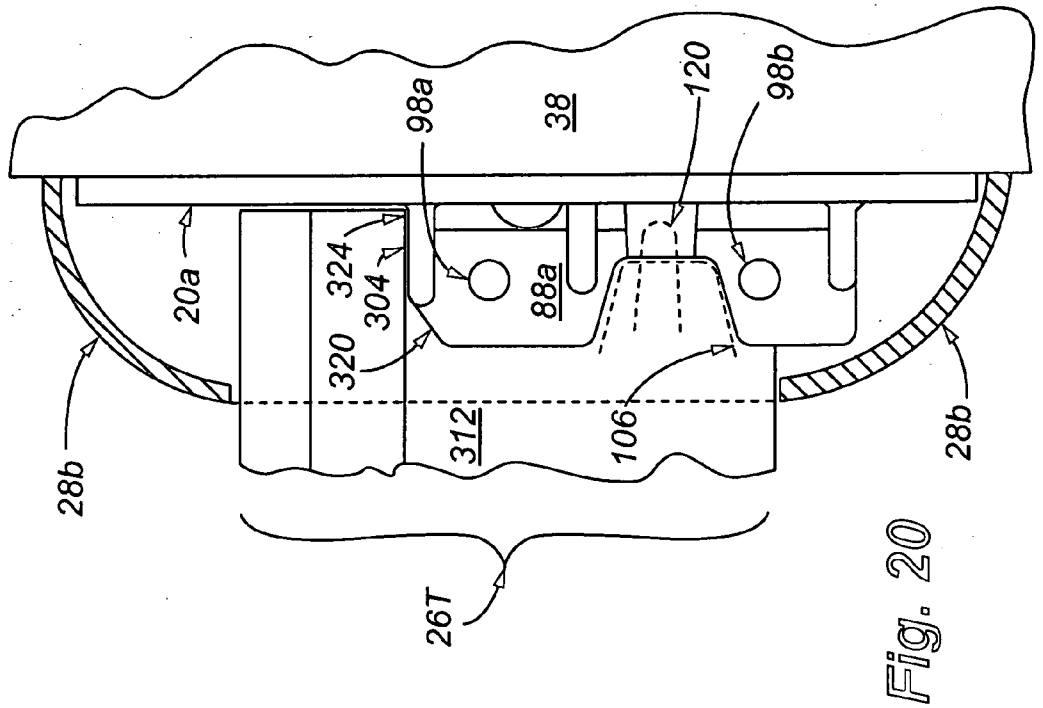
28c

Fig. 21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28b
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Fig. 20

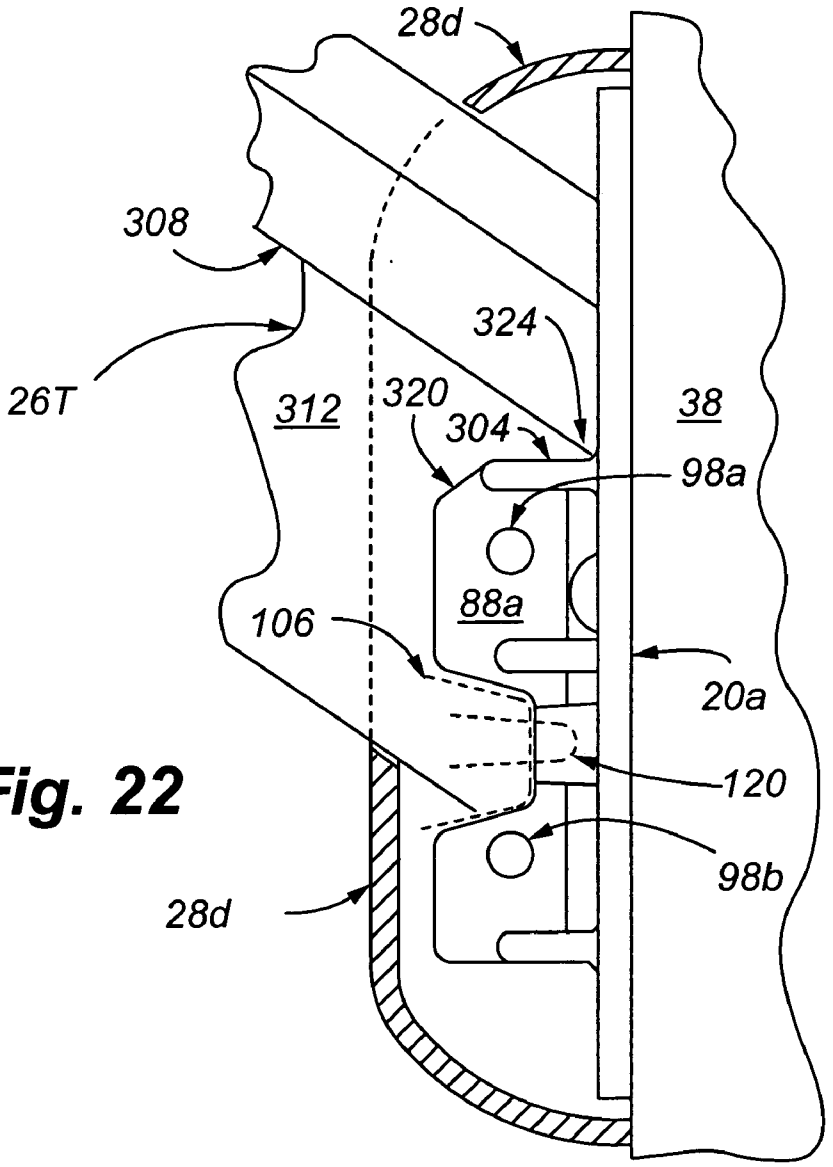

Fig. 22

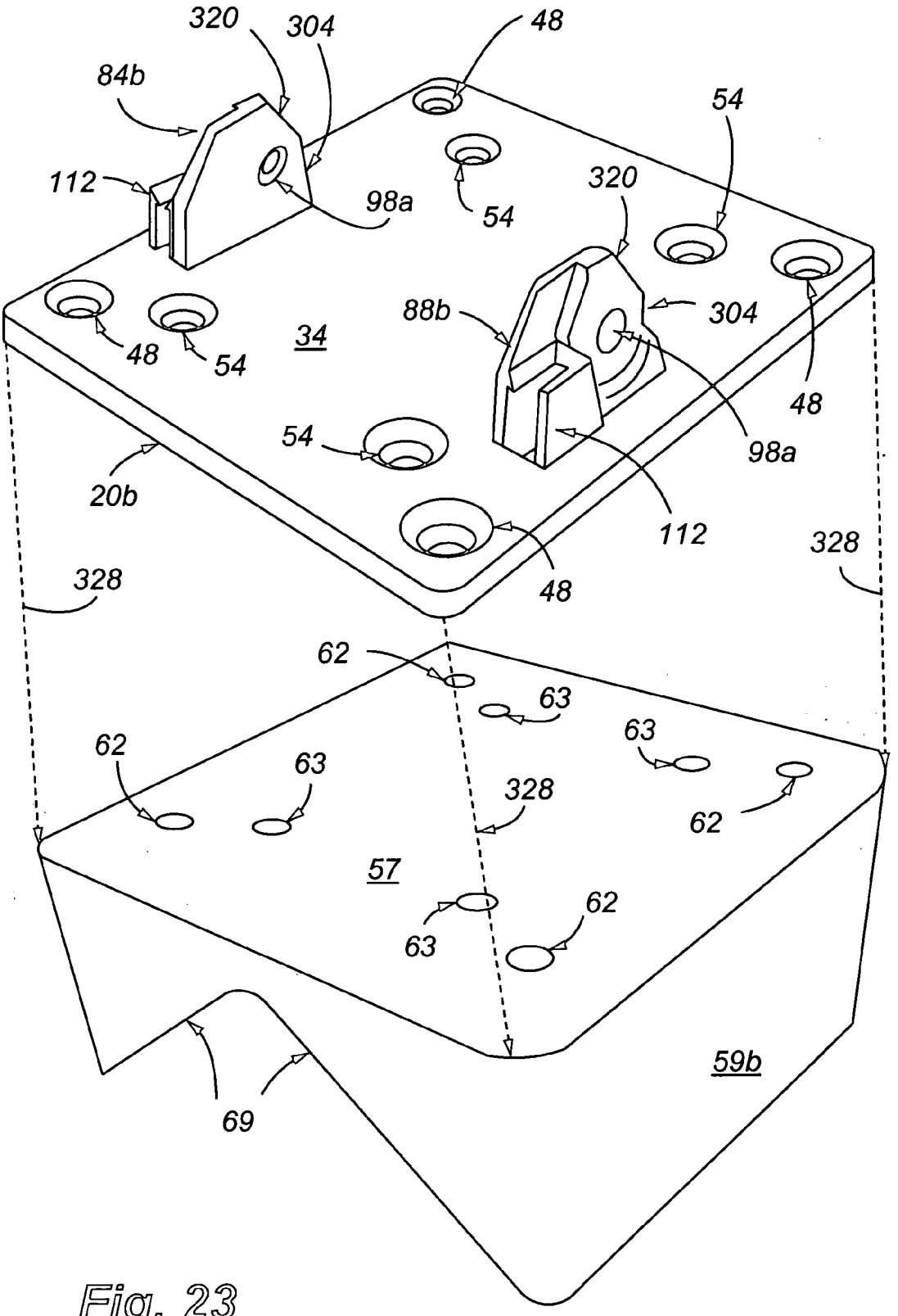
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Fig. 23

RAIL MOUNTING APPARATUS AND METHOD

RELATED FIELD OF THE INVENTION

[0001] The present invention relates to fence rail mounting apparatus and method, and in particular, to rail mounting bracket that is capable of withstanding substantial fence loadings without failure, and that allows rails to be mounted at various angles to the bracket.

BACKGROUND

[0002] Synthetic fences and railings having at least their exteriors made of vinyl, PVC, plastic or other synthetic materials (e.g., materials that can be molded in an injection mold, extruded or pultruded) are used as cost effective replacements for wood and/or metal fences and railings in numerous circumstances. Such synthetic fences and railings can be easier to install, and are substantially maintenance free. Such synthetic fences and railings are typically assembled from post and railing components, each such component made of a synthetic material(s) which typically can be, e.g., a molded, extruded or pultruded. Such synthetic post and railing components typically have a rigid exterior and a hollow interior for receiving various reinforcing components made of, e.g., plastic, wood, or metal, or in some cases reinforced with concrete. Once the composite posts and rails are assembled/constructed, they are secured together to obtain a synthetic fence or railing.

[0003] Numerous techniques have been developed for assembling such synthetic fences and railing, and in particular, for securing a composite rail to a post or other support structure (e.g., the side of a building). Most such techniques require a mounting bracket for attaching a synthetic railing to a post (more generally, to a "support structure"), the bracket is first secured to its support structure, and then a synthetic rail end is secured to the bracket. However, various esthetic and structural difficulties have not been heretofore adequately addressed for securing such a synthetic rail and a bracket together. For example, securing a synthetic rail end with the bracket can require manually maintaining the rail in position or alignment while securely fastening the bracket to the post. Additionally, since the synthetic rail may have to be secured to the bracket at an angle other than perpendicular to a vertical support structure upon which the bracket is mounted (e.g., when providing railings for stairs between vertically positioned posts) such manual alignment of the rail is made even more difficult.

[0004] Another difficulty in assembling synthetic fences and railings results from the perception that such synthetic fences and railings will not withstand the side impacts (or various other loadings) as effectively as their counterpart wood or metal fences or railings. Accordingly, various building regulations have been put in place requiring such synthetic fences and railing to withstand very high impacts and loads from various directions. In many instances, the failure point of such synthetic fences and railings has been at the railing mounting bracket and/or the attachment of the railing thereto. For example, the railing may detach from the bracket and/or the bracket may deform.

[0005] Additionally, since the bracket, and its various support structure and railing fasteners (e.g., screws, clips, etc.), are metal, it is very desirable esthetically to hide such hardware when the synthetic fence or railing is fully assembled. Although covering plates for hiding such hardware are available, such covering plates may not easily attachable to their brackets, and once attached cannot be detached without damaging at least the covering plate.

[0006] Accordingly, it is desirable to have a synthetic rail mounting bracket that addresses and substantially alleviates the above-described difficulties with heretofore available synthetic rail mounting brackets.

Description of Terms

[0007] Moldable materials: Materials that can be molded according to molding techniques such as compression, transfer, and injection molding, extrusion, and pultrusion.

[0008] Synthetic fencing, posts, rails and components thereof: These terms, respectively, refer to fencing, posts, rails and components thereof that provide at least some of the following attributes: (a) such components are manufactured from a synthetic or a non-naturally occurring material such as vinyl, PVC, plastic or another polymer based compound(s), or composite including such a synthetic material, (b) such components are manufactured using a molding technique such as injection molding, extrusion, and pultrusion, wherein a flowable material is shaped into a rigid fencing components, generally having a hollow interior, and (c) such components are assembled/constructed into fence posts and rails by combining such components together with reinforcing structural materials such as metal, wood, and concrete, wherein such reinforcing structural materials are provided in a hollow interior the components.

SUMMARY OF THE INVENTION

[0009] A rail mounting system is disclosed for mounting a rail (e.g., a stair, walkway, or fence railing) to a support structure, and a method for performing and using the same is also disclosed. The rail mounting system includes a novel bracket that serves as an intermediary apparatus between, e.g., a fence or banister rail, and a support structure. Thus, a rail may attach to the bracket after the bracket has been attached to a support structure (such a support structure may be, e.g., the side of a building, a post, a column, a beam, a wall or other rigid members to which a rail can be fixedly attached). The bracket is particularly useful in that once the bracket is secured to a support structure, a rail (more precisely, a rail end) may be easily placed on the bracket for supporting the rail in a desired position, wherein the rail can be subsequently firmly secured to the bracket. In particular, a rail end may be aligned on the bracket by placing the rail end within a rail holding portion of the bracket that includes side supports, and may include a support for the bottom edge of the rail. Thus, the rail can be positioned in the rail holding portion wherein it is supported on the bracket in a properly aligned position until the rail can be firmly secured to the bracket.

[0010] Moreover, the rail may be attached to the bracket in any one of a plurality of orientations, e.g., for a vertical support structure surface having the bracket thereon, the rail may extend substantially horizontally, extend downwardly (e.g., the corresponding acute angle between vertical and the rail being approximately 60 degrees or less), or extend upwardly (e.g., the corresponding acute angle between vertical and the rail also being approximately 60 degrees or less). To readily provide such variation in rail orientations, the bracket may include a plurality of rail supports for supporting the rail at at least two different angular orientations. Thus, when the rail is oriented substantially perpen-

dicular to a planar face of the bracket, a first of the rail supports may be used, and when the rail is angled either downwardly or upwardly from the bracket face by, e.g., a deviation from a perpendicular to the face of the bracket by an angle greater than approximately a 30 degrees, a second rail support may be used.

[0011] The rail mounting system may also include a bracket cover for covering the bracket and the end of a rail attached thereto. The bracket cover provides an esthetically pleasing exterior that hides the bracket, the rail end and the (any) fasteners used to secure the bracket and the rail end together.

[0012] The rail mounting system may further include a bracket attachment component, wherein this component can be secured in place between the bracket and the support structure. Thus, such a bracket attachment allows a bracket having a fixed contour for its surface facing a support structure to be attached to a support surface having a different surface contour. In particular, the contour of a first side of the bracket attachment (facing the back side of the bracket) mates with the bracket, and a second side of the bracket attachment (facing the surface of the support structure) conforms to the contour of the support structure surface.

[0013] Further description of advantages, benefits and patentable aspects of the present invention will become evident from the accompanying drawings and description hereinbelow. All novel aspects of the invention, whether mentioned explicitly in this Summary section or not, are considered subject matter for patent protection either singly or in combination with other aspects of the invention. Accordingly, such novel aspects of the present invention disclosed hereinbelow and/or in the drawings that may be omitted from, or less than fully described in, this Summary section are fully incorporated herein by reference into this Summary. In particular, all claims of the Claims section hereinbelow are fully incorporated herein by reference into this Summary section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** shows a perspective view of one embodiment of the rail mounting system **18**, and in particular, shows an embodiment of a bracket **20** to which the rail **26** is to be secured.

[0015] **FIG. 2** shows the embodiment of the rail mounting system **18** of **FIG. 1**, wherein the bracket **20** is secured to a support structure **38** and a rail **26** is secured to the bracket.

[0016] **FIG. 3** shows a face-on view of the bracket **20** together with various embodiments of fasteners **52** for attaching the bracket to a support structure and/or attaching a rail to the bracket **20**.

[0017] **FIG. 4** shows a side view of the bracket **20** together with a dashed profile of the end of a rail **26**, wherein the rail is supported on the bracket at an angle (e.g., 45°) to the front face **34** of the bracket.

[0018] **FIG. 5** is a perspective view showing the components of both the bracket and the bracket cover **28** that mate together for securing the bracket cover over both the bracket and the rail end joined to the bracket.

[0019] **FIG. 6** shows a more detailed view of the cover lock **112** of the bracket **20**.

[0020] **FIG. 7** shows a top view of the cover lock **112**.

[0021] **FIG. 8** shows the internal structure of an embodiment of the bracket cover **28**.

[0022] **FIG. 9** shows an exterior view of an embodiment of the bracket cover (**28***a*), wherein the bracket cover can be used for covering the bracket **20** when a rail **26** attaches to the bracket at an angle substantially different from orthogonal to the front face of the bracket.

[0023] **FIG. 10** shows a side view of the bracket cover **28***a* in place for covering the bracket **20** and the end of a rail **26** which is attached to the bracket so that the rail extends upwardly away from the bracket.

[0024] **FIG. 11** shows a perspective view of an embodiment of a bracket attachment **59** which serves as an intermediary component between embodiments of the bracket, and a support structure **38**. In particular, such a bracket attachment **59** (and variations thereof) allow a bracket having a fixed contour of its surface for facing a support structure (e.g., back face **36**, **FIGS. 1 and 4**) to be attached to a support surface having a different surface contour (e.g., including a corner).

[0025] **FIG. 12** shows an internal structure of the bracket attachment **59** shown in **FIG. 11**.

[0026] **FIG. 13** shows an alternative embodiment of the bracket attachment **59**, wherein the raised portion **61***a* assists an installer in properly mounting a bracket thereto.

[0027] **FIG. 14** shows another embodiment of a bracket attachment **59** for attaching to a curved support structure **38**.

[0028] **FIG. 15** shows another embodiment of a bracket attachment **59**, wherein the raised bracket alignment portions **61** are positioned across the width of the bracket attachment rather than lengthwise as shown in **FIGS. 13 and 14**. Additionally, this figure illustrates that bracket attachments can be fitted to a support structure surface so that a rail **26** extending therefrom at substantially any angle by adjusting the bracket attachment profile **69**.

[0029] **FIG. 16** shows a face-on view of a guardrail assembly **204** constructed using the rail mounting system **18** for securing the rails **26***a* and **26***b* to the posts **208**.

[0030] **FIG. 17** shows a guardrail assembly **204** specimen undergoing horizontal load testing to determine, in particular, the performance of the brackets **20**.

[0031] **FIG. 18** shows a guardrail assembly **204** specimen undergoing inclined load testing to determine, in particular, the performance of the brackets **20**.

[0032] **FIG. 19** shows another embodiment for the bracket (**20***a*) of the rail mounting system **18** together with a "T" shaped rail **26**T for attaching to the bracket **20***a*.

[0033] **FIGS. 20 through 22** show side views of the bracket **20***a* with a rail **26**T supported thereon at various angular orientations. Additionally, these figures show the cross sections of various embodiments of bracket covers **28***b*-**28***d* attached to the bracket **20***a*.

[0034] **FIG. 23** shows another embodiment of both the bracket (**20***b*), and a corresponding bracket attachment (**59***b*).

DETAILED DESCRIPTION

[0035] **FIG. 1** shows an embodiment of the rail mounting system **18**. The rail mounting system **18** includes a bracket **20** for mounting an end **24** of a rail **26** thereto (e.g., a synthetic rail, or alternatively, a wood, or metal rail). The rail **26** may be, e.g., up to ten feet in length (**FIG. 1** does not show such a length of the rail **26** according to scale), and may have cross sectional dimensions of, e.g., less than eight inches by eight inches. The bracket **20** is correspondingly dimensioned to appropriately mate with the rail end **24**. Additionally, the rail mounting system **18** includes a bracket cover **28** (e.g., **FIGS. 1 and 8**) for covering the bracket **20** once the rail end **24** is secured to the bracket **20** (as shown in **FIG. 2**). The bracket cover **28** may be manufactured from a moldable material(s) such as, e.g., vinyl, PVC, plastic, and the like. The bracket cover **28** includes a central channel **30** extending through the thickness **31** of the bracket cover, wherein a front end opening **29** of the central channel (furthest from the rail end **24**) tightly, but slidably, follows the outer shape of the rail **26**, and when traversing through the thickness **31** toward the rail end **24**, the bracket covering expands outwardly about the rail **26** until the opposite or attachment end **32** of the bracket cover is of sufficient size to entirely enclose the bracket **20** and any fasteners required to secure: (a) the bracket and rail end together, and (b) the bracket to a support structure (e.g., support structure **38**, **FIG. 2**). In particular, the bracket cover **28** can be slid on the rail **26** toward the joined bracket **20** and rail end **24** for attaching to the bracket (as is described hereinbelow). Thus, when the bracket cover **28** is secured to the bracket **20**, the bracket cover entirely covers the joined bracket and rail end **24**, such as the joined bracket and rail end of **FIG. 2**.

[0036] Referring now to the bracket **20**, the bracket includes a plate **33** having a front face **34** and an opposing back face **36** (occluded in **FIG. 1**). These faces have dimensions that are, e.g., one to three centimeters larger, in both their length and width, than the cross section of the rail end **24** for joining to the bracket **20**. In at least some embodiments, the bracket is a die-cast #3 zinc part having thickness **40** (**FIG. 1**) in a range of 0.25 cm to 0.7 cm. However, in other embodiments, the bracket **20** may be manufactured from a zinc alloy, stainless steel, a high strength plastic (e.g., polyvinyl chloride (PVC), thermoplastics; polyurethane, polyethylene (and/or high density variations thereof), polypropylene, nylon, polycarbonate, butyrate, PETG, propionate, ABS plastic, polystyrene, styrene (e.g., ASA and similar variations thereof), a polyacetal resin such as Delrin), high strength resins (e.g., epoxy resins), aluminum (or an alloy thereof). When the bracket **20** is secured to a support structure **38** (**FIG. 2**), e.g., a post or the side of a building, it is preferred that the back face **36** entirely contact the support structure. Ignoring for the moment the dashed lines **44** of **FIG. 1**, since a typical support structure **38** will likely have a vertical planar surface, the back face **36** may be substantially flat or planar with the exception of the holes and extrusions that indent toward the front face **32** and/or pierce the thickness **40** of the bracket **20**. However, the back face **36** may be curved, as illustrated by the dashed lines **44**, so that the back face follows a surface contour of a non-planar support structure **38** upon which the back face seats (e.g., the support structure may be a column or cylindrical post).

[0037] The bracket **20** includes a number holes therethrough for securing the bracket to a support structure **38**. Referring to **FIG. 3**, there are three attachment holes **48** along each bracket side **50** for providing fasteners **52** (e.g., screws **52***a*, threaded bolts **52***b*, rivets **52***c*, expandable shaft fasteners **52***d*, nails (not shown), and the like) therein to attach the bracket **20** to the support structure **38**. Additionally, there are two inner columns of holes, each having three holes **54** for securing the bracket **20** to the support structure **38** with fasteners **52**. Note that the holes **54** are tapered so that the heads of fasteners **52** secured in these holes can be substantially flush with the front face **34**. As will become evident from the description hereinbelow, the reduction (or complete exclusion) of any protrusion of such fastener heads out from the front face **34** is desirable in that the end **24** of a rail **26** covers an area of the front face containing the holes **56**, and preferably abuts against this area.

[0038] The bracket **20** also has two large holes **56** vertically oriented relative to one another. These holes **56** provide a reduction in the bracket material needed to manufacture the bracket **20**. Additionally, the holes **56** may be helpful to a person mounting a rail **26** to a bracket **20**. In particular, for a synthetic rail **26**, such as the rail shown in **FIG. 1**, the person mounting the rail may wish to fit the bracket **20** onto a rail end **24** prior to the bracket being attached to the support structure **38**, e.g., so that he/she can view where various fasteners **52** (screws, etc.) will contact rail interior reinforcements (e.g., reinforcements **58**, **FIG. 1**). Moreover, such holes **56** may be used for aligning the bracket **20** on a support structure **38**. For example, a bracket attachment **59** is shown in **FIG. 11**, wherein this attachment is positioned on a corner of a support structure **38**. The bracket **20** can be aligned onto the front surface **57** of the bracket attachment **59** by inserting the cylindrical raised portions **61** into the holes **56** of the bracket. Accordingly, once the bracket **20** is positioned on the bracket attachment **59**, the bracket and the bracket attachment **59** can be secured to the support structure **38** by appropriate fasteners **52** (e.g., **52***a*, **52***b*, **52***c*, or **52***d*) that extend through the holes **48** and **54** of the bracket, and respectively through the holes **62** and **63** of the bracket attachment. Note that the holes **62** and/or the holes **63** may be asymmetrically offset from an axis **65** of points equally spaced from each of the raised portions **61**. In a similar manner, the holes **48** and **54** may be correspondingly asymmetrically offset from an axis (not shown) of points on the bracket front face **34** that are equally spaced from each of the holes **56**. Such asymmetric alignment of holes can assist in securing the bracket **20** with the bracket attachment **59** since the corresponding holes in the bracket and the bracket attachment will only align when the bracket is in a desired orientation to the bracket attachment. Thus, by requiring a person to position the bracket **20** correctly on the bracket attachment **59**, he/she is more likely align the bracket **20** as shown in **FIG. 1** (instead of upside down). **FIG. 12** shows the side of the bracket attachment **59** that faces the support structure **38**. Note that each of the holes **62** and **63** are provided within reinforced tubes **67** that extend from the front surface **57** to the surface of the support structure **38**.

[0039] In the embodiment of the bracket attachment shown in **FIG. 13**, the lower cylindrical raised portion **61** has been replaced by a triangular raised portion **61***a*. When this embodiment is used with an embodiment of the bracket **20** having correspondingly shaped holes **56** (e.g., the lower hole **56** being triangularly shaped rather than circular), there can be only one way to align the bracket **20** on the bracket attachment **59** (e.g., the triangular raised portion may have a side that extends beyond the perimeter of the upper

cylindrical portion **61**). Moreover, for the person installing the bracket **20** and the attachment bracket **59**, the triangular raised portion **61***a* can assist the person with orienting the bracket attachment properly on the support structure **38** in that the raised portion **61***a* appears to point to the end of the bracket attachment that should be the uppermost.

[**0040**] **FIG. 14** shows another embodiment of the bracket attachment **59**, wherein this embodiment is used as an intermediary component between a support structure **38** having a curved surface and the bracket **20**.

[**0041**] **FIG. 15** shows yet another embodiment of the bracket attachment **59**, wherein this embodiment is for securing the bracket **20** to a corner of a support structure **38** such that the front surface **57** is tilted approximately 22 degrees from one of two adjacent support structure sides (not shown) that meet at a support structure corner (also not shown), wherein a contour of these adjacent sides and their mutual corner mates with the contour **69**. Note that in this embodiment, the raised portions **61** are aligned across the width of the bracket attachment **59** instead being aligned across the length of the bracket attachments (as in the previous embodiments). Moreover, instead of mating with the holes **56** of the bracket **20**, the raised portions **61** here mate with the holes **54** that are nearest to the center of the front face **34** (**FIG. 3**). Note that raised portions **61** here are also offset so that the remaining bracket holes **48** and **54** only align with the holes **62** and **63** when the bracket **20** is properly positioned on this bracket attachment **59**.

[**0042**] Returning now to the description of the bracket **20**, **FIGS. 1-7** show various protrusions extending outwardly from the front face **32** of the bracket **20**. Upper pair of rail supports **60** (**FIGS. 1 and 4**) are provided as such protrusions upon which the bottom side **64** of a rail end **24** rests when it is mounted on the bracket **20** so that the rail **26** extends outwardly from the bracket in a direction approximately perpendicular to the front face **32** (e.g., the rail extends at an angle within a range of +30 degrees of being perpendicular to the front face). In one embodiment, each of the upper rail supports **60** extends approximately one centimeter from the front face **32** for supporting on its upper surface **66** a rail end **24**. Each of the upper rail supports **60** may have a corresponding opening **68** adjacent to it (and above it in the operable position of **FIG. 1**). Only a lower portion of the thickness **72** (**FIG. 4**) of each upper rail support **60** attaches to the bracket **20** with a remaining upper portion of the thickness occluding the corresponding opening **68** through the front face **32**. The reduced amount of bracket material attaching each upper rail support **60** to the remainder of the bracket **20** is sufficient for supporting a rail **26** while it is being further secured to the bracket. However, this reduced amount of bracket material also allows the upper rail supports to be easily broken off or detached from the remainder of the bracket **20** with pliers or other gripping tool.

[**0043**] The upper rail supports **60** can be broken off in the event that the lower rail support **76** is to be used in supporting the rail end **24**, at least during the process of firmly securing the rail end **24** and the bracket **20** together. The lower rail support **76** may extend outwardly from the front face approximately 0.5 centimeters. The lower rail support **76** is used for supporting a rail end **24** when the rail **26** is pitched at an angle of more than, e.g., 30 degrees from being perpendicular to the front face **32**. **FIG. 4** shows a dashed outline of a side view of a rail end **24** supported by the lower rail support **76** (it is assumed that the upper rail supports **66** were previously broken off). Note that the lower rail support **76** can also be used for supporting a rail end **24** cut for fitting flush with the front face **32**, wherein the rail **26** extends upwardly from the bracket instead of downwardly as shown in **FIG. 4**. In fact as shown in **FIG. 10**, the outline of the rail end **24** shown in **FIG. 4** need only be flipped bottom to top so that the upper most portion of the rail outline is positioned on top surface **80** of the lower rail support **76**.

[**0044**] Additionally projecting outwardly from the front face **32** is a pair of rail side supports **84** and **88** (**FIGS. 1-6**). In the embodiment of **FIG. 1**, each of the rail side supports **84** and **88** are mirror images of one another, and each extends perpendicularly from the front face **32** approximately two centimeters (at their furthest points). Additionally, each of the rail side supports **84** and **88** has a thickness **90** of approximately 0.4 centimeters. However, such dimensions are illustrative since alternatives to such dimensions are possible. Each rail side support has an inner surface **92** (**FIG. 3**), and an outer surface **94** on the opposite side to the inner surface. The inner surfaces **92** face one another. The rail side supports **84** and **88** are substantially parallel to one another and are spaced apart by a distance that is substantially the width "w" (**FIG. 1**) of the rail end **24** so that when the rail end **24** is positioned between the rail side supports, the rail end simultaneously (and slidably) contacts both inner surfaces **92**. Thus, when a rail end **24** is positioned on the bracket **20** (e.g., one of the upper or lower rail supports), the rail end is prevented from shifting or moving laterally by the rail side supports **84** and **88**. Accordingly, the rail end **24** can be maintained in a desired alignment with the bracket **20** during the process of securing the rail end to the bracket. In particular, there are rail securing holes **98***a* and **98***b* on each of the rail side supports **84** and **88** (**FIG. 1**) for receiving rail fasteners **96** (e.g., screws, expandable shaft fasteners, threaded bolts or the like, such as the fasteners **52** of **FIG. 3**) used for securing the rail end **24** (and the reinforcements **58** therein) to the bracket **20** as shown in **FIG. 2**. Note that if a threaded bolt is used mating nuts may be fastened to the end of the bolt in the interior of the rail **26**, or if the bolt extends from a first hole of one of the hole pairs **98***a* or **98***b* through the other or second hole of the pair, then the nut can be attached to the portion of the bolt extending from second hole. Additionally, note that once the rail end **24** is secured to the rail side supports **84** and **88**, these side supports (with their fasteners **96**) provide the primary attachments that secure the bracket and the rail **26** together.

[**0045**] Each of the rail side supports **84** and **88** further includes a central recessed portion **100** (**FIG. 2**) of reduced height from the front face **32**. This recessed portion of each rail side support is beneficial in securing a fastener **52** (e.g., a screw, threaded bolt, rivet, or the like) in the middle hole **48** adjacent to the side support's the recessed portion **100**. In particular, the recessed portion **100** allows a person securing the bracket **20** to a support structure **38** to more easily tighten a fastener **52** in this adjacent hole **48** using any appropriate tool (screw driver, bolt tighter, rivet gun, hammer, etc.). Moreover, each middle hole **48** has, on the outer surface **94** adjacent thereto, a cylindrical recess **104** that provides greater clearance for tightening (or untightening) a fastener **52** in such a middle hole.

[0046] Furthermore, the recessed portion **100** is useful in combination with the alignment tabs **106** (**FIGS. 5 and 8**) of the bracket cover **28** for aligning the bracket cover on the bracket **20** so that bracket cover is properly secured thereto as is described hereinbelow. In particular, when the bracket cover **28** is properly positioned for covering the bracket **20**, each of the alignment tabs **106** fits within one of the recessed portions **100**.

[0047] Additionally, each of the rail side supports **84** and **88** is reinforced on its outer surface **94** by reinforcements **108** for further strengthening the rail side supports from deforming when an attached rail **26** sustains a lateral impact.

[0048] Adjacent to each end of each of the rail side supports **84** and **88** is a cover lock **112** (e.g., **FIGS. 1, 5** and **6**) for attaching the bracket cover **28** (e.g., **FIGS. 1 and 5**) over both the bracket **20** and the rail end **24** mounted thereto. As described above, the front end of the bracket cover **28** includes a front end opening **29** that follows the outer shape of the rail **26** so that once the rail end **24** is securely attached to the bracket **20** (as in **FIG. 2**), the bracket cover then can be slid on the rail toward the joined bracket and rail end. The embodiment of the bracket cover **28** shown in **FIGS. 5 and 8** includes four cover locking projections **120** for inserting into the four cover locks **112**, one such projection **120** per cover lock. Each of the cover locks **112** may be identical. Accordingly, only one such cover lock **112** is provided with detailed labeling in the figures (e.g., **FIGS. 6 and 7**). Each cover lock **112** includes an outer wall **124** connected to the adjacent outer surface **94** by a connecting wall **128** (**FIGS. 1 and 7**). An interior **132** (**FIGS. 6 and 7**) is provided that is bounded by the two walls **124**, **128**, and a portion of the outer surface **94**. The interior surface **136** (**FIG. 7**) of the outer wall **124** and the opposing portion of the outer surface **94** each include a barb **140** that is angled toward the front face **32** (**FIG. 6**). The edges **144** (**FIG. 7**) of the barbs **140** are spaced apart a slightly smaller distance than the thickness **148** (**FIG. 5**) of the corresponding projection **120** so that for securing the bracket cover **28** to the bracket **20**, the corresponding projection enters the interior **132** by forcing the barbs **144** further apart. Accordingly, when an attempt is made to remove the bracket cover **28**, the barb edges **144** are biased to bite into the bracket cover material of the projections **120** thereby resisting removal of the bracket cover from the bracket **20**. In at least some embodiments, for a rail **26** having a cross sectional size of less than, e.g., 400 sq. cm, a force of approximately between five and twenty-five pounds is required to disengage the projections **120** from their corresponding cover locks **112**. Note that in one embodiment, the cover lock insertion end of each projection **120** can be roughened on the sides that contact the edges **144**, and/or each projection **120** may have a greater thickness **148** than the thickness of the projection closer to its attachment to the rest of the bracket cover **28**. Thus, when such an enhanced surface roughness and/or enhanced thickness **148** enters the interior **132**, the bond between the projection **120** and its corresponding cover lock **112** can be substantially strengthened.

[0049] Moreover, there are various ways to permanently attach the bracket cover **28** to the bracket **20** such as by providing glue on the projections **120** prior to inserting them into their corresponding cover locks **112**. Alternatively and/or optionally, an oppositely oriented barb may also be provided on the cover lock insertion end of each projection **120** so that each such projection barb couples or mates with one of the barbs **140**. In such permanently attached bracket cover **28** embodiments, the bracket cover may only be removed by rendering the bracket cover incapable of being reattached to a bracket **20**.

[0050] In **FIGS. 4 and 10**, the bracket **20** is shown in use with a rail **26** that is sufficiently angled relative to the plane of the front face **34** (as, e.g., may be required for stair railings) so that the lower rail support **76** supports the rail end **24**. In such circumstances, the embodiment of the bracket cover **28** shown in **FIGS. 1 and 8** is unlikely to fit onto the bracket **20**. Accordingly, an alternative embodiment of the bracket cover (labeled **28***a*) is shown in **FIGS. 9 and 10**, wherein this alternative embodiment can be used to effectively to attach to a bracket **20** as described hereinabove, and also cover the bracket **20** and the rail end **24** when the rail **26** is angled more than, e.g., 30 degrees from being perpendicular to the front face **34** of the bracket. The cover bracket **28***a* may be substantially identical to a cover bracket **28** with the exception that:

[0051] (a) the end **152** (**FIGS. 9 and 10**) of the bracket cover **28***a* has a cutout **154** to accommodate the more acute angle between the rail **26**, and the front face **34**; and

[0052] (b) in order to provide a close fit between the rail **26** and the edge **156** of the front end opening **29**, the edge **156** is shifted toward the end **152**, and the slope of the surface **160** (**FIG. 10**) of the material of the bracket cover **28***a* (adjacent to the edge **156**) is angled at least 60 degrees from the front face **34**.

[0053] It is important to note that the cover bracket **28***a* can be used both for a rail **26** that extends downwardly from the bracket **20** (e.g., **FIG. 4**), and for a rail **26** that extends upwardly from the bracket (e.g., **FIG. 10**). Thus, to use the bracket cover **28***a* for a downwardly extending rail **26**, the bracket cover is flipped so that the cutout **154** is above the rail rather than below it.

[0054] Utilization of the bracket **20** and its corresponding bracket cover **28** (**28***a*) has been generally described above. However, for further clarity, the rail mounting system **18** may be used according to the following steps:

[0055] Step 1: Orient and secure a first bracket **20** to a first support structure **38** by placing fasteners **52** within the holes **48** and causing the fasteners to enter or otherwise attach to the first support structure **38**. Alternatively, the bracket **20** may be secured to the first support structure **38** by gluing, welding, banding, or securing the bracket **20** onto projections (not shown) extending from the first support structure **38**, wherein such projections enter at least one of the holes **48**, and/or one of the large holes **56** (e.g., such projections may have a threaded central bore into which a threaded bolt **52***b* may be secured to hold the bracket **20** on the first support structure **38**). Note, as a substep, if a bracket attachment **59** is to be used, the bracket attachment and the bracket **20** are mated together in the proper orientation and jointly attached to the support structure **38**. However, in some embodiments of the bracket attachment **59**, there may be holes in addition to the holes **62** and **63** that align with corresponding holes of the bracket **20**, wherein such additional holes may be used to first secure the bracket attachment to a support structure so that subsequently the bracket **20** can be aligned on the bracket attachment and attached to both the bracket attachment and the support structure as described hereinabove. Additionally, note that

embodiments of posts (or other support structures) may be manufactured with features corresponding to the bracket attachments being integral with each such post. Accordingly, such posts (or other support structures) may reduce the amount of measuring an installer must perform since the positions for attaching the brackets **20** is predetermined on the posts.

[**0056**] Step 2: For a second support structure **38** that is secured in a stationary position the distance of a desired rail length away from the first support structure, orient and secure a second bracket **20** to the second support structure **38** by placing fasteners **52** within the holes **48** and causing the fasteners to enter or otherwise attach to the first support structure **38**. Note that the various substeps and embodiments described in Step 1 also apply here as well. In typical embodiments, the first and second brackets will be at the same vertical offset from an end of their corresponding support structures. However, in alternative embodiments, the first and second brackets **20** may be vertically offset different amounts on their corresponding support structures so that when the rail **26** is provided therebetween, the rail extends from a relatively high position on one of the support structures to a relatively low position on the other support structure.

[**0057**] Step 3: If either of end of the desired rail is to form a vertical angle that is, e.g., greater than or equal to approximately 30 degrees from an orthogonal alignment with a front face **34** of the corresponding one of the first and second brackets for supporting the rail end, then detach the rail supports **60** from this corresponding bracket using pliers or another gripping tool.

[**0058**] Step 4: Obtain the desired rail **26** of the desired rail length and having rail ends **24** that are of a desired angle so that each of the rail ends can be supported on a corresponding one of the first and second brackets **20**. If necessary, such a rail **26** may be obtained by cutting a rail that is too long and/or by cutting one or both rail ends **24** at an angle that is appropriate for mounting the cut rail on the first and second brackets.

[**0059**] Step 5: Slide two bracket covers **28** onto the rail **26** obtained from Step 3, wherein the bracket covers are oriented so that their front end openings **29** face on another on the rail **26**. If the rail **26** is to be oriented at an angle less than approximately 30 degrees from the front face **34** of one of the first and second brackets, then the corresponding one of the bracket covers for covering this bracket may be substantially functionally similar to the bracket cover **28** shown, e.g., in **FIGS. 1 and 8**. Alternatively, if the rail **26** is to be oriented at an angle greater than approximately 30 degrees from the front face **34** of one of the first and second brackets (as in **FIGS. 4 and 10**), then the corresponding one of the bracket covers for covering this bracket may be substantially functionally similar to the bracket cover **28***a* shown, e.g., in **FIG. 9**.

[**0060**] Step 6: Place each of the rail ends **24** between the rail side supports **84** and **88** of a corresponding one of the first and second brackets **20** to which the rail end is to be secured, wherein the rail end is supported on the rail supports **60**, if they are still attached, and the lower rail supports otherwise.

[**0061**] Step 7: With the rail **26** supported on the first and second brackets, secure the rail **26** to each of the first and second brackets using, e.g., fasteners **52** as described hereinabove.

[**0062**] Step 8: Subsequently, slide the two bracket covers **28** (**28***a*) away from one another and toward a corresponding one of the first and second brackets **20**. Attach each bracket cover **28** (**28***a*) to its corresponding (nearest) bracket **20** by mating each of the alignment tabs **106** and the cover locking projections **120**, respectively, with a corresponding recessed portion **100** and cover lock **112** as described hereinabove.

Load Tests of the Rail Mounting System **18**

Tests were conducted to determine the structural performance of guardrail assemblies **204** (**FIGS. 16-18**) having the rail mounting system **18** for connecting upper and lower rails **26** (denoted **26***a* and **26***b*, respectively) to posts **208**. The tests were performed using 2 inch by **3½ inch die-cast** #3 zinc brackets **20** substantially as shown in **FIGS. 1-3**, wherein the plate **33** (**FIG. 1**) had a thickness **40** of approximately 0.160". Each bracket **20** was attached to their corresponding posts **208** and rails using screws **52***a* as shown in **FIG. 3**. More specifically, each bracket **20** was attached to: (a) a support post **208** with six (6) #10×1-½" Phillips panhead wood screws, and (b) attached to one of the rails **26***a* and **26***b* with four (4) #12×1" Phillips panhead wood screws. All screw locations for attachment to the support(s) and rail(s) were pre-drilled. The posts were common 4×4 treated Southern Pine with PVC covers. The rails **26***a* and **26***b* were synthetic rails as described in the Description of Terms above having a length of 10 feet. In particular, each of the rails **26***a* and **26***b* included a hollow PVC extruded exterior frame having an aluminum reinforced interior, e.g., as shown in **FIG. 1**. Each of the guardrail assemblies **204** incorporated a midspan support leg **210** located beneath and supporting the bottom rail **26***b*.

[**0063**] Each of the guardrail assemblies **208** also included a plurality of vertical pickets **212** attached between each of the rails **26***a* and **26***b*. Each of the pickets **212** was a synthetic fencing component having a PVC extruded exterior frame with a hollow interior in which an aluminum reinforcing component (not shown) was provided. Each of the pickets **212** was attached to each of the rails **26***a* and **26***b* via insertion of the aluminum reinforcing component within each picket into connector holes (not shown) providing access to the interior of each of the rails **26***a* and **26***b*.

[**0064**] The brackets **20** were evaluated using the load requirements identified in the following building codes:

[**0065**] (a) IBC-2000/ICC—International Code Council, published by International Code Council, 900 Montclair Road, Birmingham, Ala. 35213-1206 USA; URL: www.iccsafe.org;

[**0066**] (b) BOCA-1999—Building Officials and Code Administrators (Reference ASCE 7-95) published by Published by Building Officials and Code Administrators International, Inc. 4051 West Flossmoor Road, Country Club Hills, Ill. 60478-5795;

[**0067**] (c) SBC-1999/SBCCI—Southern Building Code Conference International published by International Code Council 900 Montclair Road, Birmingham, Ala. 35213-1206 USA; URL: www.iccsafe.org.

In particular, the brackets **20** were tested for determining whether they satisfied the load requirements for guardrails as specified by the above identified building codes.

[**0068**] Rail assembly **204** specimens were tested in a self-contained rigid steel test frame **220** (**FIGS. 17 and 18**) designed to anchor one of the rail assemblies **204** during the application of test loads to be applied. An electric winch (not shown) mounted to the rigid steel test frame was used to induce loads on the rail assemblies for determining, e.g., maximum deflection, load at rail assembly failure, and/or extent of permanent bending. Chains, cables, nylon lifting straps, and load distribution beams **224** were used to impose the test loads on each specimen of the rail assemblies **204**. Each applied load was measured using an electronic load cell located in-line between the specimen and the electric winch. Deflections are measured to the nearest 0.01" using electronic linear transducers (not shown).

[**0069**] Each rail assembly **204** was tested by securing its posts **208** into the rigid steel test frame. The rigid test frame **220** rigidly restrained the posts **208** from deflecting. The linear transducers were mounted to an independent reference frame to record movement of reference points on various components of the specimen being tested (e.g., end points and mid-point of the rails **26***a* and **26***b*) to determine net component deflections. Uniform distributed loads with simple end supports were simulated with ¼-point loading (i.e., a load distributed evenly over two or four locations equally spaced across the horizontal length of the specimen). Uniform distributed loading conditions with interior support (e.g., **FIG. 18**), as per SBC top rail loading requirements, were simulated by distributing a load across four equal load points.

Test Procedure:

[**0070**] Each rail assembly **208** specimen was preloaded up to a level not exceeding design load (e.g., the load which the rail assembly is designed to withstand). After pre-loading, all load was released and any necessary fixture adjustments were made. An initial load, not exceeding 20% of design load, was applied and initial deflections recorded. Loads were then applied at a steady uniform rate in step loading increments. Each load increment was reached in approximately one minute and deflections were recorded. The load/deflection procedure continued until reaching 2.0 times design load. At 2.0 times the design load, the load was released. After allowing a minimum period of one minute for stabilization, load is reapplied to the initial load used at the start of the load/deflection procedure and deflections were again recorded and used to analyze recovery. For tests that require ultimate loads greater than 2.0 times design load, loading is reapplied and increased at a steady uniform rate until failure occurred or the required ultimate load is reached. The testing time was continually recorded from the application of initial test load until the maximum test load is reached.

[**0071**] The tables hereinbelow are representative of results from the test procedure.

[**0072**] Tables 1 through 3 are the test results from a test of a first specimen of the rail assemblies **204**, wherein a uniform horizontal design load on the top rail **26***a* of the specimen was approximately 50 pounds per linear foot (lpf) of the top rail **26***a*. The tests performed simulated various uniform horizontal loads both above and below the design load. Each simulation applied equal loads at two or four points equally distributed across the rail **26***a* of the specimen as shown in **FIGS. 17 and 18**.

[**0073**] For the first table (TABLE 1) following, the columns can be described as follows:

[**0074**] Load Level: The multiplicative factor indicative of the relative amount of the design load to which the specimen was subjected (e.g., a load level of 0.2 represents a load that is 20% of the design load).

[**0075**] Test Load: The actual load (in pounds) to which the specimen was subjected.

[**0076**] Test Data Top Rail Deflection (Inches)

[**0077**] End-1: Identification of one of the ends of the top rail **26***a*. Each number of this column is a measurement (in inches) of the deflection of the rail **26***a* end represented by End-1 when the load in the same row was applied to the specimen.

[**0078**] Mid: Each number of this column is a measurement of the deflections of the rail **26***a* midway between the posts **208**.

[**0079**] End-2 Identification of the end of the top rail **26***a* opposite from End-1.

[**0080**] Net This is an abbreviation for "Net Deflection". Each "Net" value was computed as follows: average the deflection values for the "End-1" and "End-2" columns in the same row as the Net entry to be computed, then subtract the "Mid" value for the same row from this average.

[**0081**] Deflection Analysis

[**0082**] y=mx The values in this column are obtained from a linear regression of the values in the "Deflection" column. Thus, for a linear equation of the form y=mx, "x" can be interpreted as the test load applied to a specimen of the rail assemblies **204**, and "y" can be interpreted as the corresponding deflection of the specimen.

[**0083**] Deflection The maximum displacement from initial configuration of a specimen of the rail assemblies **204**.

TABLE 1

IBC and BOCA Design Load: 50 plf Uniform Load on Top Rail[2]

Load	Test Load	Test Data Top Rail Deflection (inches)				Deflection Analysis	
Level[1]	(lbs)	End-1	Mid	End-2	Net	y = mx	Deflection
0.0	0	—	—	—	—	0.00	0.00
0.2	105	0.000	0.000	0.000	0.00	0.50	0.51
0.4	203	0.069	0.536	0.068	0.47	0.97	0.98
0.6	301	0.141	1.031	0.128	0.90	1.44	1.41
0.8	400	0.225	1.605	0.204	1.39	1.91	1.90
1.0	507	0.308	2.229	0.287	1.93	2.43	2.44
1.2	605	0.388	2.784	0.367	2.41	2.89	2.92
1.4	701	0.464	3.365	0.447	2.91	3.35	3.42
1.6	805	0.550	4.017	0.527	3.48	3.85	3.99
1.8	903	0.640	4.717	0.610	4.09	4.32	4.61
2.0	1001	0.726	5.446	0.698	4.73	4.79	5.25
0.2	107	0.068	0.645	0.045	0.59	88% Recovery	
2.5	1267	Maximum Test Load - Sustained without failure.					

[0084] For the second table (TABLE 2) following, the columns can be described as follows:

[0085] Load Level: Same as for TABLE 1.

[0086] Test Load: Same as for TABLE 1.

[0087] Test Data Top Rail Deflection (inches)

[0088] Post: Each number of this column is a measurement of the deflections of the post **208** at the rail **26***a* end identified as End-1.

[0089] Rail: Each number of this column is a measurement of the displacement of the rail **26***a* end identified as End-1. Note, this column is identical to the End-1 column of TABLE 1.

[0090] Net: Each number of this column is a measurement of the net displacement of the rail **26***a* relative to the post **208** to which the rail end End-1 is attached. Note that the net displacement is determined by subtracting the corresponding rail deflection value (in the same row) from the post deflection value (in the same row).

[0091] Displacement Analysis

[0092] y=mx Same as for Table 1 above.

[0093] Displacement Same as for Table 1 above.

TABLE 2

IBC and BOCA Design Load: 50 plf Uniform Load on Top Rail[2]

Load	Test Load	Test Data Displacement (inches) At Rail End-1			Displacement Analysis	
Level[1]	(lbs)	Post	Rail	Net[3]	y = mx	Displacement
0.0	0	—	—	—	0.00	0.00
0.2	105	0.000	0.000	0.000	0.03	0.04
0.4	203	0.043	0.069	0.026	0.07	0.06
0.6	301	0.082	0.141	0.059	0.10	0.10
0.8	400	0.129	0.225	0.096	0.13	0.13
1.0	507	0.175	0.308	0.133	0.17	0.17
1.2	605	0.211	0.388	0.177	0.20	0.21
1.4	701	0.249	0.464	0.215	0.23	0.25
1.6	805	0.290	0.550	0.260	0.26	0.30
1.8	903	0.329	0.640	0.311	0.29	0.35
2.0	1001	0.366	0.726	0.360	0.33	0.40
0.2	107	0.033	0.068	0.035	90% Recovery	
2.5	1267	Maximum Test Load - Sustained without failure.				

[0094] For the third table (TABLE 3) following, the columns can be described as follows:

[0095] Load Level: Same as for TABLE 1.

[0096] Test Load: Same as for TABLE 1.

[0097] Test Data Top Rail Deflection (inches)

[0098] Post: Each number of this column is a measurement of the deflections of the post **208** at the rail **26***a* end identified as End-2.

[0099] Rail: Each number of this column is a measurement of the deflections of the rail **26***a* end identified as End-2. Note, this column is identical to the End-2 column of TABLE 1.

[0100] Net: Same as for TABLE 2 above.

[0101] Displacement Analysis

[0102] y=mx Same as for TABLE 1 above.

[0103] Displacement Same as for TABLE 1 above.

TABLE 3

IBC and BOCA Design Load: 50 plf Uniform Load on Top Rail[2]

Load	Test Load	Test Data Displacement (inches) At Rail End-2			Displacement Analysis	
Level[1]	(lbs)	Post	Rail	Net[3]	y = mx	Displacement
0.0	0	—	—	—	0.00	0.00
0.2	105	0.000	0.000	0.000	0.03	0.03
0.4	203	0.034	0.068	0.034	0.07	0.07
0.6	301	0.065	0.128	0.063	0.10	0.10
0.8	400	0.108	0.204	0.096	0.13	0.13
1.0	507	0.154	0.287	0.133	0.16	0.17
1.2	605	0.189	0.367	0.178	0.20	0.21
1.4	701	0.236	0.447	0.211	0.23	0.24
1.6	805	0.268	0.527	0.259	0.26	0.29
1.8	903	0.305	0.610	0.305	0.29	0.34
2.0	1001	0.336	0.698	0.362	0.32	0.40
0.2	107	0.009	0.045	0.036	90% Recovery	
2.5	1267	Maximum Test Load - Sustained without failure.				

[0104] Tables 4 through 6 are the test results from a test of a second specimen of the rail assemblies **204**, wherein a uniform downward sloping design load on the top rail **26***a* of the specimen was approximately 112 pounds per linear foot (plf) of the rail **26***a* at approximately a 63.4 degree downward direction from horizontal as shown in **FIG. 18**. The tests performed simulated various uniform downward sloping loads both above and below the design load. Each simulation applied equal loads at four points equally distributed across the rail **26***a*. Note that the columns for each of the tables 4 through 6 have the same interpretations as described above for Tables 1 through 3.

TABLE 4

SBC Design Load: (50 Horizontal + 100 Vertical) plf Uniform Load[1] on Top Rail

Load	Test Load	Test Data Top Rail Deflection (inches)				Deflection Analysis	
Level[2]	(lbs)	End-1	Mid	End-2	Net	y = mx	Deflection
0.0	0	—	—	—	—	0.00	0.00
0.2	226	0.000	0.000	0.000	0.00	0.38	0.44
0.4	453	0.046	0.348	0.049	0.30	0.76	0.74
0.6	678	0.097	0.728	0.101	0.63	1.14	1.07
0.8	903	0.162	1.205	0.167	1.04	1.51	1.48
1.0	1126	0.246	1.758	0.235	1.52	1.89	1.96
1.2	1345	0.342	2.424	0.315	2.10	2.26	2.53
1.4	1583	0.408	2.876	0.373	2.49	2.66	2.92
1.6	1815	0.499	3.534	0.457	3.06	3.04	3.49
1.8	2016	0.547	3.959	0.504	3.43	3.38	3.87
2.0	2250	0.610	4.518	0.564	3.93	3.77	4.37
0.2	228	0.061	0.535	0.053	0.48	88% Recovery	

[0105]

TABLE 5

SBC Design Load: (50 Horizontal + 100 Vertical) plf Uniform Load[1] on Top Rail

Load	Test Load	Test Data Displacement (inches) At Rail End-1			Displacement Analysis	
Level[2]	(lbs)	Post	Rail	Net[3]	y = mx	Displacement
0.0	0	—	—	—	0.00	0.00
0.2	226	0.000	0.000	0.000	0.02	0.02
0.4	453	0.028	0.046	0.018	0.04	0.04
0.6	678	0.058	0.097	0.039	0.06	0.06
0.8	903	0.098	0.162	0.064	0.09	0.08
1.0	1126	0.149	0.246	0.097	0.11	0.12
1.2	1345	0.202	0.342	0.140	0.13	0.16
1.4	1583	0.236	0.408	0.172	0.15	0.19
1.6	1815	0.271	0.499	0.228	0.17	0.25
1.8	2016	0.294	0.547	0.253	0.19	0.27
2.0	2250	0.320	0.610	0.290	0.21	0.31
0.2	228	0.030	0.061	0.031	89% Recovery	

[0106]

TABLE 6

SBC Design Load: (50 Horizontal + 100 Vertical) plf Uniform Load[1] on Top Rail

Load	Test Load	Test Data Displacement (inches) At Rail End-2			Displacement Analysis	
Level[2]	(lbs)	Post	Rail	Net[3]	y = mx	Displacement
0.0	0	—	—	—	0.00	0.00
0.2	226	0.000	0.000	0.000	0.02	0.02
0.4	453	0.028	0.049	0.021	0.05	0.04
0.6	678	0.057	0.101	0.044	0.07	0.07
0.8	903	0.094	0.167	0.073	0.10	0.10
1.0	1126	0.125	0.235	0.110	0.12	0.13
1.2	1345	0.163	0.315	0.152	0.14	0.17
1.4	1583	0.188	0.373	0.185	0.17	0.21
1.6	1815	0.230	0.457	0.227	0.19	0.25
1.8	2016	0.245	0.504	0.259	0.22	0.28
2.0	2250	0.275	0.564	0.289	0.24	0.31
0.2	228	0.029	0.053	0.024	92% Recovery	

[0107] Satisfactory performance for the above tests is specified in the above-identified building codes. In particular, the performance requirements in these building codes are satisfied when there is a 75% recovery from a load of 2.0 times the design load in both the horizontal and downward sloping application of a uniform top rail load, and additionally, for the horizontal uniform load simulation, an ultimate load of not less than 2.5 times the design load can be sustained without the specimen failing. From the above Tables 1-6 it is apparent that the rail mounting system **18** meets these performance requirements.

ADDITIONAL EMBODIMENTS

[0108] **FIGS. 19 through 22** show an embodiment of the bracket **20***a*. Additionally, **FIGS. 20 through 22** show cross sections of three alternative bracket covers **28***b*, **28***c* and **28***d* attached to the bracket **20***a* (wherein the cross sectioning plane is normal to the front face **34** of the bracket **20***a*, and includes the axis **300** in **FIG. 1**).

[0109] The bracket **20***a* has many features that are substantially the same as those of bracket **20**. Accordingly, such substantially identical features are labeled with the same numerical labels used hereinabove for features of bracket **20**, and such features will not be further described in the context of bracket **20***a*.

[0110] The bracket **20***a* is designed to be used with a rail **26** whose cross sectional profile is generally in the shape of a "T". One such "T" rail **26** is shown in **FIGS. 19 through 22**, this rail being labeled **26**T. The bracket **20***a* includes side supports **84***a* and **88***a* of reduced length, wherein each of the side supports has a shelf **304** at its upper end. The shelves **304** function as a support for the rail **26**T in a similar manner to the function of the upper pair of rail supports **60** in the bracket **20**. That is, the rail **26**T can be placed on the pair of shelves **304** for supporting the rail in position until the rail can be secured to the bracket **20***a* with fasteners **52** as described hereinabove. In particular as shown in **FIG. 20**, the overhangs **308** contact the shelves **304** for supporting the rail until rail fasteners **96** (e.g., as shown in **FIG. 2**) can be provided in the holes **98***b* and through both: (a) the sides **312** of the rail **26**T, and (b) the reinforcement(s) **58** (for simplicity, not shown in **FIG. 19**) provided in the interior **316** (**FIG. 19**) of the rail. Accordingly, the bracket **20***a* does not need the upper rail supports **60** shown in **FIG. 1**.

[0111] For rails **26**T that extend at a downward incline from the bracket **20***a* (as shown in **FIG. 21**), each of the side supports **84***a* and **88***a* also include an inclined support **320** for supporting the rail on its overhangs **308**. Thus, the bracket **20***a* does not need the lower rail support **76** shown in **FIG. 1**. Note, however, that for rails **26**T extending upwardly from the bracket **20***a*, the overhangs **308** contact the shelves **304** for initial support (as shown in **FIG. 22**), and in particular, the end edge of the each of the overhangs **308** may seat into a corresponding one of the corners **324** formed between the front face **34** and one of the shelves **308**.

[0112] The bracket covers **28***b*, **28***c*, and **28***d* shown **FIGS. 20 through 22**, attach to the bracket **20***a* as described above for bracket cover **28** and bracket **20**. However, due to the reduced length of the side supports **84***a* and **88***a*, each such side support has a single adjacent cover lock **112**.

[0113] Note that since various embodiments of the bracket **20***a* can have the same hole patterns for the holes **48**, **54** and **56** as shown in **FIGS. 1 and 3** for bracket **20**, the bracket attachments **59** described hereinabove can be used to attach the bracket **20***a* to a support structure **38**.

[0114] **FIG. 23** shows another embodiment of the bracket (**20***b*) together with an embodiment of a bracket attachment **59***b* for mating with the bracket **20***b*. The bracket **20***b* can be used in a substantially similar manner to the bracket **20***a* for attaching a railing thereto. However, bracket **20***b* is particularly useful for "T" rails having sides **312** (**FIG. 19**) of reduced height, wherein it may be difficult or impossible to secure two spaced apart fasters **52** in each of the rail sides **312** via the rail securing holes **98***a* and **98***b* of **FIG. 19-21**.

[0115] As shown in **FIG. 23**, the bracket **20***b* can be aligned onto the front surface **57** of the bracket attachment **59***b* by aligning the holes **62** with the holes **48** of the bracket, and aligning the holes **63** with the holes **54** of the bracket so that fasteners **52** can be placed through the aligned holes for securing the bracket and bracket attachment to a support structure. In at least one embodiment, note that these corresponding holes in the bracket **20***b* and bracket attachment **59***b* will not completely align with one another unless the

bracket **20***b* and the bracket attachment **59***b* are placed together as indicated by the dashed arrows **328**; i.e., if the bracket is rotated 90° (keeping the front face **34** in the plane) the holes in the bracket and the bracket attachment will not align. In other embodiments, the bracket **20***b* and the bracket attachment **59***b* can mate together via, e.g., additional holes in the bracket and mating raised portions on the front surface **57** of the bracket attachment as, for example, are shown in **FIGS. 11 and 13-15**.

[**0116**] Several of the above-described methods, techniques, and/or components may have additional alternative embodiments. For example, the cover locks **112** may be provided within the bracket cover channel **30**, and the mating locking projections **120** may be provided as part of the bracket **20**. Additionally, various types of resilient locking tabs or protrusions and mating catches may be provided (e.g., such as the protrusions 36 and passages 32 of U.S. Pat. No. 6,460,829, filed Jan. 15, 1999 and fully incorporated herein by reference) as a replacement for the cover locks **112** and projections **120**.

[**0117**] Further embodiments of the rail mounting system **18** can be provided by utilizing various alternative methods, techniques and/or components (e.g., components that are substantially functionally equivalent to the components described herein) such as:

[**0118**] (a) alternative fasteners **52** (e.g., clips providing corresponding functionality, shafts having a locking lever, or the locking pin of disclosed in U.S. Patent Application 20040261243, filed Apr. 5, 2994, fully incorporated herein by reference);

[**0119**] (b) alternative types of rails **26** (e.g., non-synthetic rails, metal or wood rails, and/or non-hollow rails);

[**0120**] (c) alternative techniques for mounting a bracket cover **28** (or **28***a-d*) to a bracket **20** (or **20***b*) such as a snap on bracket cover as shown in FIGS. 3, 3A, and 3B of U.S. Pat. No. 5,873,671, filed Feb. 19, 1997 and fully incorporated herein by reference, or the disclosure of U.S. Patent Application 20040261243;

[**0121**] (d) alternative rail **26** orientations relative to the bracket **20**, e.g., embodiments of the bracket **20** wherein the side supports **84** and **88** are parallel to one another, but each are at an angle such as 45° to the front face **34** thereby allowing a rail **26** to fitted between the side supports when the rail approaches the front face **34** from a non-orthogonal angle such as 45°; and/or

[**0122**] (e) alternative support structures **38** (e.g., composite posts of various composition, and walls of various composition, such as concrete, wood, metal, stone, brick, etc.).

[**0123**] Additionally, the alternative fence constructing techniques described in the following list of references that are fully incorporated herein by reference:

[**0124**] U.S. Patent Application having publication number US 2003/0030048 filed Jun. 6, 2002;

[**0125**] U.S. Patent Application having publication number US 2003/0101673 filed Jun. 5, 2003;

[**0126**] U.S. Pat. No. 6,682,056 filed Oct. 30, 2000;

[**0127**] U.S. Pat. No. 6,460,829 filed Jan. 15, 1999;

[**0128**] U.S. Pat. No. 6,314,699 filed Jan. 15, 1999;

[**0129**] U.S. Pat. No. 6,202,987 filed Nov. 8, 1999;

[**0130**] U.S. Pat. No. 6,041,486 filed Jan. 28, 1999;

[**0131**] U.S. Pat. No. 5,988,599 filed Feb. 19, 1997;

[**0132**] U.S. Pat. No. 5,873,671 filed Feb. 19, 1997;

[**0133**] U.S. Pat. No. 5,853,167 filed Feb. 19, 1997;

[**0134**] The foregoing discussion of the invention has been presented for purposes of illustration and description. Further, the description is not intended to limit the invention to the form disclosed herein. Consequently, variation and modification commensurate with the above teachings, within the skill and knowledge of the relevant art, are within the scope of the present invention. The embodiment described hereinabove is further intended to explain the best mode presently known of practicing the invention and to enable others skilled in the art to utilize the invention as such, or in other embodiments, and with the various modifications required by their particular application or uses of the invention.

What is claimed is:

1. A rail support for supporting at least a portion of a rail on a support structure, comprising:

front and back faces, wherein the back face fixedly faces the support structure so that at least a portion of the rail weight is transferred to the support structure;

first and second rail side supports extending from said front face, wherein the first and second rail side supports are spaced apart a distance for providing at least a portion of an exterior end of the rail therebetween, and for restricting horizontal movement of the end of the rail;

first and second lower supports extending from said front face, wherein the first lower support is spaced vertically above the second lower support when the back face fixedly faces the support structure;

wherein the first lower support is effective for supporting the exterior end of the rail when the rail is in a substantially horizontal orientation, and the second lower support is effective for supporting the exterior end of the rail when the rail is angled from horizontal by more than approximately 30 degrees.

2. A method for supporting at least a portion of a rail on a support structure, comprising:

attaching a bracket having front and back faces to the support structure, wherein the back face fixedly seats against the support structure so that at least a portion of the rail weight is transferred to the support structure;

positioning an end of the rail between first and second rail side supports extending from said front face, wherein the first and second rail side supports are spaced apart a distance for providing an exterior of the end of the rail therebetween, and for restricting horizontal movement of the end of the rail;

supporting the end of the rail on one of first and second lower supports extending from said front face, wherein the first lower support is spaced vertically above the second lower support when the back face is fixedly seated against the support structure;

wherein the first lower support is used for supporting the exterior end of the rail when the rail is in a substantially horizontal orientation, and the second lower support is used for supporting the exterior end of the rail when the rail is angled from horizontal by more than approximately 30 degrees.

3. A support bracket for supporting at least a portion of a rail on a support structure, comprising:

front and back faces, wherein the back face fixedly seats against the support structure so that at least a portion of the rail weight is transferred to the support structure;

first and second rail side supports extending from said front face, wherein the first and second rail side supports are spaced apart a distance for providing an exterior end of the rail therebetween, and for restricting horizontal movement of the end of the rail;

first and second lower supports extending from said front face, wherein the first lower support is spaced vertically above the second lower support when the back face is fixedly seated against the support structure;

wherein the first lower support is effective for supporting the exterior end of the rail when the rail is in a first orientation, and the second lower support is effective for supporting the exterior end of the rail when the rail is in a second orientation; and

wherein the first lower support is supported on a remainder of the bracket along a predetermined edge so that the first lower support is separable from the remainder of the bracket along the predetermined edge.

4. A method for supporting at least a portion of a rail on a support structure, comprising:

attaching a bracket having front and back faces to the support structure, wherein the back face fixedly seats against the support structure so that at least a portion of the rail weight is transferred to the support structure;

positioning an end of the rail between first and second rail side supports extending from said front face, wherein the first and second rail side supports are spaced apart a distance for providing an exterior of the end of the rail therebetween, and for restricting horizontal movement of the end of the rail;

supporting the end of the rail on one of first and second lower supports extending from said front face, wherein the first lower support is spaced vertically above the second lower support when the back face is fixedly seated against the support structure; and

separating the first lower support from a remainder of the bracket when the second lower support is used to support the end of the rail.

5. A rail support for supporting at least a portion of a rail on a support structure, comprising:

front and back faces, wherein the back face fixedly seats against the support structure so that at least a portion of the rail weight is transferred to the support structure;

first and second rail side supports extending from said front face, wherein the first and second rail side supports are spaced apart thereby providing a recess for receiving an exterior of an end of the rail;

wherein each of the first and second rail side supports has: (a) a rail contacting side that contacts the end of the rail in the recess for restricting horizontal movement of the rail, and (b) a side facing away from the end of the rail;

at least one lower support extending from said front face, wherein the at least one lower support supports the end of the rail;

for each rail side support of the first and second rail side supports, there are one or more guide slots exterior to the recess and adjacent to the rail side support;

a cover having an opening for receiving the rail therein, said cover extending about the opening an effective amount for covering the front face, said cover including a plurality of guides wherein each guide enters a corresponding one of the guide slots when the cover attaches over the front face;

wherein for at least one of the guide slots and a corresponding one of the guides, the one guide frictionally engages the at least one guide slot, and wherein the cover is removable from the remainder of the rail support with a force in the range of five to twenty pounds.

6. A method for supporting at least a portion of a rail on a support structure, comprising:

attaching a bracket having front and back faces to the support structure, wherein the back face fixedly seats against the support structure so that at least a portion of the rail weight is transferred to the support structure;

positioning an end of the rail between first and second rail side supports extending from said front face, wherein the first and second rail side supports are spaced apart thereby providing a recess for receiving an exterior of an end of the rail;

wherein each of the first and second rail side supports has: (a) a rail contacting side that contacts the end of the rail in the recess for restricting horizontal movement of the rail, and (b) a side facing away from the end of the rail;

wherein for each rail side support of the first and second rail side supports, there is at one or more guide slots exterior to the recess and adjacent to the rail side support;

supporting the end of the rail on at least one lower support extending from said front face;

attaching a cover over the front face, the cover having an opening for receiving the rail therein, said cover including a plurality of guides, and wherein each guide enters a corresponding one of the guide slots when the cover attached over the front face;

wherein for at least one guide slot and a corresponding one of the guides, the one guide frictionally engages the one guide slot, and wherein the cover is removable from the remainder of the rail support with a force in the range of five to twenty pounds.

* * * * *